INTERNATIONAL ENERGY AGENCY - SOLAR HEATING AND COOLING PROGRAMME

TASK 41 – Solar Energy and Architecture

SUBTASK C – COMMUNICATION GUIDELINE

'The Communication Process'

2012

IEA SHC TASK 41 SOLAR ENERGY AND ARCHITECTURE

REPORT T.41.C.1:

COMMUNICATION GUIDELINE

EDITORS: ROLF HAGEN & OLAF BRUUN JØRGENSEN

JULY 2012

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Communication is the basis of every successful design.

Solar energy technologies are well established in today's market, and are considered mature and reliable technologies with a comparatively low associated risk. These technologies have a number of inherent qualities, such as reduced risk from increasing energy costs, increased independence and a positive long-term cost-benefit ratio. However, the successful design and realization of Solar Architecture relies upon the effective communication of these qualities in the development of a project.

This Communication Guideline is intended to provide recommendations and arguments to assist design professionals in the communication of solar energy strategies, and to realize high quality, well designed solar architecture.

The first section of this guideline focuses on strategies to convince clients to request and commission solar buildings. This includes recommendations for identifying client goals and motivations, and important integration considerations for common project types.

Section two addresses communication strategies at the design and construction team level. Techniques for anchoring solar energy strategies within the project team and communication with manufacturers are addressed, as well as a separate discussion of communication strategies within a design-build process.

Section three discusses tools for communication and design development, and includes national references to design guidelines for solar energy and architecture within the participating countries.

The Communication Guideline is deliverable T.41.C.1 of Task 41 : Solar Energy and Architecture, within the Solar Heating and Cooling programme (SHC) of the International Energy Agency (IEA).

CONTRIBUTORS TO THE REPORT (IN ALPHABETICAL ORDER)

Miguel Pires Amado (contributor)
FCT/UNL
Campus da Caparica
PT-2829-516 Caparica
PORTUGAL
ma@fct.unl.pt

Rachel Dix (contributor/ layout)
Context AS
Villaveien 16A
N-3660 Rjukan
NORWAY
rachel@context.as

Doris Ehrbar (author)
Lucerne University of Applied Sciences and Arts - Engineering and Architecture
CC Typology & Planning in Architecture
Technikumstrasse 21
CH-6048 Horw
SWITZERLAND
doris.ehrbar@hslu.ch

Francesco Frontini (author)
University of Applied Sciences and Arts of Southern Switzerland (SUPSI)
Institute for Applied Sustainability to the Built Environment (ISAAC) Campus Trevano CH - 6952 Canobbio
SWITZERLAND
francesco.frontini@supsi.ch

Susanne Gosztonyi (author)
AIT Austrian Institute of Technology
Energy Department
Giefinggasse 2
1210 Vienna
AUSTRIA
susanne.gosztonyi@ait.ac.at

Caroline Hachem (author)
Building, Civil and Environmental Engineering,
Concordia University
1455 boul de Maisonneuve Ouest
Montréal, QC
CANADA
carolinehachem@gmail.com

Rolf Hagen (editor/ author)
Context AS
Villaveien 16A
N-3660 Rjukan
NORWAY
rolf@context.as

Merete Hoff (author)
DARK Arkitekter AS
Drammensveien 130
N-0277 Oslo
NORWAY
mho@dark.no

Miljana Horvat (author)
Dept. of Architectural Science
Ryerson University
350 Victoria St., Toronto,
CANADA
mhorvat@ryerson.ca

Olaf Bruun Jørgensen (editor/ author)
Esbensen Rådgivende Ingeniører A/S
Gammel Køge Landevej 22
2500 Valby
DENMARK
obj@esbensen.dk

Jouri Kanters (author)
Energy and Building Design,
Department of Architecture and Built Environment
Lund University
P.O. Box 118
SE-221 00 Lund
SWEDEN
jouri.kanters@ebd.lth.se

Karin Kappel (contributor)
Solar City Copenhagen
Arkitekternes Hus
Strandgade 27A
DK-1401 København K
DENMARK
kk@solarcity.dk

Margarethe Korolkow (author)
IBUS – Institut für Bau-, Umwelt- und Solarforschung GmbH
Alt-Tempelhof 18
12099 Berlin
GERMANY
margarethe.korolkow@ibus-berlin.de

Andreas Lechner (author)
Institut für Gebäudelehre
Technische Universität Graz
Lessingstraβe 25/IV
8010 Graz
AUSTRIA
andreas.lechner@TUGraz.at

Gabriele Lobaccaro (contributor)
Politecnico di Milano
Dipartimento BEST
Via Ponzi 31
I-20133 Milano
ITALY
gabriele.lobaccaro@mail.polimi.it

Marja Lundgren (author)
White Arkitekter
P.O. Box 4700
Östgötagatan 100
SE-116 92 Stockholm
SWEDEN
marja.lundgren@white.se

Laura Maturi (author)
EURAC research, Institute for Renewable Energy
Universitá degli Studi di Trento
Viale Druso 1, I-39100 Bolzano, ITALY
laura.maturi@eurac.edu

Maria Cristina Munari Probst (author)
EPFL-LESO
Bâtiment LE
Station 18
CH-1015 Lausanne
SWITZERLAND
mariacristina.munariprobst@epfl.ch

Christian Roecker (author)
EPFL-LESO
Bâtiment LE
Station 18
CH-1015 Lausanne
SWITZERLAND
christian.roecker@epfl.ch

Mark Snow (author)
Faculty of the Built Environment
University of New South Wales
NSW 2052 Sydney
AUSTRALIA
m.snow@unsw.edu.au

Maria Wall (operating agent)
Energy and Building Design
Lund University
P.O. Box 118, SE-221 00 Lund
SWEDEN
maria.wall@ebd.lth.se

ACKNOWLEDGEMENTS

The authors of this report thank their respective funding agencies for supporting their work:

- ENOVA SF, Ministry of Petroleum and Energy, Norway
- Danish Energy Agency
- Swedish Energy Agency
- ARQ, body of the two foundations established by White arkitekter, Sweden
- Arkus - Foundation for Research and Development in Architecture and the Built Environment, Sweden
- NRCan – Natural Resources Canada: CanmetENERGY/Sustainable Buildings and Communities Group, Ottawa, Canada
- Ryerson University, Faculty of Engineering, Architecture and Science, Toronto, Canada
- Swiss Federal Office of Energy (SFOE)
- Lucerne University of Applied Sciences and Arts - Engineering & Architecture, Switzerland
- SUPSI-ISAAC, Swiss BIPV competence centre
- Bundesministerium für Wirtschaft und Technologie, Projektträger Jülich, Germany
- Department of Innovation, Industry, Science and Research (DIISR), Australian Government
- Stiftung Südtiroler Sparkasse (Fondazione Cassa di Risparmio di Bolzano), Italy
- European Academy of Bozen/ Bolzano (EURAC), Italy
- Universitá degli Studi di Trento, Italy
- Bundesministerium für Verkehr, Innovation und Technologie, Austria

Table of contents

01 Introduction: Solar Energy, Architecture and Communication

Future energy systems must be based upon renewable sources. Climate neutrality and energy security will be increasingly important considerations in the coming decades. Solar energy systems are ideally suited to address these requirements – they are flexible, climate positive, energy independent, suitable for almost every project and based on a limitless energy source. Solar energy systems are also becoming more and more cost-efficient through continuing technological development.

However, solar energy systems today are not automatically included in many projects, and are still largely seen as a complex and unnecessary solution. The communication of the qualities of solar energy systems is vital in order to develop solar energy systems into a widespread and commonplace solution – a natural choice for all projects.

Client awareness, communication and organization

What does it take to convince a client to use solar energy in architecture? Different values from client to client mean that facts and arguments concerning solar architecture need to be adapted to the specific state of mind of the recipient. Understanding the psychological aspects that motivate the particular client or investor is very important when first communicating the use of solar energy. Issues like immediate and long term profits, timescale, profiling, consciousness, value and security must be addressed. Does your client have a conservative or an idealistic focus, a global view or a local one, an individual or a collective mindset? Communication on solar energy in architecture must be based on a mutual understanding of primary goals and values. It is also important to be well informed and prepared to answer both open and unstated questions like the following:

- **Functional:** Why is solar energy better than or complementary to any other choice of energy source?
- **Economy:** Is solar energy the most profitable short or long term solution?
- **Aesthetics:** How will it affect the visual appearance of the building?
- **Global energy focus:** What is the total lifetime output compared to the energy investment?
- **Security:** Will the technology last or quickly be outdated? What about life expectancy of the system?
- **Timescale:** Do you have the necessary knowledge and know products that are ready for use now?
- **Use:** What will the energy production be used for in the building?

Research is necessary in order to understand how the use of solar energy could support the client companies' policies and values. Is the client a visionary pioneer, a market leader, a conservative developer or a combination of these? Arguments must be tailored to suit the motives and values of the client.

Knowledge and information: One of the main reasons for not considering solar energy in projects today is the lack of client confidence in the field. This is based on a lack of knowledge, experience and accessible information about benefits, risks and system characteristics, and is a major reason why many investors decide not to specify the use of solar energy as a goal in their projects.

It is natural to unconsciously avoid topics in which the consequences are unclear. One cannot expect a client to be aware of all the perspectives related to the use of solar energy in a building when envisioning a new development, especially since the specific issues vary from case to case. Clients will often find it easier to skip what they perceive as a complex issue, rather than investigate it along with all of the other major challenges that are encountered early in a project.

It is therefore vital to ensure that all stakeholders in the project organization have access to up-to-date information, such as high quality examples, cost benefit data and information about available products, robustness and architectural integration. Easily accessible information can counter obsolete knowledge and negative perceptions about solar energy. Being open and honest about experiences from other projects can also be positive if this can inform the current development process.

Key facts presented with appealing graphics, convincing arguments and success stories are often important factors in creating an initial interest and possibly a decision to integrate solar energy in architecture. All of these topics are discussed in this guideline.

Goals and market demands in building design and development: With a few exceptions, a project's solar energy goals will be tempered by financial constraints. For example, the use of clean energy may depend upon a potential tenant's willingness to accept a higher rent, or an investor's appetite for risk or desire for profit. Clearly defined and well-balanced goals will greatly contribute to the realization of well integrated solar energy systems within a tight financial framework.

In order to make informed and wise choices for his project, the client must base his decisions on a dialogue with a qualified team of managers, architects and consultants. It is necessary for the whole project organization to have a common understanding of the project's primary goals in order to work effectively. The project manager will then have a better basis on which to guide the project development, and the architect and consultants can work within a clearly defined, multidisciplinary design process.

Using convincing methods to inform the client and project leader why solar energy should be part of the project's energy solution is essential, especially since the energy solution and the use of solar energy are only small parts of the overall considerations when designing a building. It is vital that the issue of solar energy is considered as early as possible in order to have sufficient time to successfully integrate the technologies into the building process. Recommendations must be based on an analysis of the project's potential for use of solar energy as a clean energy source. Some major issues essential to advising and convincing the client are:

- Good cost/benefit data
- A guaranteed level of quality
- Delivery within the planned timeframe
- Good reference examples on performance and aesthetics

Goals defined by a client early in the project will affect every part of the building process: programming, planning, feasibility studies, early design phase, design development, building phase and operations. Maintaining a holistic approach throughout the entire process and focusing on clearly defined goals are major steps towards the realization of a building's full potential, including in the use of solar energy.

"What is the ambition of this project with regards to environmental design and energy use?"

If the project goals are not already defined the architect can attempt to initiate this discussion in the initial meeting with the client and project leader:

"***What is the ambition of this project with regards to environmental design and energy use?"***

Many countries have existing standards and certification systems, such as BREEAM, LEED and LIDERA, which can be helpful in planning goals related to environmental design, including the evaluation and analysis of solar energy use.

Project organization: The way a project is organized is vital for the exchange of information, knowledge sharing and decision-making. Changing from a linear to a team-based organization will change the flow of information within the team and increase the possibility of innovation. A continuing, clear communication between the client, the project manager and the project development team is the best basis for creating and testing new ideas, performing the appropriate analyses for decision-making and communicating the best solutions in order to fulfill a project's visionary goals.

Stakeholders: Along with the core project team consisting of project managers, architects, consultants and contractors it is important to consider and include other key stakeholders in the planning and communication process; the marketing group (sales/ contract issues), the municipality (limitations/ planning framework), the occupants/ tenants (use of the system), construction workers (execution) and facility managers (maintenance). Communicating goals and sharing information and ideas also with these stakeholders will facilitate a clear and mutual understanding making it easier to support the projects goals throughout the entire project development. Communication must also consider the changing target audience in each project phase. Reminding stakeholders about the project goals is important in order to ensure continued support.

Inspiration and knowledge

There is no precise recipe for how to communicate the advantages of using solar energy in building design. In every project the development team, project managers and architects will have different dynamics and different common and individual goals. Obsolete knowledge and a lack of understanding about solar energy are still widespread in the building sector, and information about rapid technological development can be overshadowed by information about earlier unappealing and nonfunctional designs. However, all of these obstacles can be addressed through communication – accessible information, good examples and visionary solutions – focusing on inspiring interest and sharing knowledge, in order to realize high quality solar energy solutions in architecture.

Part 1 :
Convincing clients to request and commission solar buildings

02 Introducing Solar Energy Strategies

When developing a project it is always important to understand the wishes, priorities and decision-making process of the client, as different clients naturally have different priorities. There are a number of very different client types: the ”careful with the money” client, the idealistic client, the owner/developer, the visionary client and the profit-oriented client, to name but a few. Each of these client types prioritises differently, but they all want satisfied users, well-running buildings and exclusive buildings.

The method of getting a clear impression of the client’s wishes is quite simple. It is all about asking.

By asking about key topics using open and clarifying questions, focus areas are defined and formulated together with the client, increasing client involvement and ownership of the project. This questioning process also clarifies what is “nice to have” and what is “need to have”, and ensures consensus between the client and the architect about the level of ambition regarding energy conscious design and the use of solar energy.

Often investments in solar solutions are seen as expensive additional costs, and many clients automatically have objections to solar solutions. Such objections may be clarified or overcome through a few simple measures:

- Turn the objection into a question
  - “What does it mean when you say the solution is too expensive?”
  - “What could change your position on this material?”
  - “What could reduce this risk for you?”

- Neutralize the objection
  - Understand the customer and give a solution to the problem
  - Show understanding

The starting point for introducing solar energy solutions to the client can come naturally in the discussion on building energy needs. The reasons for covering part or the totality of these needs with free energy can be shown, explaining the various forms solar energy can take, and the influence they have on building architecture (Fig 1).

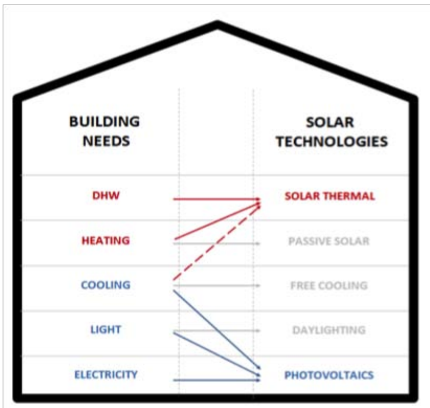


Figure 1: Solar technologies covering different building energy needs (EPFL/LESO-PB)

Passive solar, as the simplest and most diffused form of solar energy use is quite straightforward to present. Windows are not questioned and explanations over common use for natural lighting and passive solar can be given. Seasonal strategies like solar protections for summer and maximal sun penetration in winter can be presented.

The interest of using solar thermal systems for hot water production, which are more and more often requested by national regulations and become compulsory, should be highlighted. The reliability and efficiency of solar thermal should be stressed to comfort the client that this is a proven technology.

Finally the option to produce electricity with photovoltaics can be introduced, explaining the advantages of grid storage, and the possible financing schemes available. Use of electricity is becoming more and more dominant in new buildings for which reason use of photovoltaics is becoming increasingly relevant.

Globally, the presentation should highlight the opportunities that solar technologies offer in terms of clean energy production, it should show their reliability and their durability, and should convince the client of the interest and effectiveness of these technologies.

Advantages of using solar energy in Architecture

There are a number of benefits to utilizing solar energy strategies in architecture, in addition to the purely technical advantages (reduced energy demand and energy costs and improved indoor climate). The following points are considered some of the most valuable arguments in convincing a client to include solar energy systems in his or her project.

User demands define the market: Future tenants and real estate investors will be increasingly well informed about the advantages of sound environmental choices, and be aware of the related savings on operating (energy) costs. A focus on optimization and long-term quality when renting or buying a building is a natural consequence. Tomorrow's tenants will almost certainly require a clear environmental conscience without reducing their standards of living or working. This means access to clean renewable energy, like solar energy, in addition to a well-designed, energy efficient building.

Development of building technology: Rapid development of environmental consciousness will very soon render today's

Advantages of using Solar Energy in Architecture:

- **User demands define the market**
- **Development of building technology**
- **Market benefits and profitability**
- **Reputation/ CSR**
- **Independence**
- **Architectural freedom**
- **Product development**

contemporary design methods for environmentally friendly buildings obsolete. Current building improvements have typically been driven by minimum building regulation requirements where initial investment costs often are low. Intelligent energy systems to improve operational energy are being deployed. Most buildings, however, still only utilize a small proportion of the buildings full potential integrated into the design. Future designed buildings will be planned for zero energy use or plus energy production and will need to maximize their potential to harness onsite or close to site clean energy sources. This means that implementation of solar technologies will more or less be a prerequisite for future building design.

Market economy and profit: Short-term savings by avoiding investment costs tied to optimal energy design, however economically appealing, will not appear to be good planning when the consequences of adding solar energy strategies at a later stage or to a retrofit building become evident. A lack of forward thinking investment that reduces flexibility in energy use will quickly render the planned building less appealing for a future buyer or tenant as they become only too aware of the danger of exposing themselves to future energy costs which in turn will affect the asset value of the building. In a very few years a demand for optimized zero energy buildings will allow the visionary developer to command higher rental and resale values, providing a market advantage compared to real estate without the same foresight.

Reputation: Many developers, especially market leaders, find it important for their reputation to be viewed as pioneers and trendsetters – setting examples where others will follow. An ambitious solar energy strategy can be linked to the corporate social responsibility (CSR) policy of such clients.

Independence: It is a clear advantage for a building owner to be more independent from increasing energy costs and limited and “politically risky” energy resources. Solar energy is the largest, most stable and limitless natural energy source with non-restricted access for every client with a building facing the sun. It should make obvious sense to take advantage of this.

Architectural freedom: An important benefit of using solar energy is that the energy supplied by solar solutions in many cases will increase the maximum energy allowance of the building as defined by the national building codes. This can provide greater architectural freedom compared to buildings that are developed within the standard energy allowance.

Product development: As demand and product efficiency rapidly increase, product coordination will improve and the investment costs associated with solar energy systems will be reduced. The development of more appealing and flexible designs through increasing innovation and creative application becomes the next step. Appealing products are an easy choice for ambitious developers who see the long-term value in aesthetically pleasing designs.

We hope that these developments will be guided by the various recommendations and examples provided by IEA SHC Task 41 “Solar energy and Architecture” (see detailed list of Task 41 documents on page 70).

IEA SHC Task 41

Task 41: Solar Energy and Architecture, gathered researchers and practicing architects from 14 countries in the three year project whose aim was to identify the obstacles architects are facing when incorporating solar design in their projects, to provide resources for overcoming these barriers and to help improving architects' communication with other stakeholders in the design of solar buildings. To achieve this goal the task was structured into three subtasks; A, B and C.

- **Subtask A defines the criteria for a successful integration of the different active solar technologies in building architecture. The deliverables include a set of integration guidelines, a collection of good integration examples for each technology, a comprehensive collection of innovative solar products and a set of development guidelines for manufacturers.**
- **Subtask B includes the assessment and testing of tools. Through the use of tools a client and their advisors can be guided on the benefits of using solar energy in building design.**
- **Subtask C includes this Communication Guideline and selected case studies. The case studies provide examples and information on existing solar buildings integrating different solar energy strategies into high quality architecture.**

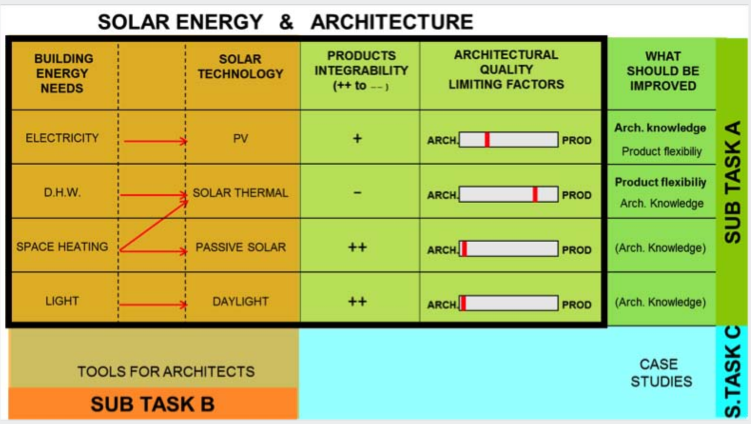


Illustration of IEA SHC Task 41 structure (EPFL/LESO-PB)

03 Convincing the Main Stakeholders

Assuming that the client has been convinced during the first meeting(s) that solar energy is an interesting and effective option, the next step is to help him/ her to face the following main concerns on active solar systems:

- not degrading the building's architectural quality
- make sure that the systems proposed will work properly without causing any damage or malfunction to the building
- keeping the extra costs for solar systems under control (through national/local subsidies and/or by replacing building elements and/or by the value added to the building).

Providing professional answers and warranties over these topics will help to win the adhesion of the client and his partners.

3.1 Integration considerations

The architectural possibilities offered by the solar collectors, in their standard forms or using innovative products, should be shown both for photovoltaics (PV) and solar thermal (ST), using good examples or specific 3D rendering variants of the project.

Information on the integrability of the available technologies, to be shown at this stage, can be found in report T.41.A.2 “Solar Energy systems in Architecture - integration criteria and guidelines”**.** Specific products for roofs or facades can be found in chapters 3A Solar Thermal and 3B Photovoltaics.

A wide collection of inspiring solar buildings can be found on the website of case studies developed within Task 41. (www.iea-shc.org/task41).

To help answer questions on general integration principles and criteria as well as to clearly explain common elements and major differences between PV and ST, comprehensive information is provided in report T.41.A.2 §1 and §4 (“Architectural integration quality” and “Differences and similarities between PV and ST”).

Showing a convincing knowledge of the integration principles and possibilities of solar energy is the major contribution the architect can have to build the confidence for solar in his client.

3.2 Technical considerations

Solar systems, both photovoltaics and solar thermal, have been established technologies for more than 20 years, and their reliability can be warranted. The integration problematic is solved by the cooperation between the architect and the specialist, ensuring the quality of the systems.

Depending on the size and complexity of the envisioned solar system(s), and the degree of integration with other systems in the building (DHW, combi-systems, batteries back-up etc.) a presentation by specialists may be required to demonstrate the feasibility and durability of such systems.

References of previous successful installations by the architect, in collaboration with specialists, will reinforce the confidence of the client in the design team.

3.3 Financial considerations (photovoltaics)

PV cost is currently expensive with average price around 3 $ US/ 2,40 € per Wp (Solarbuzz, 2011). This cost is however constantly

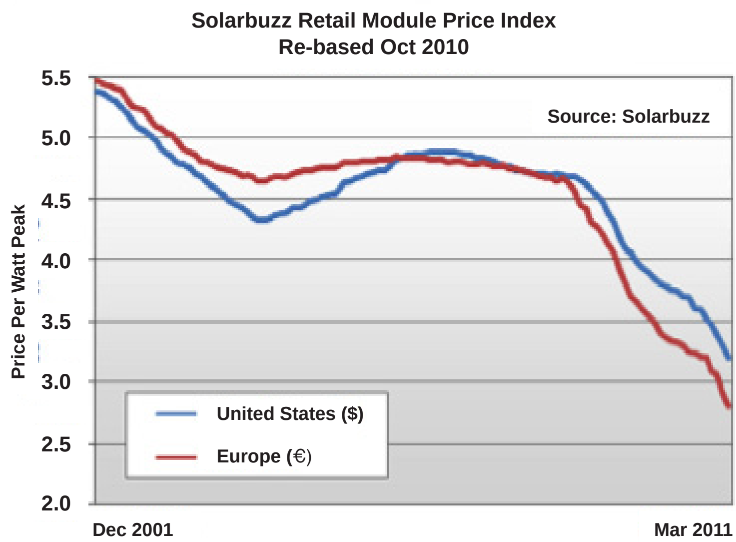


Figure 1: PV cost index (Solarbuzz, 2011)

dropping (about 10 % p.a, see Figure 1), and a target price of 1 $/Wp is believed to be likely. At this price it would be financially viable to integrate PV systems on facades exposed to the west and east.

The cost of a PV system can be offset in two ways: 1) the offset of the original cost - initial immediate return and 2) energy saving and selling to the utility (Holbert, 2009).

The first approach relates to the method of implementation of active solar systems in the building. This depends mainly on the decision of the stakeholder. A building integrated PV or solar thermal system acts as exterior weather barrier, thus replacing materials that would usually be used as an outer layer. Additionally, this approach uses the existing building structure, eliminating the structural framework required to support a freestanding system. This can help offsetting the cost associated with additional support structure as well as the cost of multiple roof penetrations for the supports. The principle of using an active solar system as the outer layer of the roof/ facade, instead of being attached to an outer layer (such as shingles) can increase the life time of the system by avoiding joints and connections that can lead to rain penetration (Athienitis et al, 2011). This assists in enhancing the overall durability and performance of the system.

The second approach depends on existing financial incentives and policies provided by governments and utility companies, and it differs among countries. Utility and governmental incentives can provide investment subsidies. In these cases the authorities refund part of the cost of installation of the system, thus offering the owners (in commercial and residential projects) a premium price for all the renewable power produced at their site.

Maximizing the total revenue by selling excess electricity to the grid can reduce the payback period for the initial cost of PV systems. Currently, there are few incentives that buy the electricity at a price that can significantly reduce the payback period. The most commonly used incentives include feed in tariffs and time of use. These are summarized below.

Feed-in tariffs/net metering: the electricity utility buys PV electricity from the producer under a multiyear contract at a guaranteed rate. The solar buyback rate can be large enough to cover the cost for remaining electricity need at the going residential rate. In Germany, for instance, the federal law Renewable Energy Sources Act (EEG) dictates that the grid operators pay fees for electricity from renewable energy sources that equal the difference between fees and the market price for electricity from traditional sources. This has proved to be extremely successful, in particular for wind power and PV (Hagemann, 2007).

Time of use plans (TOU): According to this plan, the cost of electricity varies as a function of time and day (due to demand variations). When demand is high the electricity price is high and vice versa. In locations where the price of electricity varies with TOU, return on annual energy produced may be a more important object than the total energy produced. Consequently, orienting the PV system to obtain peak generation that better matches the grid peak load is of predominant importance (Holbert, 2009). Variation of PV orientation enables the spread of peak electricity generation over up to six hours (Hachem et al, 2011).

Feed – in programs are not offered by all countries. In such cases it is possible to design an off-grid PV system. Such systems are less cost-efficient since they do not benefit from feed-in tariffs or subsidies. Sizing the PV array is a key issue in the case of off-grid systems, in order to achieve an economic and profitable investment. Designing a PV system to supply the total energy use of the building under all weather conditions is expensive. PV systems with availabilities of less than 95 percent can be realized at half the cost or less of systems designed to be available 99.99 percent of the time (Risser, 1995). For off-grid PV systems the power has to be supplied from a substitute source during night or on dark cloudy days.

Since PV systems produce electricity only during daytime, energy can be stored in batteries (or other emerging technologies). This however has some limitations, such as the size of the batteries and their additional cost.

Table: Current PV incentives in participating countries

Country	Incentives (PV)
Australia	Feed-in tariffs and mandatory renewable energy targets
Austria	Feed in tariff
Belgium	Feed in tariff
Canada	Feed in tariff
Denmark	Feed-in premium tariffs for renewable power (Promotion of Renewable Energy Act)
Germany	Feed in tariff
Italy	Feed in tariff
South Korea	Feed in tariff
Norway	-
Portugal	Feed-in premium tariff
Singapore	-
Sweden	Quota system based on “Green Energy Certificates”
Switzerland	-

(2011 data)

References

Athienitis, A.K., Bambara, J., O’Neil, B., Faille, J., 2011, A prototype photovoltaic/thermal system integrates with transpired collector, Solar Energy, 85:139-153.

Hachem C., A. Athienitis, P. Fazio, 2011b. Investigation of Solar Potential of Housing Units in Different Neighborhood Designs, Energy and Buildings, doi:10.1016/j.enbuild.2011.05.008.

Hagemann, I.B., 2007, Solarsiedlung am Schlierberg, Freiburg (Breisgau), Germany , PV Upscale, retrieved from (http://www.pvupscale.org/IMG/pdf/Schlierberg.pdf), on Jan 15, 2011.

IEA SHC Task 41- Sub task A

Within the general work of the IEA Task 41 “Solar Energy and Architecture”, Subtask A focuses on quality criteria in the architectural integration of active solar energy collectors systems (solar thermal, PV and hybrids technologies). The goal is to help promoting this new domain by publishing targeted recommendations for the main actors: architects and manufacturers.

The work has been organized as follows:

- **Identify the barriers to a broader use of active solar systems by architects and their related needs (DA1, see details p.65)**
- **Establish architectural criteria for the integration of active solar energy systems in the building envelope**
- **Propose recommendations to architects, based on these criteria, with good examples (DA2, see details p.65)**
- **Give recommendations to the solar industry on the ways to improve the architectural integrability of products and systems (DA3, see details p.65).**
- **Inform architects over the state of the art in innovative solar products (DA6, see details p.65)**

04 Common Project Types and Communication Strategies

Project types and communication

Different project types have different characteristics and preconditions, which will affect the choice of communication strategy and approach. This section will discuss these typical differences in relation to new buildings, retrofit projects and urban design projects.

4.1 New Build

Characteristics and preconditions

New build projects are typically open-ended, allowing in the early project stages a great freedom of expression and choice of solar strategies. The specific requirements and room program of the client can usually be resolved in a number of ways, and the final form of the project is the result of a design development process in which the design team seeks to resolve a number of issues in parallel through an iterative and exploratory cooperation.

In a new build process solar strategies will be evaluated along with many other issues. The final choice of solutions will be a compromise of aesthetic, functional and financial considerations, and the realisation of a well-integrated solar system will therefore depend on a multidisciplinary approach involving both technical and architectural expertise as early in the project as possible.

One challenge which is typical for many new-build projects can be that the client is reluctant to engage a full design team in the early design phase (EDP), when many important decisions affecting the successful integration of solar energy are made. There can be a number of reasons for this:

- The early stages of a project are associated with the greatest uncertainty. The financing of the project may not be finalised, regulatory issues may not be fully explored, and tenants or buyers may not be decided. Many clients will be unwilling to invest more than necessary before project realisation is more certain.
- Public projects can have funds allocated on a phase-by-phase basis. This will limit the funding available for the early design phase, especially if the client is unfamiliar with the multidisciplinary design process.
- Clients may not see the need for EDP teams if they are unfamiliar with this form of design process.

Important issues

The presence of a complete design team in the early design phase is important to ensure a thorough consideration of technical and architectural issues while key decisions of building form, organisation and massing are being made. Some arguments in favour of a complete design team in the early project phase can be:

- In the early design phase there is a greater level of flexibility in the project than in later phases, and the costs of major changes in the design are less. As the design progresses more and more decisions are made, and the design becomes increasingly fixed. The cost of major changes (poor orientation, roof structure etc) may be prohibitive by the time the appropriate solar consultants are involved in later design stages.
- A multidisciplinary early design phase can result in considerable cost savings in later project phases by establishing an interdisciplinary, quality-assured design for further development. This can result in more energy efficient buildings without increasing costs (building integrated energy solutions) and avoid costly reworking in later stages.

One challenge of solar technologies is that they span a number of the traditional design disciplines. A successful integration of a solar system is reliant on both architectural and technical considerations, involving architects, solar energy experts and manufacturers. Integration aspects may therefore not naturally be considered within a traditional design approach.

4.2 Retrofit

Characteristics and preconditions

Retrofitting refers to the addition of new building components, technologies or other systems to existing buildings. A retrofit project may therefore be for any building type and any client, public or private.

The primary characteristic of a retrofit project is that any solar technologies will be added to an existing building structure, and often to an existing energy system. This will affect the choice of solar strategies and the integration opportunities. For example, an existing electrical heating system may exclude water-based solar heating solutions that would otherwise be suitable.

The existing structure and design of the building must also be considered part of the energy system. Building design issues such as the proportion of glazing, thermal storage abilities and solar shading/ cooling will all affect the energy flows within the building and may influence the choice of solar strategy. It is therefore important to analyse the existing energy system before considering the integration of solar technologies.

In minor retrofitting projects a client may be reluctant to engage a full design team, especially if the scale of works within some disciplines is minor. This can result in important disciplines for the design of solar energy systems being missing from the team. One way of dealing with this can be to involve a manufacturer in the detailed design of the system.

Important issues

The existing structure and energy system are important preconditions in a retrofit project, and should be analysed as early as possible. Some important issues are:

- Will the scope of the project allow the installation of facade or roof mounted solar systems?
- To what extent will the building energy system be replaced, and which restrictions does this place on the choice of solar installations?
- Are there conservation issues associated with the project which may exclude solar solutions?
- Are there conservation issues that can be used to increase the focus on and promote investment in quality of architectural integration?

Case Story: Sørenga Energy Workshops

Sørenga is a new urban area in the centre of Oslo, Norway. The peninsula comprises part of the Bjørvika development, and is underlayed strict environmental guidelines

Read more on page 112...

Integrated solar energy systems are often justified financially by including the fact that they replace other building components, for example roof or wall cladding. In retrofit projects this may not be the case, as existing cladding may be suitable for reuse. This will impact on the cost efficiency of the solar installation.

Communication strategies

Establish solar systems as a design issue as early as possible. Try to include solar strategies in design meetings, preferably with their own heading in the minutes so that they are followed up in future meetings. Make sure integration of solar systems remains a priority issue throughout the project development.

Attempt to influence the client to choose a multidisciplinary design team as soon as possible. Many new build projects are preceded by a programming and contracting phase in which a multidisciplinary EDP should be decided, if possible.

In the design phase, consider arranging multidisciplinary workshops in order to assess the building energy system and/or solar strategies. A workshop can be a dynamic and effective way of working with issues that span several traditional design disciplines, as well as opening up communication on complex issues.

An example of a multidisciplinary design workshop is given in the case story on this page.

4.3 Urban design

Planning process, regional differences and similarities

The planning processes differ between countries, but generally the process is defined in levels from masterplanning down to detailed level and building permit. Important preconditions at the national level that will influence the way active solar can be incorporated in planning are:

- fulfilment of national energy requirements due to the demands of national building codes
- other laws and policy issues
- the existing structure for energy production
- climatic conditions regarding solar potential
- ways in which new technology is governmentally supported; eg. green certificates, feed-in tariffs or other strategies
- tools to assist planners in professional practice

In the later stages of the process there are also restrictions due to building heritage considerations where the laws and policies differ between countries.

Urban planning with new local energy production requires early decisions as well as new tools for pre-assessments. It is necessary to evaluate the consequences of planning and architectural design actions in relation to the possibilities of using solar potential. A greater global interest in quality assurance and communication of sustainable planning has led to the development of different assessment systems, for example BREEAM Communities, LEED neighborhoods and Green Star, which are developing an impact on planning and building outcomes. These assessment systems in general focus on renewable energy and will be an important factor for the realisation of active solar in urban design.

Solar potential studies are becoming more common. In Europe there are several examples of solar potential studies of existing urban fabric, but still very few tools that incorporate the relation between solar potential, architectural and economic aspects. The approach should differ when planning new areas as opposed to planning retrofit projects and infills.

In discussing solar potential studies it is important to underline that building construction and urban planning have a long timescale; solar access planning will increase the potential of utilising solar energy in an area for a long time into the future, while the lack of taking solar access into account in planning will instead create a barrier for potentially a hundred years ahead in time. In order to integrate active solar it is important:

- to analyse the impact of the design in relation to integration of solar energy and visa versa in the very early stages of planning.
- to optimize planning of new areas, where buildings can be oriented in favourable ways and be prepared for the integration of solar systems, even if not all buildings will integrate them from the start.
- that the integration of active solar in city planning also has to relate to who the owner of the energy is, to the energy need on a local and national level and to what extent the design shall correspond to the energy prices (responding to energy use on a national and international level). On a structural plan level this will mean considerations regarding orientation, inclination within building form and interfacing with local energy networks, and on a detailed level inclination of building elements.
- to deal with developing urban form in new areas, i.e. new typologies and morphology regarding the interrelation between design, energy efficiency, energy production and sellable/rentable area.

Dealing with existing urban fabric, it is important:

- in existing urban areas (including heritage buildings and areas) to deal with architectural criteria (zone sensibility, zone visibility, political context).

- with knowledge of solar thermal and photovoltaic techniques and products as a material in the urban fabric.

Political directives are already aiming towards nearly zero-energy buildings, while the urban planning of today does not take the aspects of active solar (solar thermal and photovoltaics) into account to the necessary extent.

An increased use of solar energy is an important part of the development ahead, where the urban fabric needs to utilize passive solar gains and daylight to reduce the energy use in buildings, as well as to improve the inhabitants' comfort indoors and in urban outdoor areas. Active solar energy systems integrated in the urban context will also enable a supply of renewable energy as heat and electricity and help cities reach sustainable solutions. However, it is also important to design the buildings in an area in a way that they do not increase the use of energy in order to produce energy, for instance by focusing on vegetation, shading and passive cooling strategies as well as active solar integration.

...the urban planning of today does not take the aspects of active solar into account to the necessary extent.

It may also be possible to integrate active solar, especially PV, in street furniture and transport infrastructure, for example:

- Shelters for tram stops, bus stops etc.
- Chargers for cars (DC-chargers are much faster – one to seven – than AC chargers).
- Lighting
- Signs

Part 2 :
Communication Strategies at the Design / Construction Team Level

05 Design Development

The design of sustainable buildings or urban developments including solar energy strategies has reached a level of complexity where the traditional and well-established design processes of planners – mainly referring to design, construction, functionality and cost – may no longer meet the requirements for sustainable buildings. Solar energy strategies, like sustainability aspects in general, have to be integrated into an iterative design process in the very early design phase. At that time, fundamental decisions on building form and orientation, number and size of openings as well as materialisation and construction leave manifold options for optimising the functionality of the building or urban development, as well as adjusting the design to meet the specific user requirements or to make best use of the potential of the local site. The later solar energy strategies are included in the iterative design process, the narrower is the range of options and the higher the respective costs for their realisation.

Besides a strong commitment on the part of the client or investor, design developments including solar energy strategies require adapted design development processes relying on multi-disciplinary project teams, advanced design development processes and collaboration models as well as well-targeted know-how transfer and training practices.

The following chapter provides guidelines that may facilitate a design development process that supports the anchoring of solar energy strategies within the project team as well as the collaboration between project teams and external manufacturers or suppliers.

5.1 Anchoring solar energy strategies within the project team

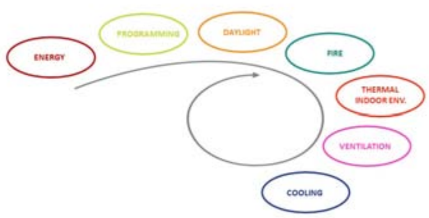


Figure 1: An integrated design process is based on close multidisciplinary cooperation and iterative design loops. Source: Esbensen Rådgivende Ingeniører AS

The integration of solar energy strategies in buildings is often associated with higher cost, poorer design and limited design flexibility, or increased planning time and effort. Experiences with integrated design processes (IDP)[1] have shown that these arguments can be invalidated if there is a strong vision with precisely targeted goals, a multi-disciplinary planning team aiming at achieving the goals, and a clear plan of how to get there. The following four key aspects will help to anchor solar energy strategies in buildings or urban developments:

- Setting up a strong vision and precisely targeted goals
- Setting up an appropriate project team
- Implementing a project management plan
- Signing a target agreement

The aims of the four key aspects are briefly presented below.

---

1 Compare to [Zimmerman, Alex. Integrated design process. Available at: http://www.schl.ca/en/inpr/bude/himu/coedar/upload/Integrated_Design_GuideENG.pdf. January 29, 2012].

Setting up a strong vision and precisely targeted goals

Through all phases of a project development process – from the strategic planning well into the post occupancy phase - it is necessary to keep an eye on the aim of the project, whether assigned to sustainability in general or the use of solar energy specifically. Also, all partners of the project team must be convinced that well designed and sustainable buildings or urban developments, which make the best use of locally available energy sources – such as solar energy – are essential to achieve sustainable habitats with long lasting market value. They must also be ready to bring in their own expertise to reach the assigned goals as well as possible. These intentions will be the base of a detailed target agreement that includes all aspects related to the building or urban development. It has to be signed by all partners of the planning team at the initial stage of collaboration.

Case Story: Green Lighthouse

The new design of the Faculty of Science of the University of Copenhagen, focused on a low-energy building, was achieved through the means of an invited competition.

Read more on page 90...

Setting up an appropriate planning team

The composition of the planning team as well as its organisation depends on the size and the complexity of the project. Small planning and design companies will have to contract the missing specialists while larger firms might already have them at their disposal. Also, small projects might be developed in a basic team of architects and planners, energy or HVAC (heating, ventilation, and air conditioning) engineers and building physicians. Larger and more complex projects will need to additionally include climate designers, urban planners, financial specialists as well as a representative of the client, the facility management and/ or representatives of future tenants. In any case, it is of great value if the partners of the planning team are already experienced in working in multi-disciplinary teams or in developing projects including solar energy strategies. All aspects regarding the management of the project are stated in a project management plan[2] that has to be signed by all partners at the initial stage of collaboration.

2 Project management plans are mandatory for all ISO qualified firms.

Implementing a project management plan

The more complex the design and the bigger the planning team, the greater is the need to have a clear picture on how to manage the design development. The respective partners and their responsibilities have to be determined accordingly. All aspects necessary to facilitate the collaboration and to reliably coordinate the interfaces between the disciplines are included in the project management plan. This document basically identifies the head of the project team, all partners of the project and their roles as well as their organisation and responsibilities, their know-how and the handling of know-how. It also includes the organisation of the project, the milestones and the reporting schemes as well as review and decision-making principles or penalties for not meeting specific goals. Furthermore, it can define the tasks and deliverables, tools and software used, standards for data exchange, number and time of project meetings, training and training requirements for all partners of the project team as well as quality standards and risk management plans.

By managing all these aspects, many prevalent conflicts within planning team or deficiencies in the design development can be avoided. Examples of the handling of know-how, multi-disciplinary collaboration and understanding or risk management strategies are discussed below:

- Today, many architects and planners do not have enough know-how to virtuously implement solar energy strategies into architecture. In addition, specialists are only consulted when important decisions have already been taken. To successfully anchor solar energy strategies into the design development, it is of great importance that solar energy strategies are included in the early design phase. Also, the design development should rely on skilled multi-disciplinary project teams, which are familiar with multi-disciplinary work and are ready to share disciplinary know-how. As such, the training of single partners or the entire planning team can be included into the process in order to meet the requested state of know-how and to establish a common language as well as to build up trust and acceptance among the project partners.

- Multi-disciplinary work is only possible if all partners of the planning team 'speak the same language', enabling them to effectively exchange information through verbal communication, and graphical and numerical data exchange. While a glossary might help to clarify the basic terms, visualizations and design studies help to underline design ideas or to break down complex arguments into an easily understandable form. Also, design standards and data formats must be defined to support an easy exchange of plans and other documents (e.g. vector or numeric data) among the different partners of the multi-disciplinary team.
- Implementing a large multi-disciplinary team in the early design phase might involve major risk to clients or investors as it is not foreseeable if the building permission can be achieved or if the building finally can be built. To limit this risk, planning teams must be aware of potential risks and dispose of strategies to diminish them effectively. Buildings and urban designs that are planned with foresight, tolerances and potential for adaptations will be able to better react to legal, technical or functional needs during the entire planning and operation phase, limiting resulting costs.

Signing a target agreement

The target agreement is meant to meaningfully define all aspects needed to meet the aim of the building or urban development. It includes information, requirements or benchmarks for sustainability and solar energy strategies, CO_2 or operational

Case Story: IDP in Bolzano

The IDP approach, has been applied in the design process of a new building in the Technology Park of Bolzano

Read more on page 110...

energy benchmarks, construction quality, materials, products or systems used as well as a framework for time and costs. Having set up and signed the agreement, all partners of the project team, from architects, planners and engineers to builders, suppliers or representatives of the client or investor, are obliged to work towards the assigned goals, even if restraints arise on time and cost issues or on design and technical considerations.

- Constraints on time and costs are often strong arguments to change the goals initially agreed on. Signed target agreements help to track the initial goals and to find other ways to deal with the constraints, asking all partners to mutually negotiate and work out the most eligible strategies. Even though these processes might be time and cost consuming, they are very important to improve the result; multi-disciplinary work on the achievement of the key goals has great potential to explore synergies and related cost saving. In addition, these processes raise the know-how of the partners, help to understand the needs and requirements of other disciplines and improve the ability to present and weight own arguments.
- Design ideas, technical requirement and costs often seem to be incompatible. Having defined the overall goal for the integration of solar energy strategies into the target agreement, the project team is asked to develop a solution that fulfils all requirements as well as possible, such as design[3], cost, quality or efficiency.
- Solar products and systems are developing very rapidly, while the costs are decreasing and the efficiency is increasing. In order to integrate present know-how and technology as well as to achieve a smooth design development, it is important to clearly state goals, responsibilities and decision making processes. This

3 Specific guidelines on the integration of design strategies can be found in T.41.A.2.

means that – no matter what happens in the market - the product selection must be locked at a certain design stage, to optimise energetic, technological and design aspects.

Barriers linked to the design development

Target agreements and project management plans are helpful tools to anchor solar energy strategies within project teams. Nonetheless, there are major barriers linked to the project team and design development, such as increased planning costs during the early design phase, building legislation or tender practices.

- The importance of the early design phase should have a major impact on the project team – especially planners and architects. They must be able to present strong arguments to claim appropriate fees covering the increased amount of work delivered during the early design phase. For experienced project teams it is easier, as they can refer to former cases showing that high early planning costs do not increase the overall costs.
- Clients must be convinced that the multi-disciplinary planning team has to be implemented at the sensitive early design phase, even though it is not clear at all if the building can be approved or realised.
- The implementation of solar energy strategies does not have priority in most building laws. Also, building permission applications require clear statements on many characteristics of the buildings, such as the shape of the building, its design and construction, colours and materials as well as limited energy consumption. In that phase, the optimisation of the building (e.g. daylight access or passive solar gains) has not yet been finalised. As such, building laws and building permission

requirements might strongly impact the optimisation process of buildings or urban developments.

- Today, small project teams might consider contractors, manufacturers or suppliers to support the design development or to assist in developing custom designed solutions. Involving non-paid contractors, manufacturers or suppliers in the design development process might contradict present tender practices, where the cheapest tendering party has to be considered. It might therefore be necessary to include these specialists into the planning team and to pay for their know-how.

Summary

A clear vision with precisely targeted goals, an appropriate design team as well as a signed target agreement and project management plan are the key issues for better anchoring solar energy strategies in the design development process. The content of the individual issues has to be defined according to the size and complexity of the building or urban development as well as the size and organisation of the project team. Supported by the client or investor, the resulting buildings or site developments are ready to become lighthouses for solar energy strategies.

5.2 Working with manufacturers

A well-established cooperation process between contractors, energy consultants, product developers (manufacturers) and architects often plays a significant role in a successful design process in which solar technology is to become an architectural element of the building envelope. Photovoltaic modules or solar thermal collectors, suitable for building integration, demand a good understanding of architectural and technical criteria and boundary conditions by all involved disciplines.

Some relevant information to facilitate communication has been collected from interviews with manufacturers, architects and energy consultants as well as experiences from competence networks of some IEA SHC Task 41 members.

The following information is discussed in this section:

- **Prior information** – the first steps before the design process starts
- **Cooperation channels** – approaches to cooperation within the design process
- **Information exchange** – proven methods for communication within the channels of cooperation
- **Recommendations –** what to consider when selecting the right cooperation channel

The information is illustrated through case stories – experiences from successful workshops and collaborations between architects and manufacturers.

Case Story: BISOL Workshops

The BiSol project, started in 2009, was specifically addressed to all stakeholders involved in solar energy development,

Read more on page 105...

Prior information

Information about solar thermal collectors or photovoltaic modules (hereafter referred to as "modules") is usually provided to architects and clients by energy consultants, suppliers or planners of solar energy systems. Depending on the company size and services, consultants and planners are either sales partners or a division of a manufacturer.

Product range: The product range and design options presented in the initial consultation depend on the product assortment of the possible contractors and manufacturers. It should be noted that manufactures present their products on their homepages, while some general information platforms on solar technologies present best case studies with specific information on products as well. A comprehensive collection of available innovative solar products is provided in the IEA Task 41 report T.41.A.2 and in a dedicated website (http://leso2.epfl.ch/solar/index.php). A methodology for the design of new productst for building integration is presented in the Task 41 T.41.A3.1/2 reports together with a set of detailed guidelines for manufacturers - both of solar thermal and photovoltaic products. See T.41.A3 details on page 70.

Integration knowledge: Secondly, the implementation criteria of solar systems into the built environment depend on national construction laws and regulations as they are treated as building components. The involvement of experts with experience in building integration of solar systems in the initial phase of the design process should be considered.

Cooperation channels

By applying a rough simplification the channels of collaboration between architects and manufacturers can be divided into **indirect cooperation** and **direct cooperation**.

Indirect cooperation describes a design communication process in which the manufacturer usually is involved only indirectly through the consultants or planners. In **direct cooperation**, the manufacturer and the contractors play active roles in the design communication process together with the architects and consultants. This approach is more likely to be found in cases aiming at the development of specific technical solutions. Both channels have advantages and conditions, and need to be assessed according to the project characteristics.

Indirect cooperation: Communication between architects and consultants or planners only, with no direct contact with manufacturers. This is typical for inquiries with a focus on cost efficiency, short design time availability and/or standard design requests.

- *Advantage*: well-established communication process with solutions based on already certified products providing a short planning phase and predictable costs.
- *Disadvantage*: exchange of information / design integration is limited to existing designs, no “new” design approach or product development.
- *Experiences*: benefits include a time- and cost-effective planning process and established standard design process. The flexibility of design solutions is governed by variations of spatial arrangement of existing module and collector types and sizes; the manufacturer will consider new product development only above a certain size of order.
- *Challenges*: early involvement of a consultant or planner in the preliminary design phase is valuable for better architectural solutions with standard modules and collectors. The quality of information and solution depends on the knowledge level of the consultant/planner and the quality of cooperation between the consultant/ planner and the manufacturer.

Direct cooperation: Communication directly between the architect, contractors and manufacturer; occurs in case of bespoke design inquiries when specific solutions are desired. Costs, development time and workload will generally be higher than with standard solutions.

- *Advantage*: the communication process efficiency depends on the flexibility and experience of all participating experts within the design process. The design solution shall be new and tailor-made, involving constraints such as: technical feasibility, legal and constructive boundary restrictions; time schedule and development costs.

- *Disadvantage*: the development phase for bespoke design solution takes longer, technically and formally. Additional time is also required for the certification of new products prior to implementation. Costs are higher than standard solutions and the communication process more intense and complex depending on design requirements and the knowledge base of the participants.
- *Experiences*: benefits include a win-win situation regarding the product development – a new product for the manufacturer, a bespoke solution for the architect, a new implementation method for contractors. The process must be calculated with extra time and cost expenses. Flexibility in solutions is open and only restricted to technical feasibility, while the interdisciplinary experience of all parties is beneficial and necessary for efficient product development in time.
- *Challenges*: the early involvement of a manufacturer and consultant or planner in the preliminary design phase is necessary for bespoke modules or collectors. The quality of information and product development depends on the knowledge level and willingness to cooperate of all participants.

Information exchange

Indirect cooperation is usually initiated by the architect or client to the consultant and takes place mainly with clear requests (sketches, drawings, descriptions of requirements). A technical design solution must be provided within the standard design process and will be developed by a consultant or planner (with the support of the manufacturer only in cases of specific technical challenges and modest adaptations to the chosen product).

Direct cooperation is usually initiated by the architect or client and starts with a first request (sketches, drawings, descriptions of requirements). Manufacturers and contractors are usually involved as early as the initiation phase, for example through the IDP (integrated design process) approach. The IDP includes the organization of several workshops during the entire design phase, in which all stakeholders involved in the project collaborate (architects, clients, solar energy consultants, specific contractors and manufacturers) to guarantee a more holistic approach to building design. These workshops are highly recommended to clarify architectural and technical target criteria and constraints.

Recommendations

Indirect cooperation is most likely to be suitable in cases that are focusing on cost-effective solutions and that involve manufacturers with competitive serial products on the market. Advantages lie in higher production efficiency, and in proven and low-cost design solutions. It is recommended that architects start inquiries (references, product availability) prior to the preliminary design phase to get key information regarding the technical implementation requirements of the intended solar technologies.

Direct cooperation is most appropriate for cases of bespoke solutions and often involve manufacturers who are focusing on specific market niches. The advantage lies in the high flexibility with regards to architectural design requests.

All involved experts, including architects, consultants/planners and manufacturers, usually require tools and information which can facilitate the promotion, design and realization of building integrated solar systems. These tools and guidelines can support the process of assessment, dimensioning, visualization and financial estimation of installations in the early design stage. A comprehensive guideline regarding useful tools and methods can be found in the IEA SHC TASK 41 report T.41.B.3 "Solar Design of Buildings for Architects: Review of Solar Design Tools" (see page 70).

06 The Design-Build Process

Benefits and disadvantages of the design-build model

The design-build model of project realisation is of increasing prevalence in most developed countries. A design-build process is a project-delivery system in which the design and construction services are contracted by a single legal entity. The model reduces client risk by creating a single point of responsibility – the design-build contractor. The model is also commonly used to reduce the project delivery schedule by overlapping the design and construction phases.

The design-build model has both benefits and disadvantages with regards to the architectural integration of solar energy systems. The early involvement of the contractor can create an opportunity to assess costs and construction issues prior to final design development. An active contractor can also be a valuable contributor in the design of architecturally integrated systems, providing hands-on knowledge and guidance on buildability and cost-efficiency.

However, early contractor involvement can also result in an early focus on investment costs instead of life-cycle costs, making the selection of a solar energy system less likely. The rapid project development typical of design-build contracts can also be a barrier, giving insufficient time to adequately design and assess solar systems.

6.1 Communicating with the client

The most important step for implementing solar energy in a design-build contract is establishing a clear client commitment prior to entering into the design-build phase. A committed client may be willing to establish clear requirements for the solar energy system in the tender documents, allowing the design team the necessary resources to develop a well-integrated solution. A clear client commitment will also increase the chance of keeping solar strategies in the project should cost issues and cutbacks be necessary.

Possible reasons for choosing the design-build model

In order to successfully implement solar systems in a design-build project it is important to clarify the client's reasons for choosing this model. Some common reasons are:

- Greater cost control and financial predictability
- Reduced risk (single contractor = single point of responsibility)
- Simplicity
- Rapid project realisation (reduced delivery schedule)

None of the reasons above inherently exclude the architectural integration of solar systems. However, it is critical to raise the issue of solar systems as early in the design process as possible, and almost always before the design-build contract.

Arguments in favor of architecturally integrated solar systems have been dealt with in previous sections of this guideline.

Before the design-build contract

The phase before the design-build contract is critical. If the client is in favour of using active solar technologies, and is willing to allow time for design development and clear specification of the solar system prior to the design-build contract, the chance of realising a successful integration of the system is greatly increased.

One of the main arguments in favour of this approach is architectural quality. Most clients consider the architectural expression of their projects to be important, and may be willing to invest some time in order to ensure as high an architectural quality as possible. Design development of the solar system prior to the design-build contract will generally result in:

- Improved architectural integration due to increased design development time.
- Greater understanding of the system and therefore a reduced pricing of risk by the contractor, especially as solar systems are unfamiliar to many design-build contractors. This may result in a lower total cost for the client.
- Reduced risk of construction issues through a clearer understanding of fixings, integration etc.
- Reduced chance of hidden costs at a later project stage.

Clear qualitative criteria and a precise specification of the solar system in the tender documents is fundamental to ensuring the desired qualities are carried through into the design-build contract. It is therefore generally advisable to develop the solar system as far as possible prior to the design-build phase.

The client should be encouraged to consider contract forms that encourage a long-term financial view on the part of the contractor. This may include design-build-lease contracts or a contractual payout linked to building or solar performance. Though these contract forms will not in themselves ensure a successful architectural integration, they will change the focus of the design development to a more long-term view and may give greater flexibility in the specification and design of solar systems.

Case Story: Frodeparken

In the city of Uppsala, Sweden, a new urban area is emerging north of the train station... An example of a design-build process.

Read more on page 95...

After the design-build contract

Design-build contracts vary greatly in the amount of contact between the client and the consultant or design professional. In some design-build forms the contractor has all contact with the client, excluding the consultant from any discussions concerning changes or qualities. In others the consultant maintains some client contact, and is able to continue to advise on qualitative and architectural issues.

In some countries the regulatory role of the consultant in obtaining building permissions, etc, can provide a platform for defending qualitative issues in a design-build contract, as long as these issues are linked to the building permits. This is commonly the case for facade and cladding issues, but issues concerning detailing and architectural integration can also be linked to a building permit in some cases.

The contractor and client will often focus on issues of costs and scheduling in the design-build process, and changes will crop up in almost every project. It can therefore be helpful for the consultant to maintain a focus on the qualitative issues, especially when changes are necessary and conflicting priorities must be resolved:

- Can architectural qualities be maintained in exchange for cost savings elsewhere in the project?
- Are there cost-saving opportunities in the design of the system integration that will not affect the architectural qualities? The construction skills of the contractor are vital in this discussion.
- It can also be helpful to set a value on the architectural qualities, to help in prioritising between proposed changes.

6.2 Convincing the contractor

The contractor holds a key position in design-build contracts, even more than in traditional contracts. Once the design-build contract is initiated the contractor is in effect the design team's new client, and contact with the original client may be limited. The design-build contractor has the responsibility for delivering the completed project to the client, within the specified schedule and financial framework, and to the agreed level of quality.

The contractors project manager is responsible for returning a reasonable level of profit to his or her organisation. In most design-build contracts this results in purely short-term financial planning – any reduced costs in the project equate to an increased profit margin. In these circumstances well integrated solar energy systems will be almost impossible to implement, unless they have been clearly specified prior to the design-build contract.

The single point of responsibility of the design-build contractor can create a strong risk aversion in the project. Any increased risk (unknown systems, unfamiliar technology, challenging construction details etc) is likely to be refused. It is therefore important to avoid uncertainty – make sure that proposed systems and solutions are especially well considered before attempting to convince a sceptical contractor.

At the same time the contractor can be a valuable partner in developing a well-integrated and buildable solution. Many construction professionals have extensive experience in executing design details and a broad knowledge of products and systems available in their markets, and often see challenges and potential solutions in a proposed set of details at a glance.

External funding and consultancy can be important in convincing a construction company to invest in design development of a solar system, by offsetting costs and/or reducing the risk and uncertainty involved. Some national funding organisations offer financial support for development of solar systems or low energy buildings.

...make sure that proposed systems and solutions are especially well considered before attempting to convince a sceptical contractor.

Arguments for the combined contractor/ developer

In some design-build contracts the contractor will also play the part of developer, or enter into a cooperative contract with the original client. A contractor may also continue to own the building after completion, leasing it to the client for a specified period of time.

With the contractor as developer and/ or long-term owner arguments concerning long-term value have increased relevance. Many of these arguments will be the same as those for standard clients, discussed in previous sections:

- Increased long-term asset value
- Corporate social responsibility (CSR)
- Developer/ contractor reputation and profile
- Reduced long-term risk due to high-quality integration

- Increased competitiveness in rental and sales markets

The combined contractor/ developer will often be involved in the project at an earlier stage than the pure contractor, and will commonly be part of the initial discussions concerning feasibility and architectural quality. The usual arguments concerning reduced energy costs and payback times will also be relevant in these discussions.

One clear advantage in the combined contractor/ developer model is the presence of construction competence combined with a mid- to long-term financial perspective in the early design phase. The design team should see this as a resource for the project, and seek to involve the contractor in early system design issues. Early involvement and acceptance will also help to anchor the solar system in the client organisation, making it less likely to remove or downgrade the system at a later stage.

Each of the arguments for the pure contractor (next section) are relevant for the combined contractor/ developer, and can help to create a positive and constructive dialogue in the project.

Arguments for the pure contractor

In most cases the decision to implement a solar energy system will have been taken in an earlier project phase, and the design-build contractor given the responsibility for detail design and execution of the system.

The contractor's pricing of the system will reflect the level to which the solar system has been detailed prior to pricing, as well as any other client specifications. This is the reason why the design of solar systems should be taken as far as possible before the design-build contract. However, often this will not be the case, and the contractor will have priced a minimum specification system based on a manufacturers standard details, allowing little room for changes or special qualitative solutions.

The following arguments may be of assistance:

- A high quality architectural integration within the design-build framework will be recognised by the client, and will affect the reputation of the construction company when competing for future commissions.
- Solar technologies are likely to increase in use in the coming years. The current project may be an opportunity for the construction company to gain familiarity with these systems, increasing their skill base and competitiveness. The contractor may even be willing to invest some of his or her own time in design development, as a form of further education.
- Improved detailing and buildability will reduce construction costs and the likelihood of faults or claims after the project is completed, thus reducing contractor risk.
- The contractor is a valuable partner in design development. Underline the important architectural issues, and discuss how the proposed solutions can be optimised in terms of quality, cost and buildability while preserving these issues. This will reduce contractor costs and risk while maintaining the central qualities of the proposed installation.
- Has the contractor considered the solar system as an integrated installation replacing other cladding/ roofing components? If not, he/she may be willing to exchange the cost saving of integrating the system with a higher level of detailing.
- Can cost savings elsewhere in the project be reinvested in a higher level of detailing of the solar system?

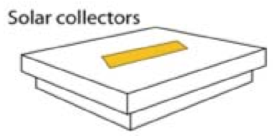
Part 3 :
Tools and References

07 Tools

Intro

Tools for solar design have a significant role to play for architects besides aiding them in solar design during the early design phase. Proper tools can be a powerful means of communication between actors throughout the entire design and construction process: from negotiations with the client and client's advisors to dialogue with engineers, solar consultants, component manufacturers and installers at later stages.

Architects obtain design commissions in a number of different ways – open or invited competitions, direct assignments, first feasibility studies etc. These obviously result in different biases in the focus and communication between the participants of these processes, but two common circumstances can be identified. Firstly, what designs and especially early stages come up with are *potential solutions*. And secondly, communicating architectural quality is intrinsically bound to the ability to produce a *visually and aesthetically convincing vision*.



Case Story: Communicating BPS

What if the architect runs simulation with BPS tools? How do they present it to the client?

Read more on page 93...

Image-making is the central activity in architectural design

The communication of architecture is inextricably linked to images and means of visual representation. This is usually taken for granted but the importance of this circumstance has to be underlined when considering how to convince a client of the architectural integration of active solar technologies.

The basic competence of architects is the communication of ideas by use of images – from clients in a presentation to an absent and anonymous jury in a competition. The old Chinese proverb „One hundred tellings are not as good as one seeing" not only holds especially true for architecture but is in fact the basic driver of all its ambitions. Architecture could not be thought, designed or built without images. The use of pictorial expression is one of the oldest and most profound means of communicating ideas.

7.1 Communicating with images

There are different forms of imagery in the architectural design process, and communication of architectural quality will rely on the successful combination of these. Roughly speaking, images in architectural production can be divided into two categories: abstract and/or diagrammatic representations addressing measurable and factual parameters on the one hand, and rendered images that appeal to the aesthetic senses on the other. While diagrams provide abstract information, renderings can be suggestive and persuasive. Issues of architectural integration are generally communicated with renderings of design, especially to non-architects.

Analytical imagery

The conventional plans, sections, elevations and axonometric views that architects produce every day with CAAD-Software are part of this first category, but the communication of solar component integration also requires plug-ins or stand-alone applications for solar and shading simulation. These simulations use simplified representations of the project to exclusively study and communicate issues of solar access and integration of solar energy systems, independently of other design issues.

Simulations and diagrams are ideal to communicate rational and quantifiable information. In the early design phase these may include quantifying solar access, analyzing shading issues, cost-benefit and sizing analyses, and comparative analyses between technologies and design alternatives. In later design phases such simulations are useful to communicate for example system organization and efficiency issues in order to finalize the detailed design.

Clear, well founded and well reasoned diagrams and analytical images in the early design phase are a key component in convincing a client to include solar energy systems in his/her project, by developing a clear understanding of the benefits of the proposed system, and ensuring a well-documented basis for decision-making.

Building Performance Simulation tools

Building Performance Simulation (BPS) tools allow the user to analyze, quantify and illustrate complex solar design issues, often within a 3D user interface. It is most likely the project engineer who runs these tools and the outcomes of such simulations are often presented in reports to the client.

Some of the CAAD tools commonly used in the early design phase (EDP) have the ability to perform solar studies of varying degrees of complexity and accuracy, and in most cases they can provide architects with an indication of qualitative solar incidence performance of one design variation over another (Figures 1, 2 and 3). The output of such tools can be very helpful in design

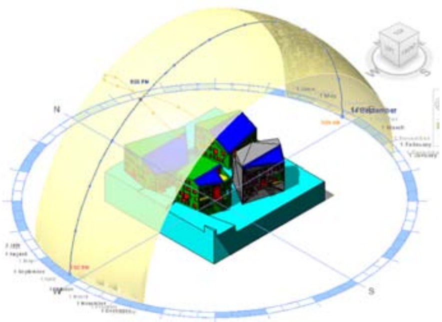


Figure 1: Revit: A sun path shows how natural light projects shadows onto the buildings due to neighboring buildings and terrain

Figure 2: VectorWorks, sun and shade study. Outputs such as this can aid the architect in design decision making and improve his/her communication with the engineer and/or solar consultant(s).

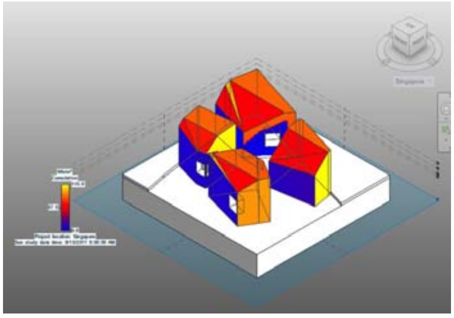


Figure 3: Project Vasari can present various solar radiation options: cumulative, average mean of hourly values, and peak maximum value in [kWh/m²/year]. Output such as this can help improve communication with engineer and solar consultant and can lead to joint decision making regarding solar strategies. In order to assist communication between architect and client such results could be transferred into potential energy savings or potential financial savings.

decision-making for the architect, as well as to communicate with other members of the design team.

However, this qualitative performance assessment is only sufficient for determining orientation and a rough overall form (shape) that may work in supporting active and passive solar strategies, as well as shadow studies.

For any kind of assessment /simulation where higher accuracy is expected, one must employ one of the more detailed simulation tools, such as Radiance (for daylighting and lighting), RETScreen, Lesosai (with built in PolySun module for PV and ST sizing), or even IES-VE. These programs require both advanced user knowledge (which is normally out of the architects' field of knowledge) and considerably more time.

In competition-based design processes time is often very limited, and the use of BPS tools is therefore even more limited – although it can be of great importance in developing and communicating a successful solar energy system. A further challenge in the use of building performance simulation tools is the lack of interoperability between different software packages. Instead of being able to import a building model from the architect's basic CAD tool it is often necessary to redraw everything and rebuild a digital model within the simulation tool itself.

Improved interoperability between tools (for example through gbXML or IFC formats) would contribute to better and faster communication between architects, engineers and solar consultants, because a new digital model would not have to be generated in the simulation tool for each new version of the architectural design. The development of BIM software standards and BIM tools can be expected to increase interoperability in the near future.

Rendering

The category of rendered images usually aims for a higher degree of realism than analytical images, often photo-realistic representations. Usually a perspective, a rendering presents a specific view of a project. Decisions are necessary as to which parts and specifics of a project will be included in a scene and which will inevitably be hidden from view.

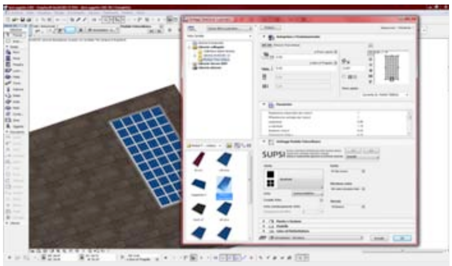
The higher the degree of simulation of the physical behavior of light the more realistic the rendering will become. The rendering engines integrated into most CAAD applications on the market are not capable of producing convincing photo-realistic images for solar systems. Third-party rendering applications set the standard at the high-end of architectural visualization as they not only calculate the physically correct behavior of light in a scene but also the lens, aperture, ISO, depth of field etc. of the camera that images are created with. Post-production software is commonly used to add the back- and foreground of a rendering as well as additional surface effects like blur, solar effects, people, activities and so on.

Renderings are ideal to communicate issues of aesthetics and architectural integration. While diagrams and simulations can document the quantifiable value of a solar energy system, renderings play an important part in communicating architectural quality. This allows the discussion of issues of colour, shape, texture, fixing and detailing in the context of the overall architectural identity of a project, allowing a client to make informed decisions and to visualize the consequences of their choices. Renderings and similar representation techniques are therefore a key element in communicating and realizing high quality architectural integration of solar energy systems.

Advanced CGI (computer-generated imagery) for the integration of solar energy technologies is currently an experimental field.

Figure 4: Visualization of proposal for evacuated tube collectors in front of listed building façade in Graz, Austria. Source: Institute of Architectural Typologies, Graz Technical University

Figure 5: Visualization of proposal for evacuated tube collectors in front of listed building façade in Graz, Austria. Source: Institute of Architectural Typologies, Graz Technical University



A number of PV plug-in modules for CGI tools are currently in development. The Solar Energy Research Institute of Singapore (SERIS) recently developed PV modules of 7 manufacturers for Revit (currently being tested). Similar modules are also being developed at the University of Applied Sciences and Arts of Southern Switzerland (SUPSI).

The number of existing libraries and models is very limited. The integration into advanced visualization relies on the skills, proficiency and willingness to experiment on the side of the CGI artist working with the architect.

7.2 Visualizing solar energy in the design process

The choice of tools, design methods and scope of visualizations will depend on the size and type of project and the current design phase. Many projects are built without any high quality visualizations at all, while others outsource the production of amazing promotional images to firms specialized in architectural visualization and illustration.

The ecological and economical aspects will generally best be communicated through diagrams and studies. The key to these diagrams is to be as clear as possible, excluding confusing or unnecessary details and focusing solely on the relevant information. Diagrams will therefore need to develop throughout the design process, as the relevant level of detail and design development increases.

If the integration of solar technologies does not affect the visual identity of a structure – e.g. collectors simply mounted on a flat roof that are rarely seen – there may be no reason for specifically addressing solar energy integration in the design renderings. However, if the integration of active solar technologies contributes to the visual identity of a building, renderings should play an important role in decision-making.

Though commonly developed in the detailed design phase, renderings can also play an important part early on in a project. This is especially true in the case of projects where the solar energy strategy is a key component of the client's goals or the architectural concept.

The choice of tools and design methods will ultimately depend on the size and type of project. However, better communication with engineers through an integrated design process (IDP) will almost certainly be beneficial regardless of the project size. Although identified as one of the best methods to successfully integrate all building systems within a holistic architectural identity, it is still not widely used. The main reason for this is that an IDP can be time consuming, especially in the early design phase and if a design team is unfamiliar with the process.

Figure 6: Alternative approaches for integrating solar thermal collectors into high rise apartment building from the late 1960 in the course of a renovation study, Source: Institute of Architectural Typologies, Graz Technical University

A possible solution is having the architect and engineer set up a simplified virtual model that can quickly give indications, for example to show if predicted energy consumption and/or energy production from active solar systems goes up or down when certain architectural decisions are made.

Another opportunity lies in the development of approximations and “rules of thumbs” similar to what architects use for structural components in the preliminary design stage. Such simplified and applicable rules could aid architects in design decisions and provide them with confidence during the early design phase and in negotiations with clients. In addition, this knowledge and confidence would provide a better starting point for communication between architects, engineers and solar consultants, when the design is to be fine-tuned in the detailed design phase.

Generally we can expect the average designers’ capability of producing high quality visualizations and simulations to increase due to a steady increase in performance in both software and hardware related aspects. Nearly photorealistic visualizations may be expected to become more and more of a standard even in early design stages, and the closer integration of CAD and building simulation software will reduce the threshold for performing advanced, early stage simulations. This tendency is very important in pushing the boundaries of architectural quality in the integration of active solar technologies. Not only because convincing architectural quality relies on convincing images and information, but because the earlier in the design process the question of solar energy systems becomes an active and visual quality of the building, the more likely the successful integration and realization of such systems.

IEA SHC Task 41 - Subtask B

Subtask B of the IEA-SHC Task 41, titled Tools and methods for solar design, has been dealing with identification of tools and design methods currently available to architects that are able to assist and support design decisions in the development of solar architecture, particularly at the early design phase (EDP). In the EDP, some of the crucial design decisions are made and the architect's impact is (or should be) the most critical. The first stage of work in Subtask B was to review and analyze the current software landscape available for architects, with a focus on early design phase (EDP) decisions of building projects, and to identify missing software tools and/or missing functionalities required for encouraging and enhancing solar design of buildings and the integration of solar systems and technologies. This review is titled: Report T.41.B.1: State-of-the-art of digital tools used by architects for solar design and includes 56 software packages which were classified in three categories: CAAD (computer-aided architectural design) tools, visualization tools and simulation tools; it is available at the IEA-SHC Task 41 website (http://www.iea-shc.org/publications/task.aspx?Task=41).

The second stage of the project aimed at learning from users, i.e. architects, about their satisfaction with currently available tools and methods for solar design, as well as to identify obstacles that they are facing especially during the early design phase. An international survey was carried out in 14 participating countries during 2010. Even though the response rates were lower than expected the findings were consistent with other similar studies covered in the literature review: software packages currently available to architects do not provide satisfactory support for solar design in the EDP. The most common barrier to respondents' use of tools related to architectural integration of solar design was that tools are too complex (18%). Further common barriers were that tools are too expensive (14%), that tools are not integrated in CAAD software (12%) and that the use of the tools takes too much time (11%). Respondents also stated that the tools do not adequately support conceptual design, that they are too systemic and that they are not integrated in normal workflow (10%). Only 2% of those who responded were satisfied with the existing tools. When asked about the needs for improved tools in each design phase, responses showed that the following categories were found important: improved tools for visualization of solar systems, tools for preliminary sizing, tools that provide quantitative feedback and tools for key data. The full report titled: T.41.B.2: International Survey about digital tools used by architects for solar design is also available at http://www.iea-shc.org/publications/task.aspx?Task=41

08 Task 41 Deliverables

The following reports and websites were developed within IEA SHC Task 41 Solar Energy and Architecture. The deliverables were developed by more than 30 experts in 15 partcipating countries in Europe, Australia, Asia and North America, and represent up-to-date information about key issues concerning the use and architectural integration of active solar energy technologies.

IEA Task 41 - publications and websites

Subtask A

T.41.A.1 "Building Integration of Solar Thermal and Photovoltaics – Barriers, Needs and Strategies"

This first report of subtask A describes the results of a large international survey on the reasons why architects do not use or rarely use solar technologies, and gives proposals to help overcome these barriers by identifying architects needs in this area.

T.41.A.2 "Solar Energy systems in Architecture - integration criteria and guidelines"

This document is conceived for architects and is intended to be as clear and practical as possible. It summarizes the knowledge needed to integrate active solar technologies (solar thermal and photovoltaics) into buildings, handling at the same time architectural integration issues and energy production requirements.

Solar thermal and photovoltaics are treated separately, but the information is given following the same structure: 1- Main technical information; 2- Constructive/functional integration possibilities in the envelope layers; 3- System sizing and positioning criteria; 4- Good integration examples; 5- Formal flexibility offered by standard products; 6 - Innovative market products.

To complete the information the manual ends with a short section dedicated to the differences and similarities between solar thermal and photovoltaic systems, which should help architects make an energetic and architecturally optimized use of the sun exposed surfaces of their buildings.

T.41.A.3/1"Designing solar thermal systems for architectural integration: Criteria and guidelines for product and system developers"

T.41.A.3/2 "Designing photovoltaic systems for architectural integration: Criteria and guidelines for product and system developers"

This deliverable is composed of two separate publications addressed respectively to manufacturers of photovoltaic and solar thermal systems. These two documents follow the same structure and are based on a common theoretical work. They describe the main criteria for a successful integration of solar systems in buildings and propose a methodology for the design of systems specifically conceived for building integration. For each specific solar technology and sub-technology, they provide a comprehensive set of practical recommendations that should lead to the production of new systems appealing to architects.

Web-site: "Innovative solar products for architectural integration"

This website shows in an attractive way the innovative/inspiring solar products for building integration now available on the market. The website is dedicated to architects and has three sections: photovoltaic, solar thermal and hybrid systems. By choosing a specific technology and integration approach (roof integration, façade integration, balcony…) the user receives a selection of appropriate products, presented in the form of virtual A4 sheets. These sheets include dedicated information, contact details and pictures, both of the product alone and in situation on buildings. http://leso2.epfl.ch/solar/index.php

Subtask B

T.41.B.1 "State-of-the-art of digital tools used by architects for solar design"

The first stage of work in Subtask B was to review and analyze the current software landscape available for architects, with a focus on early design phase (EDP) decisions of building projects, and to identify missing software tools and/or missing functionalities required for encouraging and enhancing solar design of buildings and the integration of solar systems and technologies. This report includes 56 software packages which were classified in three categories: CAAD (computer-aided architectural design) tools, visualization tools and simulation tools.

T.41.B.2 " International survey about digital tools used by architects for solar design "

The second stage of the project aimed at learning from users, i.e. architects, about their satisfaction with currently available tools and methods for solar design, as well as to identify obstacles that they are facing especially during the early design phase. An international survey was carried out in 14 participating countries during 2010. This deliverable is the full survey report, with a description of the survey and a detailed discussion of the results.

T.41.B.3 "Solar Design of Buildings for Architects: Review of Solar Design Tools"

The third report of subtask B presents the capabilities of 19 CAAD and BPS digital tools for solar design, in order to increase overall awareness, and provide inspiration and incentive for the future choice of tool(s). The review was carried out by using the same building model as input for all tools, as far as possible. In addition, the second part of the report presents three exemplary case stories that intend to convey valuable experience as they describe different design approaches, which tools were used and how the use of solar design tools affected the design process and final architectural design.

T.41.B.4 "Needs of architects regarding digital tools for solar building design"

One important outcome of Task 41 is a reach-out to the industry and digital tool developers in the form of a letter, clearly stating the perceived needs of professional architects, as they had been identified through the international survey and by Task 41 experts through experience and research reviews.

"Solar components 3D parametric CAAD objects"

Developed by the Institute for Applied Sustainability to the Built Environment (ISAAC) in collaboration with IDC AG, the Swiss national Graphisoft distributor (responsible for CAD object programming), as a part of a national Swiss project: BiPV Tools, Interactive tools and instruments supporting the design of building integrated PV installations. The objects are compatible with both Graphisoft ArchiCAD and Autodesk AutoCAD. The main goals of the new tool are: to speed up the rendering procedure when integrating PV system in building design, to facilitate and to stimulate the use of BiPV (Building integrated Photovoltaic) systems by architects and designers and to improve the architectural quality of BiPV systems.The modules are available for free download from the following website : www.bipv.ch/index.php?option=com_content&view=article&id=338&Itemid=306&lang=en

Subtask C

T.41.C.1 "Communication Guideline"

In order to stimulate an increased use of solar in energy conscious building design, the Task 41 participants have developed a Communication Guideline as a tool to support architects in their communication process with especially clients, authorities and contractors. Today the energy performance of solar solutions is well documented and well known especially in the "technical environment". This knowledge, however, needs to be communicated in a convincing way to the decision makers in order to ensure a broad implementation of sustainable solar solutions in future building design. The Communication Guideline includes convincing arguments and facts supporting the implementation of solar based design solutions, and includes references to the other IEA SHC Task 41 deliverables. The Communication Guideline is divided in three main parts:

- Part 1: Convincing clients to request and commission solar buildings
- Part 2: Communication strategies at the design/ construction team level
- Part 3: Tools and References

The guideline is available at the IEA SHC Task 41 website (www.iea-shc.org/task41).

Web-site: "Collection of case studies of architecturally attractive solar buildings"

In Subtask C a collection of case studies demonstrating architecturally attractive energy efficient solar buildings has been developed. The case study collection includes a wide range of new built or retrofitted building types. The solar technologies include passive elements and active elements (PV and Solar Thermal). More than 200 case studies have been proposed and evaluated by a broad range of trained architects from universities, research institutes, dissemination organisations and professional practices. Around 65 projects from 12 countries are included in the Collection of Case Studies. The evaluation process has focussed on criteria of specific importance with respect to architecture and energy:

- The overall global composition: How is solar energy integrated in the whole concept of the building and contributes to high architectural quality
- Detailed description of surface and materials: How is solar energy used in considerations of design which contributes to architectural quality
- Added value and functions: How does solar energy contribute to spatial experiences or other added values which contribute to architectural quality

The Collection of Case Studies is available at the IEA SHC Task 41 website (www.iea-shc.org/task41). From here one can download case studies from various categories: Solar Technology, Project Type, Country, Typology, Building Type and Construction Year.

09 Annex

Publications related to Task 41 issues in different IEA activities

IEA	Title	Authors/editors	Year
ECBCS-Annex 38	Exemplary Sustainable Solar Houses		
	Sustainable Solar Housing (2 vols.)	Edited by Robert Hastings and Maria Wall	2006
	Bioclimatic Housing: Innovative Designs for Warm Climates	Edited by Richard Hyde	2007
	The Environmental Brief: Pathways for Green Design	Richard Hyde, Steve Watson, Wendy Cheshire, Mark Thomson	2006
	Design Insights from the Analysis of 50 Sustainable Solar Houses	edited by Christel Russ	2006
ECBCS-Annex 44	Integrating Environmentally Responsive Elements in Buildings		
	State of the Art Review. Volume 1 State of the Art Report	Øyvind Aschehoug and Inger Andresen (editors)	2008
	State of the Art Review. Volume 2A Responsive Building Elements	Marco Perino (editor)	2008
	State of the Art Review. Volume 2B Integrated Building Concepts	Inger Andresen, Tommy Kleiven, Mary-Ann Knudstrup and Per Heiselberg (editors)	2008
	State of the Art Review. Volume 2B Methods and Tools for Designing Integrated Building Concepts	Inger Andresen, Tommy Kleiven, Mary-Ann Knudstrup and Per Heiselberg (editors)	2008

IEA	Title	Authors/editors	Year
	Expert Guide. Part 1 Responsive Building Concepts	Per Heiselberg (editor)	2009
	Expert Guide. Part 2 Responsive Building Elements	Øyvind Aschehoug and Marco Perino (editors)	2009
	Designing with Responsive Building Elements	Ad van der Aa, Per Heiselberg, Marco Perino	2011
ECBCS-Annex 45	Energy-Efficient Future Electric Lighting for Buildings		
	Guidebook on Energy Efficient Electric Lighting for Buildings	Liisa Halonen, Eino Tetri & Pramod Bhusal (editors)	2010
SHC-Task 8	Passive and Hybrid Solar Low Energy Buildings		
	Design Information Booklet No. 6 - Passive Solar Homes: Case Studies	H. Kok, Bowencentrum, The Netherlands & M. J. Holtz, Architectural Energy Corp., U.S.A.	1990
	Design Information Booklet No. 3 - Design Guidelines: An International Summary	M. J. Holtz	1990
	Design Information Booklet No. 7 - The Design Language	Sergio Los, Roberto Grossa, Natasha Pulitzer	1988
	Design Information Booklet No. 2 - Design Context	H. Schreck, G. Hillmann, J. Nagel, IBUS GmbH	1988
SHC-Task 13	Advance Solar Low Energy Buildings		
	Solar Energy Houses: Strategies, Technologies, Examples	Hestnes, A.G., S.R.Hastings, and B.Saxhof	1996
SHC-Task 16	Photovoltaics in Buildings		
	Photovoltaics in Buildings: A Design Handbook for Architects and Engineers	Friedrich Sick and Thomas Erge	1995
SHC-Task 39	Polymeric Materials for Solar Thermal Applications		
	Architectural integration of solar thermal energy systems	This database presents a range of buildings where solar thermal energy systems have been successfully integrated in the architecture.	2012

IEA SHC	Title	Key content	Available at
Task 23	Blueprint for a Kick-off Workshop	This document is a basis for the organization of a design team workshop at the very beginning of the integrated design process. The main objective of the workshop is to create common understanding at the beginning of the design process with regard to three important notions:knowledge about the integrated design process, a clear perception of the design task, a co-operative and open attitude towards the other members of the design team.	http://www.iea-shc.org/publications/downloads/kickoff.pdf
Task 23	Solar Low Energy Buildings and the Integrated Design Process - An Introduction	This is an introductory booklet that explains what Task 23 is about. It briefly addresses the integrated design process, how it was put into practice and what we can learn from that.	http://www.iea-shc.org/publications/downloads/introduction.pdf
Task 23	Integrated Design Process - A Guideline for Sustainable and Solar-Optimised Building Design	Integrated Design Process - a Guideline for sustainable and solar-optimized building design. This guide elaborately discusses theory and practice of the Integrated Design Process.	http://www.iea-shc.org/publications/downloads/IDPGuide_print.pdf

Other Design Guidelines for Solar Energy and Architecture

Country	Title	Key content	Available at
AT	Fink Ch. (AEE Intec), Breidler J. (AEE Intec): „Solar Systeme im Objektbau – Ein Leitfaden zur Planung, Umsetzung und Betriebsführung“ (Neue Energien 2020)	Guidelines about the planning, realization and maintenance of solar systems in the building contruction.	www.klimaaktiv.at/filemanager/download/72814
AT	Geissler, S. et al.: Planung von Plus-Energie Gebäuden auf der Basis einer optimierten Nutzung der Gebäudeflächen für Energiebereitstellungs-technologien, in: Tagungsband 2. Symposium Aktiv-Solarhaus Luzern 22.-23. Sep 2010, S.74-81. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI)	The Conference guide includes information about: Planning of Plus-Energy buildings as a basis for cost optimal use of the building envelope for energy generating technologies.	ISBN:978-3-941785-13-7

Country	Title	Key content	Available at
AT	Grazer Energieagentur: DenkMALaktiv – Sanierung alter, denkmalgeschützter Gebäude auf Aktivhausstandard. Graz 2011	Provides information about the project ´denkmalaktiv´: retrofit of old, heritage protected buildings to energy generating buildings.	http://www.grazer-ea.at/cms/projekte/denkmalaktiv/content.html
AT	Heimrath, R.: Simulation, Optimierung und Vergleich solarthermischer Anlagen zur Raumwärmeversorgung für Mehrfamilienhäuser, 2004.	Technical dissertation about simulation, optimisation and comparison of solarthermal systems for the hot water supply of multy family houses.	Dissertation TU Graz
AT	Treberspurg, M.: Neues Bauen mit der Sonne – Ansätze zu einer klimagerechten Architektur. Zweite, aktualisierte und erweiterte Auflage, Wien, New York: Springer 1999.	This book is about solararchitecture. It informs about different approaches about climate adapted design.	ISBN: 978-3211829400
AT	Photovoltaic Austria - Federal Association	Association of Austrian Photovoltaic industry providing useful data and statistics for national subsidies, feedin tarifs, basic planning facts, etc.	http://www.pvaustria.at
AT	solarfassade.info	building integrated photovolatics: provides information on planning fundamentals, economic efficiency, implementation and architectural aspects, case studies, suppliers, etc.	http://www.solarfassade.info
AT	Austria Solar - Federal Association for Solar Thermal Systems	Association of Austrian Solar thermal industry providing useful data and statistics for national subsidies, feed-in tarifs, basic planning facts, etc.	http://www.solarwaerme.at
AT	klima:aktiv - the Austrian climate protection initiative	Information portal that provides useful information for the thematic clusters Building, Energy Efficiency, Mobility and Renewable Energy	http://www.klimaaktiv.at
CAN	Roadmap for Integrated Desogn Process Developed for BC Green Building Roundtable Prepared by Busby Perkins + Will and Stantec Consulting	Busby Perkins+Will, in collaboration with Stantec Consulting Ltd., have produced the Roadmap for the Integrated Design Process (IDP). Developed for the British Columbia (BC) Green Building Roundtable, the design industry increasingly accepts that an IDP is required in order to achieve high performance, sustainable buildings while avoiding or minimizing incremental costs.	http://www.greenspacencr.org/events/IDProadmap.pdf
CAN	Solar energy for Buildings Introduction: Solar Design Issues by Keith Robertson and Andreas Athienitis	This Introduction to Solar Design Issues, presents basic notions of solar design and describes different passive, active and hybrid systems and the solar aspects of design elements, which include window design, cooling and control, and water heating.	http://www.cmhc-schl.gc.ca/en/inpr/bude/himu/coedar/upload/OAA_En_aug10.pdf

Country	Title	Key content	Available at
CAN	Daylighting Guide for Buildings by Keith Robertson	The intent of this Guide is to explain daylighting design principles for buildings and to assist designers in locating useful sources of tools and information.	http://www.cmhc-schl.gc.ca/en/inpr/bude/himu/coedar/upload/Daylighting-Guide-for-Buildings.pdf
CAN	NRCan - CANMETEnergy website	Various publications	http://canmetenergy.nrcan.gc.ca/renewables/solar-photovoltaic/562
CAN	Solar Building Research Network website	Various publications	http://www.solarbuildings.ca/
CAN	Tap the Sun - Passive Solar Techniques and Home Designs: CD Rom Included by Canada Mortgage and Housing Corporation (CMHC)	The only Canadian guide of its kind covers all aspects to consider with respect to passive solar houses and techniques: solar radiation, solar energy collection and window performance, heat storage and distribution, shading and summer comfort, window selection considerations, design integration, site planning and overheating. The CD-ROM contains database of window manufacturers and products, program that estimates appropriate window area for a house, and more (2006).	ISBN-10: 0660172674 ISBN-13: 978-0660172675
CAN	RETScreen® Clean Energy Project Analysis Software	RETScreen clean energy decision-making software. Free-of-charge, provided and supported by CANMETEnergy, Natural Resources Canada (NRCan). Although not primarily targeted to architects as users, a considerable number of architects who are interested in solar design in Canada are using it.	http://www.retscreen.net/ang/home.php
CH	Photovoltaik und Architektur: Die Integration Von Solarzellen in Gebäudehüllen (in German, French, Italian, English) The Integration of Photovoltaic Cells in Building Envelopes	This book presents technical and design requirements for photovoltaic facades and roofs, and demonstrates how they can be integrated into architecture. It provides a collection of 48 buildings, plans and visions as well as background information on physics, engineering and energy.	Othmar Humm, Peter Toggweiler, Birkhäuser, 1993
CH	Energiekollektoren - Empfehlung zur Auswahl und zur Anordnung (in German) - Active-solar products - Guidelines for selection and layout	In 1994, the publication of the canton of Berne was the first one giving guidelines on the legal background for the installation of active-solar products as well as guidelines and expamles on how to layout and to integrate active-solar products. Over time, most cantons have followed this example.	Amt für Gemeinden und Raumordnung, Bern, 1997

Country	Title	Key content	Available at
CH	Integration von Solaranlagen (in German) Integration of solar plants	Provision of rules for the integration of solar plants on buildings as well as easy understandable and well illustrated documentation of good and bad examples. It is meant for building authorities, planners, clients and technical associations.	Solar Agentur Schweiz / Swiss Solar Agency, 2003, www.solaragentur.ch
CH	Solar-Architektur - Entwurfsprozess und Umsetzung (in German) - Solar architecture - design process and implementation	Illustration of architectural potential of photovoltaics, looking at building physics, estethics and energy production as well as design process, timetable and actors involved. In addition, it provides a checkliste for the design and construction process using photovoltaics.	Bundesamt für Energie BFE, CH-3003 Bern, 2006, www.admin.ch/bfe
CH	Solare Siedlungsentwicklung - Raumplanung mit der Sonne (in German) solar settlement development - urban and regional development with the sun	In view of an optimised urban development including solar strategies, this publication provides examples on how to use photovoltaics in different settlement structures, interfaces between urban planning and basics of energy efficieny as well as case studies, guidelines and examples of existing solar developments.	Bundesamt für Energie BFE, CH-3003 Bern, 2006, www.admin.ch/bfe
CH	Solarstrom in der Gemeinde - Beispiele, Erfahrungen, Massnahmen (in German) Solar energy in communities - examples, experiences, measures	This publication investigates the possibilities for increased implementation of photovoltaics in communities. It gives tangible examples, from parking meters to solar cities as well as collaboration possibilities for communities.	Bundesamt für Energie BFE, CH-3003 Bern, 2006, www.admin.ch/bfe
CH	Bauen mit Solarenergie (in German) - Building with solar energy	This publikation presents 40 seminal residential buildings, describing the variety of design solutions as well as indicating future trends. Besides the technical aspects, it also integrates experiences of architects and inhabitants.	Christian Hanus, Robert Hastings, vdf Hochschulverlag AG, 2007
CH	Architectural integration and design of solar thermal systems	Investigation of possibilities to enhance the architectural quality fo building integrated solar thermal systems for facade integration.	Maria Cristina Munari Probst, 2009
CH	Building integrated photovoltaics (BiPV)	BiPV online database presents different buildings with good solar system integration. Together with a short description of the building, these examples provide a table with the specification of the installed solar system. A BiPV product database is also available at the same web-page.	Supsi, www.bipv.ch

Country	Title	Key content	Available at
CH	Sustainable Renovation of Historical Buildings (SuRHIB)	SuRHIB, a research project commissionned by Swiss Federal Office of Energy (SFOE), presents an exustive report with best practice examples and guidelines for solar system integration (PV and ST) on historical building.	Supsi, 2010, www.ccem.ch/surhib
DK	Solceller i arkitekturen (in Danish) - Solar cells in architecture	An architectural evaluation of buildings examples with integrated photovoltaics. Seven examples from Denmark and countries with similar climate and solar conditions are selected to serve as inspiration for architects and building owners to use PV in buildings.	Statens Byggeforsknings-institut, www.sbi.dk
DK	Arkitektur og energi (in Danish) - Architecture and energy	A design guide focussing on the interaction between architecture and energy in a hollistic view. The book includes numerous valuable design guide especially with respect to utilisation of daylight and passive solar energy.	Statens Byggeforsknings-institut, www.sbi.dk
DK	Integreret Energidesign - IED (In Danish) - Integrated Energy Design - IED (in English, short version)	A design guide about how to implement Integrated Energy Design. The design guide is to be used in a close cooperation between client, architect, energy designer and other consultants i the project team.	Esbensen Consulting Engineers A/S, www.esbensen.dk + www.intendesign.com
DK	Solceller + arkitektur (in Danish) - Solar cells + architecture	This book deals with the architectural potential of PV and its possible use in construction. Primarily it serves as inspiration for clients architects and engineers.	Arkitektens forlag, www.arkfo.dk
ES	Guía de integración solar fotovoltatica	Examples of architectural integration of PV systems. Not all the examples presented are located in Spain.	fenercom, www.fenercom.com
ES	Clima, Lugar y Arquitectura (Rafael Serra, 1989)	A clasical handbook for passive architecture and bioclimatic design in Spain	CIEMAT, www.ciemat.es
ES	Acondicionamiento y energía solar en arquitectura (César Bedoya y Javier Neila, 1986)	Classical handbook for passive architecture and its relationship to heating, cooling and natural lighting	COAM, www.coam.org
ES	Proyectos Emblemáticos en el Ámbito de la Energía I (2005)	This is a divulgation series for singular projects regarding energy in a broad sense.	fenercom, www.fenercom.com
ES	Proyectos Emblemáticos en el Ámbito de la Energía II (2006)	This is a divulgation series for singular projects regarding energy in a broad sense.	fenercom, www.fenercom.com
ES	Proyectos Emblemáticos en el Ámbito de la Energía III (2007)	This is a divulgation series for singular projects regarding energy in a broad sense.	fenercom, www.fenercom.com

Country	Title	Key content	Available at
ES	Proyectos Emblemáticos en el Ámbito de la Energía IV (2008)	This is a divulgation series for singular projects regarding energy in a broad sense.	fenercom, www.fenercom.com
ES	Proyectos Emblemáticos en el Ámbito de la Energía V (2009)	This is a divulgation series for singular projects regarding energy in a broad sense.	fenercom, www.fenercom.com
ES	Integración de la Energía Fotovoltaica en Edificios (Nuria Martin, 2011)	Design manual focusing on PV architectural integration in buildings and urban areas with examples covering each technique	Progensa, www.progensa.com
GER	DGS: Leitfaden Photovoltaische Anlagen, 4th version, 2010.	Technical guideline for planning and dimensioning of PV systems including history, basic information, components, mounting systems, etc., computer and simulation programs, economics (also English, Spanish, Italian, Portuguese version available).	http://www.dgs-berlin.de/lfpv.0.html
GER	DGS: Leitfaden Solarthermische Anlagen, 8th version, 2008.	Technical guideline for planning and dimensioning of solar thermal systems including basic information, components, etc., computer and simulation programs, economics (also English, Spanish, Italian, Portuguese version available).	http://www.dgs-berlin.de/lfst.0.html
GER	Ingo B. Hagemann: Gebäudeintegrierte Photovoltaik: Architektonische Integration der Photovoltaik in die Gebäudehülle, 2002.	This book gives an overview of the technical and artistic aspects of photovoltaics. A lot of examples are shown and illustrated. Different modules and integration options are explained in detail.	ISBN-10 3481017766
GER	Krippner, R.: Die Gebäudehülle als Wärmeerzeuger und Stromgenerator, in: Schittich, Ch. (Hg.): Gebäudehüllen. München, 2006	This book is about building envelops as heating and electricity generator.	ISBN:978-3764376338
GER	Krippner, R.: Solartechnik im Spannungsfeld von innovativer Gebäudehülle und energetischer Sanierung. Schittich, Christian (Hg.): Solares Bauen. München (u.a.) 2003	This book deals with solar applications for innovative building envelopes and energy retrofit of building.. It informs about realized projects, product informations and materials.	ISBN:978-3764307097
GER	Ralf Haselhuhn: Photovoltaik - Gebäude liefern Strom, 2010.	Detailed explanation of how PV works, which differences exist and how to plan a PV system (separate chapters for renovation and new buildings). Detailed information for constructional integration of PV. Basic law and construction permission concerning issues. Quality, certificates, yield, costs. New developments.	Beuth-Verlag

Country	Title	Key content	Available at
GER	Susanne Rexroth (Editor): Gestalten mit Solarzellen. Photovoltaik in der Gebäudehülle, 2001.	Chapters like articles of different authors. Design potential of PV, Case Studies, function, new materials and technologies.	ISBN 3-7880-7700-X
GER	Christian Schittich: Im Detail: Solares Bauen - Strategien, Visionen, Konzepte	This book deals with multifunctional facade surfaces, organic solar cells, solar thermal, photovoltaics and HVAC, but also with urban planning and sustainable design. Examples explain different concepts and possibilities.	ISBN 978-3-7643-0709-7
GER	Umweltbewusstes Bauen Energieeffizienz - Behaglichkeit - Materialien	38 articles concerning energy efficiency, comfort and materials; subjects like sunshades, computer simulated room climate models or aspects of preservation of historical monuments etc.	ISBN 978-3-8167-7576-8
GER	Bernhard Weller, Claudia Hemmerle, Sven Jakubetz und Sefan Unnewehr: Photovoltaik - Technik Gestaltung Konstruktion, 2009.	Includes: basic information about PV; form design with PV; construction and integration of PV; technical rules and laws for PV which have to be considered; examples.	ISBN 978-3-920034-25-6
GER	Johann Reiß, Martin Wenning, Hans Erhorn, Lothar Rouvel: SOLARE FASSADENSYSTEME. Energetische Effizienz - Kosten - Wirtschaftlichkeit. 2005.	The book documents research projects with energetical retrofit of buildings. Different buildings and the applied retrofit strategies are presented in connection to the economics and the monitoring data. Calculations and simulated data are also shown.	ISBN 3-8167-6433-9
GER	Simon Roberts - Gebäudeintegrierte Photovoltaik	This book is only about technical and aesthetical aspects, no economics, costs, feed-in tariffs or CO2-savings. More than 10 examples are presented, starting with the geografical location of the building, and other PV influencing factors like radiation, area etc. The types of PV systems are categorized in e.g. shading system, weather protection, different facade types, atria.	ISBN-10 9783764399498
GER	Ökologische Architektur - ein Wettbewerb	40 Case Studies (ecological architecture) - ca. 10 project do not include passive or active solar; ca. 25 include passive solar; ca. 4 include PV and ca. 20 include solar thermal. For every project: short description, fotos and technical drawings.	ISBN 3-7667-1147-4
GER	Photovoltaik Engineering - Handbuch für Planung, Entwicklung und Anwendung	includes: description of the behaviour of solar cells; calculation of adjustment problems; dimensioning of solar systems in island mode	
GER	Schempp, Krampen, Möllring: Solares Bauen, 1992.		ISBN 3-481-00386-2

Country	Title	Key content	Available at
GER	Odersun AG: Leitfaden für BiPV-Projekte, 10.06.2011.	Short guideline about most important aspects for projects including BIPV. No detailed technical information. Not independent since Odersun AG is a manufacturer of thin film PV modules for BIPV. Good for first information. (29 pages).	http://www.odersun.com/uploads/pdf/Odersun-BiPV-Leitfaden-110610.pdf
GER	Holger Walter Regenerative Energiesysteme Grundlagen, Systemtechnik und Anwendungsbeispiele aus der Praxis 2011		ISBN 978-3-8348-1040-3
GER	Andreas Walter Photovoltaik Engineering Handbuch für Planung, Entwicklung und Anwendung (VDI-Buch) 2010		ISBN 978-3-642-05412-9
IT	B. Del Corno, G. Mottura: L'integrazione architettonica dei sistemi solari e fotovoltaici.	Guidelines and solutions, collection of several projects with drawings and pictures	ISBN 978-88-387-5217-6
IT	Guida alle applicazioni innovative finalizzate all'integrazione architettonica del fotovoltaico, 4° conto energia DM 5 maggio 2011	Description of required system characteristics to access the BiPV incentive schemes	GSE (www.gse.it)
IT	N. Aste: Il fotovoltaico in architettura, l'integrazione dei sistemi a energia solare negli edifici	Book on photovoltaic systems and their potential for the building sector (2008)	ISBN 9788851300999
IT	F. Groppi, C. Zuccaro: Impianti solari fotovoltaici a norme CEI, guida per progettisti ed installatori	Manual on design and installation of PV systems. It includes one chapter on BiPV applications. (2011)	ISBN 978-88-97323-01-3
IT	Frontini F.: Daylight and solar control in building: a new angle selective see-thorough PV-façade for solar control	This book is part of a PhD thesis dealing with Solar Control and Daylighting system integrating photovoltaic technology. The author presents the optimization of a new transparent facade integrating PV element.	ISBN 978-3-8396-0238-6
IT	Frontini F, Kuhn T. E.: A new angle-selective, see-through bipv façade for solar control	The authors present the optimization study of a new transparent facade integrating PV element. Different simulation analysis are performed to assess the properties of the facade for solar control and glare purposes.	Proceedings of Eurosun Conference 2010, Graz, September 2010.
IT	Frontini F., Zambelli E., Salvalai G., Masera G: Sustainable Smart-ECO Buildings: an integrated energy and architecture design (IEAD) process to optimize the design of the new buildings for the Technical University in Lecco, Italy	The authors present and integrated energy and architecture design process for the design of a new educational buildings. This process integrates both architect and buildings specialists which performed advanced daylight and thermal simulations.	Proceedings of REHVA world congress Clima 2010. Antalya. 2010

Country	Title	Key content	Available at
IT	Lobaccaro G., Masera G. and Poli T.: Solar districts: design strategies to exploit the solar potential of urban areas	This paper investigates what sort of influence energy issues can have on the design of new districts or buildings in urban areas, where the overshadowing by existing constructions can reduce the potential for solar energy production.	ISBN 978-975-561-417-5 Proceedings of the XXXVIII IAHS World CongressIstanbul, TURKEY April 16-19, 2012
IT	L.Maturi et al: Building skin as electricity source: the prototype of a wooden BIPV façade component	Paper on the development of the prototype of an innovative BIPV façade component	www.eurac.edu
IT	Salvalai G., Frontini F, Zambelli E: Integrated Design of low-energy houses in Selvino, Italy	This paper shows a practical example of a holistic design process integrating architectural, technological and energetic issues; the result is a low-energy building with a contemporary architecture that suite perfectly to the specific context. Using a holistic design process characterized by the integration of architectural and technological choices, the ambitious target of 30 kWh/m2a was reached.	Proceedings of Portugal SB10: Sustainable Building Affordable to All. 2010
IT	L.Maturi: Integrazione architettonica del fotovoltaico in facciata: innovazione e problematiche	Article on innovattion aspects and problematics of BiPV façade systems	SAIE TODAY, 2010
IT	L.Maturi et al: Analysis and monitoring results of a BIPV system in Northern Italy	Paper on analysis and monitoring results of a PV retrofit system integrated into the facade of an office building in Northern Italy	www.eurac.edu
IT	A. Belleri et al.: Natural night ventilation as passive design strategy for a Net Zero Energy office building	Paper on natural ventilation strategies applied to a case study to achieve NZEB (net zero energy building) target through an IDP (integrated design process)	http://re.jrc.ec.europa.eu/energyefficiency/events.htm
NO	Balansert samspill i byggeprosjekter (norwegian)	This publication describes ways in which cooperation between clients, construction contractors and technical contractors can be organised in order to optimise performance.	TELFO, http://www.arkitektur.no/?nid=146359&lcid=1044&pid0=155001
NO	Fra C til A - en veileder for byggherrer med energiambisjoner (norwegian)	A guideline for low energy new-build and refurbishment projects.	Grønn Byggallianse, www.byggalliansen.no
NO	Miljø i byggeprosessen (norwegian)	A website with guidelines for each phase of a typical design process, including key issues for each stakeholder and process recommendations.	Byggemiljø, http://www.byggemiljo.no/category.php/category/Milj%F8%20i%20byggeprosessen/?categoryID=264
NO	Integrated Energy Design - IED (project website with publications)	Project website for the INTEND Integrated Energy Design project, including design process publications and guidelines.	www.intendesign.com

Country	Title	Key content	Available at
NO	Planlegging av solvarmeanlegg for lavenergiboliger og passivhus. En introduksjon (norwegian)	An introduction to integration of solar thermal systems in low-energy housing, aimed at architects and consultants.	SINTEF, http://www.arkitektur.no/?nid=184200&pid0=155001
PT	Gonçalves, Helder et al: Edifícios Solares Passivos em Portugal, I.N.E.T.I, Lisboa 1997	This book describes 19 passive solar buildings which have been constructed in Portugal between 1980 and 1990.The use of passive systems and strategies is studied in order to get detailed information in terms of construction, thermal parameters, type of passive systems used and thermal evaluation.	ISBN 9726761638, 9789726761631
PT	A Green Vitruvius - Princípios e Praticas de Projecto para uma Arquitectura Sustentável, Ordem dos Arquitectos, Lisboa 2001	Guidelines about principles and practice of sustainable architectural design. This book provides a valuable introduction to the subject, and a clear and attractive text for architects, building designers, as well as for students.	ISBN 9729766827, 9789729766824
PT	Francisco Moita: Energia Solar Passiva, Argumentum, Lisboa 2010	The book explains how solar energy can be a practical contribution to achieve energy cost savings in buildings. Passive solar technologies, bioclimatic principles, thermal comfort and building heating and cooling loads are the principal topic.	ISBN 9789728479732
PT	Repositório aberto, Faculdade de Arquitectura, Porto	This is a short collection of links to the national university repositories. Academic works represent a relevant source of knowledges about the use of solar energy and technology in architecture. Results of research projects, scientific papers, PhD or master thesis can be useful tools for architects and engineers, as well as the photovoltaic manufacturing companies or energy designers.	http://repositorio-aberto.up.pt/handle/10216/1849
PT	Repositório Científico Lusófona, Faculdade de Arquitectura, Urbanismo, Geografia e Artes, Lisboa		http://recil.grupolusofona.pt/jspui/handle/10437/722
PT	Dissertações do Departamento de Engenharia Civil e Arquitectura, Instituto Superior Técnico,Lisboa		https://fenix.ist.utl.pt/publico/department/theses.do?method=showTheses&selectedDepartmentUnitID=61159&contentContextPath_PATH=/departamentos/decivil/lateral/ensino/dissertacoes&_request_checksum_=e31d5be04e8d9f16c680b614bb81f84566263c4c
PT	Repositório Universidade Nova, Faculdade de Ciências e Tecnologia,Lisboa		http://run.unl.pt/handle/10362/2085
PT	Associação Portuguesa da Indústria Solar	Association of Portuguese Photovoltaic Industry	http://www.apisolar.pt/

Country	Title	Key content	Available at
SE	Aktiv solenergi i hus- och stadsbyggnad - samtida perspektiv och framtida möjligheter, 2004, Lundgren, M. & Wallin, F.	Active use of solar energy in architecture and urban planning	Arkus, ElForsk
SE	Photovoltaics in architecture - lessons learned in PV Nord, 2004, Lundgren, M. & Torstensson, K.	Examples of solar panels and cells in architecture	www.pvnord.org
SE	Solenergiboken, Andrén, L.	Book with simple rules of thumb for solar energy and with an overview of available technology	www.drivkraft.nu
SE	Solen - framtidens basenergi, SSolar		http://www.ssolar.com/Solenergi/SolenFramtidensbasenergi/tabid/599/Default.aspx
SE	Solceller i arkitektur & stadsbyggnad	Information about photovoltaic cells in architecture and urban planning	www.energimyndigheten.se
SE	Räkna med solenergi	Basic information about solar energy / application in Sweden	www.svensksolenergi.se

Case stories

i) Green Lighthouse

The new design of the Faculty of Science of the University of Copenhagen, focused on a low-energy building, was achieved through the means of an invited competition. The Danish architectural office Christensen & co were one of the invited architectural offices, eventually winning the competition and designing the new faculty.

During the competition phase, Christensen & co started by organising workshops with both architects and external engineers where ideas were put forward regarding the design of the new faculty. In some workshops the end users of the projects and the contractor were also invited. Participants focused from the beginning of the design process on working together in order to establish an integrated approach, and not for instance ending up in a situation in which active solar systems would be added to the building without it being considered as a part of the whole building design. Ideas were put forward concerning the architectural, organisational, and technical aspects of the project without any line drawn in the first period of time. The client had set up the

ambitious goal of reaching a low-energy building on the levels of the 2020 building regulations. The project team focused mainly on using the sun as a primary energy source to heat and light the building, including a strategy for well-insulated walls, solar shading, and solar panels to provide electricity. A circular shape was chosen in order to save material and to be able to fully exploit the course of the sun in the context of the building.

After some workshops, first ideas were drawn by the architects in Autocad (2-dimensional). Computer models were drawn and tested by both the architect and engineer mainly concerning daylight and energy. About 5 or 6 different softwares were used during the competition phase; mainly Ecotect, Daylight Visualiser, IES VE and BE06 (a Danish building regulation tool). Different design options were evaluated within different simulation programs and the best option taking into account all parameters was chosen. The architect who was project leader called it evidence-based designing.

After winning the competition, the building was developed further. New workshops were held, in which the architects, engineers, and the contractor participated. An interesting aspect in this design process was that several companies offered their prototype building products to be incorporated in the building. It required the architects to redesign the detailing and plans in order to fit the new products into the design, since some prototypes required non-standard solutions.

During several workshops, the number of engineers totally exceeded the number of architects. The architects still experienced the cooperation as fruitful, even though so many engineers were involved and worked for different firms, because all participants had the same goal for the project. The involved engineers were keen on participating in this project since the project had the goal to be a showcase building for future sustainable building, and many new technologies were deployed in this design. Also, since the design process of the building was so short, all decisions had to be made quickly and all participants in the design process had to be well-informed.

The actual construction period was short and even though a lot of new prototype building elements were used, it did not lead to any difficulties. All construction workers were well-informed about their role in the well-functioning of the building and special attention was paid on the construction of the airtight layer in the outer walls.

back to main text...

ii) Communicating Building Performance

What if the architect runs simulation with Building Performance Simulation (BPS) tools? How do they present it to the client? One clear example of communication with the client about the energy use and the impact on the building can be seen in Figure 4. Different options with changing design parameters can demonstrate different predicted energy use. In this step-by-step layout, the architect presented different design solutions, including solar energy use. It shows both the impact on the architecture as well as on the energy performance of the building. Together with a step-by-step financial assessment, the client gets an attractive and well-detailed overview of the energy performance and costs. This form of presentation can definitely prompt the client to discuss different options and help them decide, but is as yet an exception, as it requires time and resources which are often lacking at the stage where appropriate negotiations with the client are taking place.

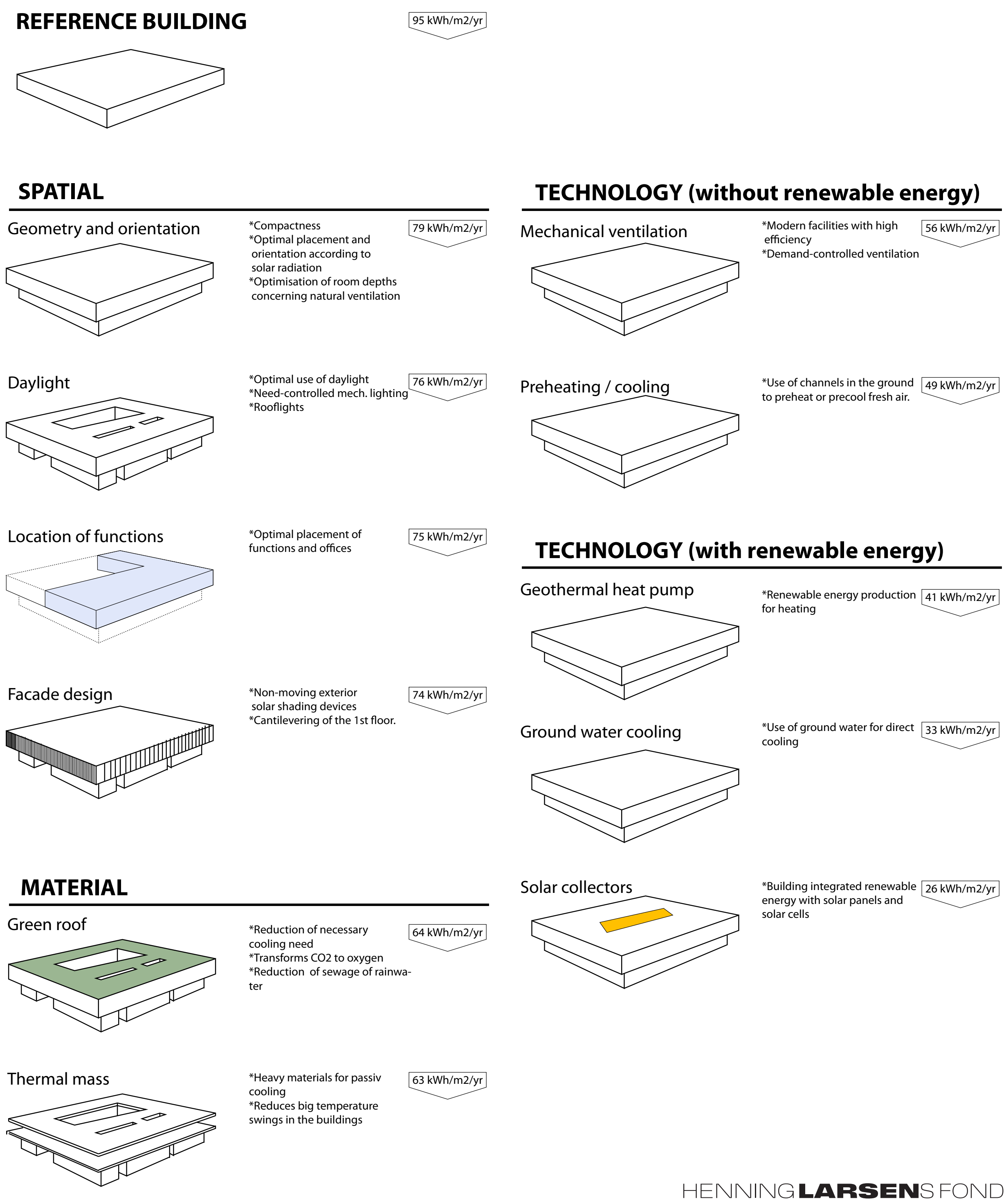


Figure 4: Consequences of different design parameters on the energy use of a building. Source: Henning Larsen Architects.

back to main text...

iii) Frodeparken

In the City of Uppsala, Sweden, a new urban area is emerging north of the train station and travel centre. The development site is north of the railway tracks, and the block Frodeparken is the first building to bee seen from the northbound trains from Stockholm. 20 000 people commute between Stockholm and Uppsala every day.

The master plan of Uppsala designated this area as a new urban development area in 2002. The area is expected to hold a total of 22-25 000 square meters of new development.

The development process started with a limited competition arranged by the planning department and the finance department of Uppsala city council. Five architectural offices from Sweden and Denmark were invited, all with extensive experience on planning new dense city developments. During the limited competition two architectural offices were chosen for continuation in June 2007. This Case Story is based on an interview with the architect Mats Egelius at White, who was chosen for the south part of the

This picture shows the train leaving Uppsala towards Stockholm. The blue building called Frodeparken is the first building seen when coming from the opposite direction.

development area.

In this Case Story the process is presented in chronological order and the Story is focused on important actions, statements and documents that enable photovoltaics in the real estate development of Frodeparken.

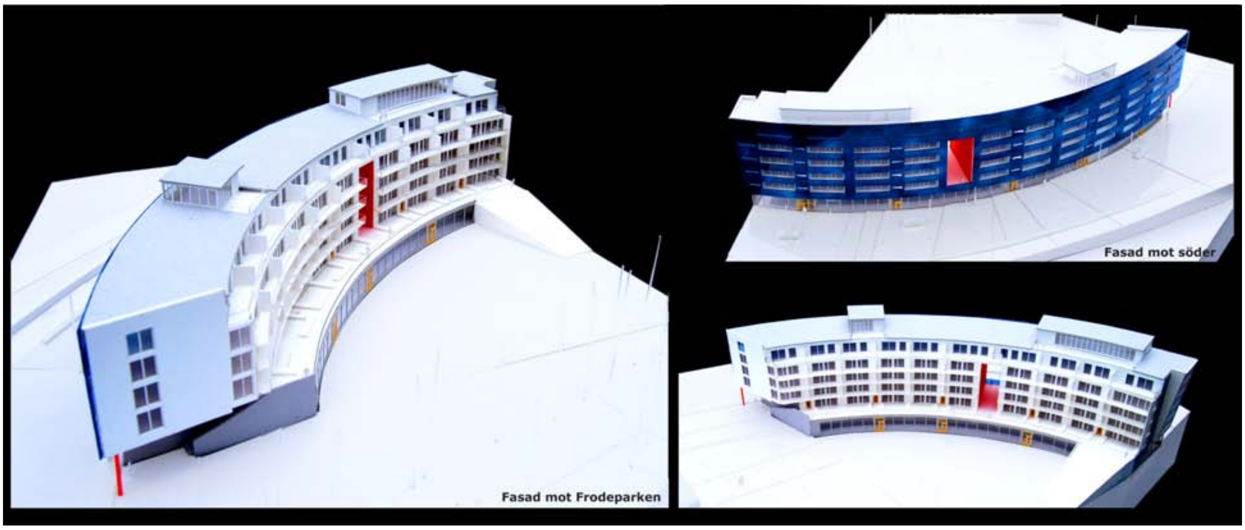
The process started as an initiative by Uppsala city council, with a limited competition, followed by a bidding process for the land designation and contracting of developers. In the case of Frodeparken, the designated developer Uppsalahem chose to proceed with a design build process, and the project is currently in the design build phase.

In order to keep the intentions of the plan, the design and the energy ambitions, especially regarding renewable energy, decisions made during the process are documented in the project steering documents. The architect of Frodeparken has played a key role in arguing in favour of photovoltaics and received positive responses from the decision-making parties in Uppsala city council in the early planning stage and at Uppsalahem during the project planning phase. The design process of Frodeparken involved photovoltaics from an early stage. Mr. Egelius explains:

“The limited competition started in 2006. In a middle meeting of the competition I draw the outlines of Whites proposition on an overhead in front of the spectators, explaining how the new additions would connect and correspond to the adjacent buildings and the features and possibilities of the site. I drew a convex curve towards the south and the entry of Uppsala City for the trains coming from Stockholm. The participants from Uppsala city council fell for the proposal there and then. In our submission we presented photovoltaics as a key feature for the buildings since Uppsala is world famous for the research on thin film solar cells (CIGS).”

At a board meeting of the city council in June 2007, where the architectural firms to continue were selected by the planning committee, it was also decided to produce information material aimed towards developers in the coming land bidding process. Another important decision was that a Design Manual was to be put forward to follow the proposed plan and form the basis of an agreement between the municipality and the prospective developers. The manual will also guide the building permit process. These important steering documents for the planning process as well as the land designation process were put forward in 2007 and 2009 respectively. In Sweden the plan is the legally binding document, and the plan for Frodeparken became final in July 2009.

The information material dated December 2007 outlined the urban project, while the Design Manual dated April 2009 outlined the characteristics of the buildings. These two documents were produced in collaboration between White, Svenborgs and



The original concept for Frodeparken presented by White in the limited competition gave the base on which developers were to bid for the land.

Uppsala city council.

In the Information material, eight key points were stated as goals for the future planning among which two addressed energy and renewable energy:

5. All south facing facades should be experienced as ”images” of a tuned composition including reflective metal louvers and solar cells - as a signal of the entrance to Uppsala from the railway.

6. Energy efficient measures are to be included in the new buildings and the city’s position as an education and research centre signalled with modern technology such as solar cells in facades.

In the information manual, White presented the block Frodeparken with a facade of blue polycrystalline cells in the convex south-

facing facade. (picture)

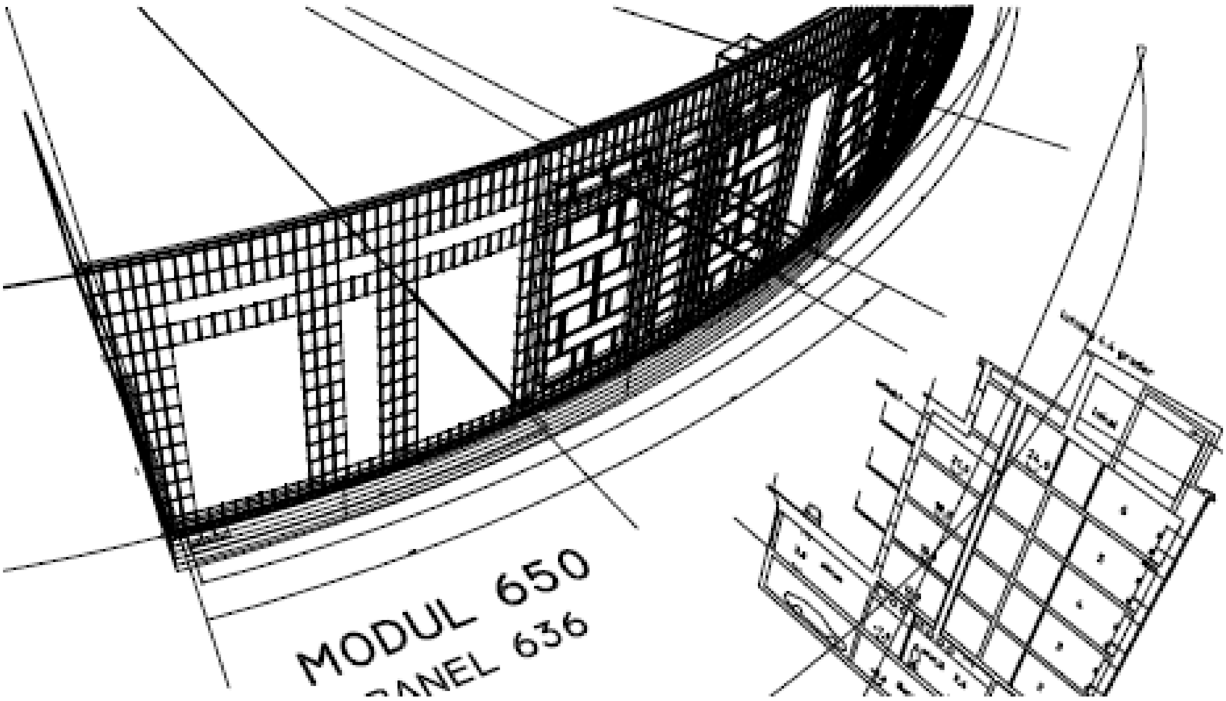
Mr. Egelius comments the process:
“White and Svenbergs worked together with the city council all through the planning process. During this collaboration Svenborgs as a theme for their plans also embraced the idea of photovoltaics. The information material was important in the land designation process, and at this stage White had presented a photovoltaic façade. In the Design Manual both offices showed principle details of photovoltaics”.

During a briefing in January 2008 large number of developers were given the opportunity to express an interest in the project. After evaluating the responses the finance department of Uppsala city council appointed Skanska Nya hem AB and Uppsalahem AB as landowners. When appointing these developers the city council also stated the importance of the goal to achieve energy efficient solutions including solar cells.

Mr Egelius explains: “During the process Uppsala city council had been very clear towards developers suggesting other planning options than those in the information material. Liv Hane said that Uppsala city council was determined to use the plans and design criteria presented in the information material, putting an end to the discussion. This was a very important statement in order to keep the planning process on track. The winners of the bid gave the highest prices, but kept to the goals and designs presented by the city council, White and Svenborgs. The city council advocated for the developers to keep the architects responsible for the respective building properties, and both developers chose to do so. I came to work for Uppsala Hem and Svenborgs for Skanska.”

When the project progressed there was a need to study photovoltaics further, both from a design and technical point of view as well as from an economical point of view. The developer Uppsalahem was positive to the design and the photovoltaics, but they needed to present more facts to their board, especially regarding economy; both the positive impact on running costs and the initial investment cost.

In order to initiate this process White invited Uppsalahem to a breakfast seminar arranged by White on active solar in april 2010. After the seminar Uppsalahem and Mats Egelius met with the experts from the seminar: Marja Lundgren, White and Lars Hedström, Direct Energy. Marja Lundgren in an expert on architectural integration of active solar and Lars Hedström manages a contractor firm; planning, installing and cost estimating photovoltaic systems. This resulted in a follow up meeting where a life cycle cost analysis was presented for Frodeparken, showing a positive result over a 30 year period, and giving Uppsalahem a base for further development. Uppsalahem is a municipal housing company and therefore have a longterm interest in their real estate investments – which was very important for this



decision.

Mrs. Lundgren comments on the detailed design process: “Then followed a process examining the detailed solutions for PV in this project, the products available, the technical solutions in the building and discussions on use of the heat produced by the cells to preheat incoming air during the heating season. White was in charge of bringing in the necessary expertise. A comparison with glass panels was also made from an economic point of view.”

“During this process the thin-film CIGS cells developed in Uppsala and produced in Germany had reached efficiencies comparable to crystalline cells, with a conversion rate of 12-13% of the solar irradiation to electricity. It was now a commercialized line of building products. The decision was therefore taken by Uppsalahem to change the façade material from blue to greyish black cells, choosing the solution that represents the research conducted in Uppsala.”

“The facade design was changed; the standard panels measurements were used and set important positions for windows, staircases etc. One challenge in the active solar industry today is that the standard modules of different companies tend to vary by 5-10 centimetres. This can make it hard to request tenders from a broad range of companies, since the important measurements of a building are set early on – making it necessary in practice to choose the brand of solar product very early.”

During the project process White suggested Uppsalahem and Skanska also conduct an assessment of the use of heat from behind the cells to preheat incoming air during the heating season.

Uppsalahem and White presented the program for Frodeparken in April 2011 and Uppsalahem agreed a contract with Skanska for a design-build process. Uppsalahem wants to have an alternative plan, should the PV become too expensive, and the program therefore states that:

“The building, in the most visible position, will be a shimmering representative for Swedens foremost research on photovoltaics, and will strengthen the city brand at the research & development forefront. The facade has an optimal orientation for solar energy and is suitable for both crystalline and thin-film solar cells. Both alternatives have been assessed. The curved form makes it possible to maximum the use of solar energy throughout the day instead of creating a peak effect at midday. If the PV will be too expensive a facade with glass or glazed panels might be in question.”

On the 14th of June 2011 Uppsalahems board decided on photovoltaic panels. Uppsalahem is a municipal housing company that needs to consider running costs as well as investment costs, and life cycle cost analysis is a very good tool for such a real estate holder.

Currently almost the only thing working against the PV facade is the building permit. The original blue facade was embraced, but the greyish black thin-film cells were found to be too dark. The building permit was accepted but not the facade. Uppsalahem has added a PM arguing in favour of the façade and a new decision has not yet been taken.

The building process started in august 2011. During the spring of 2011 Uppsalahem had an open procurement for a design-build process that was won by Skanska. Skanska and Uppsalahem set up a partnering declaration on the 24th of March 2011, which was also shown to the architect. Goals were set in the partnering declaration regarding economy, customer satisfaction, design, quality and collaboration. With regards to photovoltaics an energy goal was set, requiring energy consumption to be lower than 50 kWh/m^{2}year bought energy. This is half of the current Swedish norm. There are also goals to reach the Swedish assessment system's silver level (the highest is gold). And it is stated under design and quality that there should be a balance between architectural and technical demands.

The process is still ongoing, and the energy demand is currently estimated at 65 kWh/m^{2}year bought energy. The PV facades will lower the energy use by 8 kWh/m^{2}year to 57 kWh/m^{2}year – almost bringing the project down to the goal. If the heat from the photovoltaic cells were to be used this figure would be even lower. It is not currently known whether Skanska will address this option or not.

back to main text...

Frodeparken

The whole south facade comprises integrated photovoltaic systems, making it the largest solar facade of a residential building in the Nordic countries. The facade faces the optimum direction for maximum solar exposure over the day, from early morning till afternoon. The thin film cells have a black colour, but when reflecting the sky the colour will change from grey to black. The heat from the backside will be used to preheat air during the heating season.

Early on, the architect proposed a solar facade, as a symbol of Uppsala as a research and educational city. Uppsala held the world record in the early 2000 and the thin-film cells developed here are now in Qcells façade modules. The residential building combines a low energy building with space-efficient apartments to reach a very low energy demand/person.

iv) BISOL Workshops

The experience of BiSol : Building integrated Solar Network - BRENET

The market for active solar systems - photovoltaic modules and thermal collectors - is increasing very rapidly. This has encouraged producers, installers and designers to develop products that are more suitable for building integration. This is also because of the European directive that all new buildings after 2020 must be nearly Net Zero Energy Buildings (nZEB). Various research has demonstrated that this is possible, but that in order to do this in a more cost-effective way solar energy must be integrated in the building itself. However, barriers to the dissemination of solar thermal and PV integration are numerous and concern various aspects: architectural, planning, constructive, economical and educational. In addition the need for integrating solar energy systems, such as photovoltaic modules or solar thermal system, has to bring two distinct worlds (the industry and the architecture) to speak together and to find common solutions. This was not as obvious and immediate as thought because the languages and the needs are different for manufacturers and for designers or architects. In order to bring together these actors the Institute for Applied Sustainability to the Built Environment (ISAAC) and the Scuola Universitaria Professionale della Svizzera Italiana of Lugano (SUPSI) built a consortium of partners to share their expertise and their needs.

The BiSol project, started in 2009, was specifically addressed to all stakeholders involved in solar energy development, such as architects, engineers, building material manufacturers, solar system manufacturers, designers, contractors, public sector and researchers. The aim of the project was to initiate a competence network between different specialists to promote the integration of solar energy into building environment and overcome the actual technical and non technical barriers.

In order to encourage communication between the professionals and to identify the issues linked to building integration of solar systems and their possible solutions, thematic multidisciplinary workshops were planned and carried out during the whole period of the project.

Four different workshops were organized. The different topics of the workshop were:

i. "Facilitate the acceptance of solar installations in the built environment", hosted in Luzern the 23rd and 24th of March 2009
ii. "Interactive tools and assistance for the architectural integration of solar installations", hosted in Lugano the 16th and the 17th of November 2009
iii. "Opportunites of collaboration between the building and solar sectors", hosted in Trübbach the 1st and 2nd February 2010
iv. "Quality and reliability of building integrated PV modules

and thermal collectors", hosted in Lugano the 23rd and 24th of August 2010

The first two workshops were organized together with Swissolar (in order to be closer to installers and industries) and with EPFL-LESO PB for their competence in solar thermal systems integrated into buildings.

The outcomes of each workshop are the encouragement of collaborations between the different actors and the identification of problems and their resolution through eventual new projects and the creation of one or more working groups that will develop and manage these projects.

Resumé of the four Workshops BiSOl

1st Workshop: Facilitate the acceptance of solar installations in the built environment

The installation of solar systems in the built environment is regulated through the procedures in force by the law on constructions which principally considers the respect of article 18a enclosed in the revision of the federal law on town and landscape planning. This law stipulates that in the areas to be built, carefully integrated (roofs and facades) solar installations are authorized if they do not spoil cultural assets or natural sites of any regional or national importance. The goal of this particular workshop was to find solutions to facilitate the acceptance of solar installations and their diffusion in the built environment.

The main outcomes of the workshop can be found presented in the internet site of the BiSol Workshops [1].

2nd Workshop: Interactive tools and assistance for the architectural integration of solar installations

The different actors involved in the design/planning of building integrated solar installations, often require tools that will facilitate the promotion, the design and the realization of these systems in an optimal way. These “instruments” come in the form of software for supporting the process of dimensioning, visualization (photomontage or CAD element) and financial estimation of installations, or other sources such as websites, advices concerning the integration, books, references of integrated installations and “guidelines” for the formulation of construction demands.

Under the auspices of the working group BiSol, a “Interactive tools and assistance for the architectural integration of solar installations” Workshop was held in Lugano on the 16th and 17th of November 2009. The Workshop was attended by 34 professionals from different Swiss Cantons, Germany and Italy. These professionals were mainly architects and engineers working in diverse fields such as the private sector and university related research centers.

The main outcomes of the workshop can be found presented in the internet site of the BiSol Workshops [1].

3rd Workshop: Opportunities of collaboration between the building and solar sectors.

The goal of this workshop was to give a chance to specialists from the building and solar sectors to get together and discuss the issues, wishes, concerns and solutions related to the integration of solar systems in buildings. Particularly, the importance that PV and Solar Thermal systems become a more used building material was stressed.

The Workshop was attended by 35 professionals from different Swiss Cantons, Germany and Italy. These professionals were mainly architects and engineers working in different fields such as the private sector, industry and university related research centers. The main outcome of this particular workshop was the identification of a series of issues and observations concerning the difficulty of obtaining a compromise between standardization (producer's wish) and flexibility (architect's necessity).

4th BiSol Workshop: Quality and reliability of building integrated PV modules and thermal collectors.

The goal of this workshop was to illustrate the variety of issues linked to solar product quality and reliability and the state of the art regarding norms and regulations on these same products.

The Workshop was attended by 31 professionals from different Swiss Cantons and Italy. These professionals were mainly engineers and architects working in different fields such as the private sector, industry and university related research centers. The main outcome of workshop 4 was the highlighting of the need to test the whole system (modules + fastening system) rather than single parts; the need of more collaboration between the producers, the installers and researchers for defining the necessary tests; and the need of product development such as modules with diode bypass, modules with MPPT (maximum power point tracker), back sheet and integration of other functions, colored encapsulation and more types of dummy modules.

The main outcomes and all of the PowerPoint presentations presented during the **workshops** are available on the project website: www.bisolnet.ch.

For each workshop, **a detailed report** was written. These are available on request through info@bipv.ch.

REFERENCES

Swissolar internet site : www.swissolar.ch

Panzera G., Zanetti I., Nagel K., Tettamanti V., BISOL - Building Integrated Solar Network – Workshops to optimize the integration of solar systems in buildings, 24th EUPVSEC, 5BV.2.59, 2009

back to main text...

v) Integrated Design in Bolzano

The IDP approach, has been applied in the design process of a new building in the Technology Park of Bolzano (north-east of Italy), with the aim to achieve the target of Net Zero Energy Building (NZEB) and total primary energy consumption lower than 60 kWh/m^2/year. The design team involved in the process included a coordinator, architects, plant designers, energy consultants, future tenants and the contractor.

Dynamic energy simulation analysis supported the team decisions from the early design phase to address the architectural solutions.

Different tools were used during the design process (e.g. Trnsys, Radiance, Daysim) to evaluate the thermal flows, the overall energy needs for heating and cooling, the daylight potential and to estimate the electrical energy savings of different façade solutions. Several shapes of facade has been compared in order to ensure high level of daylight and avoid glare. The target net zero was reached by exploiting the generation from on-site

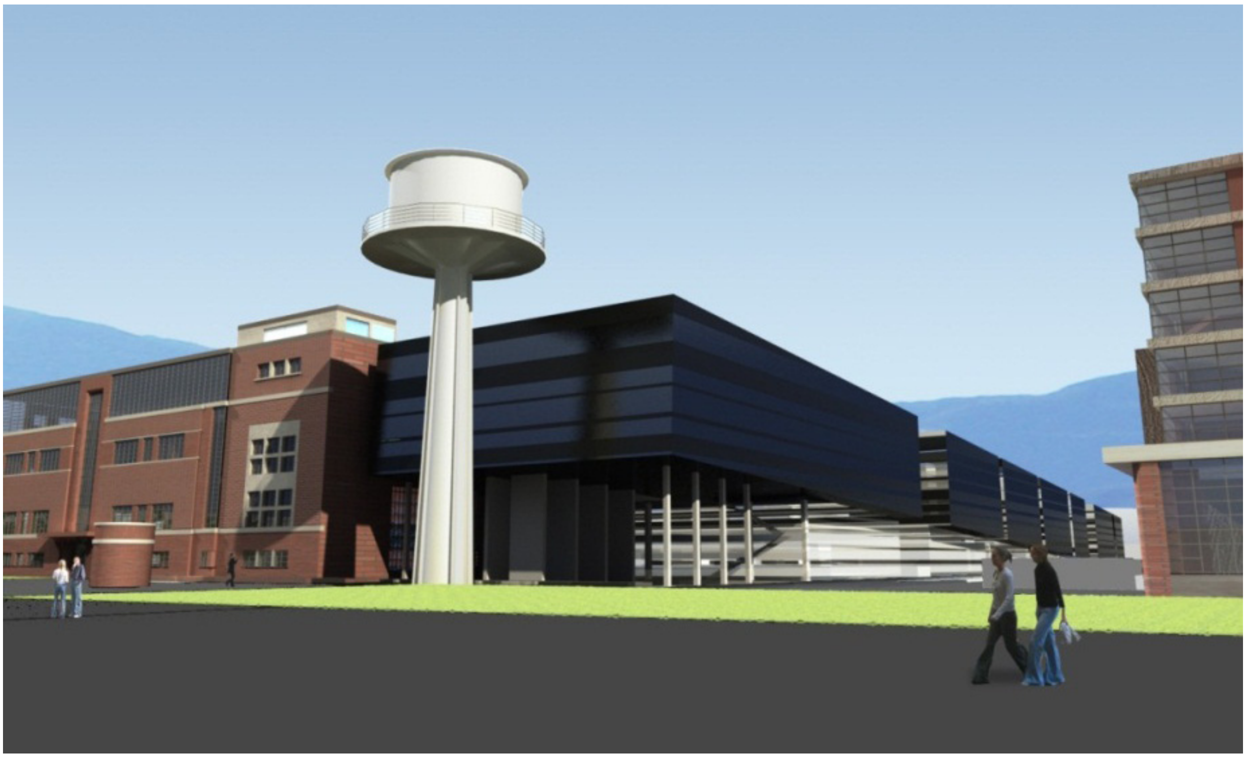


Image: M. Castagna, A. Belleri, G. Paoletti, H. Mahlknecht, R. Lollini, *Modelling to support a Net Zero Energy Building design - An Italian case study*

renewable energy sources, with the integration in the envelope of solar thermal collectors and photovoltaic modules.

Lesson learnt from this project highlighted the fundamental importance of three issues to successfully apply the Integrated Design Process: firstly, main building stakeholders (owner, designer, consultants and future tenants) should agree on basic objectives and technical strategies regarding energy efficiency design, construction and building operation. Secondly, energy simulations are fundamental means to discuss in quantitative terms on positive and negative aspects of several possible solutions to achieve high energy performances, building aesthetics and functionality. Thirdly, passive solutions and integration of solar systems are the right way to approach NZEB target, but they can be effective if they are considered since the early stages of design and with the active participation of all involved stakeholders.

back to main text...

vi) Sørenga Energy Workshops

Sørenga is a new urban area in the centre of Oslo, Norway. The peninsula comprises part of the Bjørvika development, and is underlayed strict environmental guidelines as part of the development process. These include energy goals which require a continual focus on building energy performance.

When initiating the project the client, Sørenga Utvikling KS, commissioned four teams of architects for the first four blocks, totalling approx. 50 000 m^2. In order to kick-start the project with a focus on energy performance, and to ensure a clear understanding of and commitment to the environmental goals in all of the design teams, the client and the environmental coordinator, Context AS, organised a series of workshops focusing on the different environmental topics.

The energy workshops were held a few weeks into the development process, as the teams were beginning to explore design strategies. Each team was given a series of simple exercises - to reduce the surface/ volume ratio, to increase solar

Image: Jarmund Vignæs Arkitekter AS/ 4B Arkitekter AS/ Context AS

potential, to increase daylighting while avoiding overheating - supported by environmental design and energy consultants.

The workshops resulted in estimated energy savings of 6-8%, simply through an early focus on key energy issues. In addition the workshops resulted in design teams which are motivated - and in many ways competing with each other - to achieve further energy savings. The clear client commitment to the energy goals, and the practical, hands-on nature of the workshops were fundamental to creating this positive attitude in the project.

back to main text...

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

IEA Solar Heating and Cooling Programme

The *International Energy Agency* (IEA) is an autonomous body within the framework of the Organization for Economic Co-operation and Development (OECD) based in Paris. Established in 1974 after the first "oil shock," the IEA is committed to carrying out a comprehensive program of energy cooperation among its members and the Commission of the European Communities.

The IEA provides a legal framework, through IEA Implementing Agreements such as the *Solar Heating and Cooling Agreement*, for international collaboration in energy technology research and development (R&D) and deployment. This IEA experience has proved that such collaboration contributes significantly to faster technological progress, while reducing costs; to eliminating technological risks and duplication of efforts; and to creating numerous other benefits, such as swifter expansion of the knowledge base and easier harmonization of standards.

The *Solar Heating and Cooling Programme* was one of the first IEA Implementing Agreements to be established. Since 1977, its members have been collaborating to advance active solar and passive solar and their application in buildings and other areas, such as agriculture and industry. Current members are:

Australia	Germany	Portugal
Austria	Finland	Singapore
Belgium	France	South Africa
Canada	Italy	Spain
China	Mexico	Sweden
Denmark	Netherlands	Switzerland
European Commission	Norway	United States

A total of 49 Tasks have been initiated, 35 of which have been completed. Each Task is managed by an Operating Agent from one of the participating countries. Overall control of the program rests with an Executive Committee comprised of one representative from each contracting party to the Implementing Agreement. In addition to the Task work, a number of special activities—Memorandum of Understanding with solar thermal trade organizations, statistics collection and analysis, conferences and workshops—have been undertaken.

Visit the Solar Heating and Cooling Programme website - **www.iea-shc.org** - to find more publications and to learn about the SHC Programme.

Current Tasks & Working Group:

Task 36	*Solar Resource Knowledge Management*
Task 39	*Polymeric Materials for Solar Thermal Applications*
Task 40	*Towards Net Zero Energy Solar Buildings*
Task 41	*Solar Energy and Architecture*
Task 42	*Compact Thermal Energy Storage*
Task 43	*Solar Rating and Certification Procedures*
Task 44	*Solar and Heat Pump Systems*
Task 45	*Large Systems: Solar Heating/Cooling Systems, Seasonal Storages, Heat Pumps*
Task 46	*Solar Resource Assessment and Forecasting*
Task 47	*Renovation of Non-Residential Buildings Towards Sustainable Standards*
Task 48	*Quality Assurance and Support Measures for Solar Cooling*
Task 49	*Solar Process Heat for Production and Advanced Applications*

Completed Tasks:

Task 1	*Investigation of the Performance of Solar Heating and Cooling Systems*
Task 2	*Coordination of Solar Heating and Cooling R&D*
Task 3	*Performance Testing of Solar Collectors*
Task 4	*Development of an Insolation Handbook and Instrument Package*
Task 5	*Use of Existing Meteorological Information for Solar Energy Application*
Task 6	*Performance of Solar Systems Using Evacuated Collectors*
Task 7	*Central Solar Heating Plants with Seasonal Storage*
Task 8	*Passive and Hybrid Solar Low Energy Buildings*
Task 9	*Solar Radiation and Pyranometry Studies*
Task 10	*Solar Materials R&D*
Task 11	*Passive and Hybrid Solar Commercial Buildings*
Task 12	*Building Energy Analysis and Design Tools for Solar Applications*
Task 13	*Advanced Solar Low Energy Buildings*
Task 14	*Advanced Active Solar Energy Systems*
Task 16	*Photovoltaics in Buildings*
Task 17	*Measuring and Modeling Spectral Radiation*
Task 18	*Advanced Glazing and Associated Materials for Solar and Building Applications*
Task 19	*Solar Air Systems*
Task 20	*Solar Energy in Building Renovation*
Task 21	*Daylight in Buildings*
Task 22	*Building Energy Analysis Tools*
Task 23	*Optimization of Solar Energy Use in Large Buildings*
Task 24	*Solar Procurement*
Task 25	*Solar Assisted Air Conditioning of Buildings*
Task 26	*Solar Combisystems*
Task 27	*Performance of Solar Facade Components*
Task 28	*Solar Sustainable Housing*
Task 29	*Solar Crop Drying*
Task 31	*Daylighting Buildings in the 21st Century*
Task 32	*Advanced Storage Concepts for Solar and Low Energy Buildings*
Task 33	*Solar Heat for Industrial Processes*
Task 34	*Testing and Validation of Building Energy Simulation Tools*
Task 35	*PV/Thermal Solar Systems*
Task 37	*Advanced Housing Renovation with Solar & Conservation*
Task 38	*Solar Thermal Cooling and Air Conditioning*

Completed Working Groups:

CSHPSS; ISOLDE; Materials in Solar Thermal Collectors; Evaluation of Task 13 Houses; Daylight Research