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Criteria for architectural integration of active solar systems IEA Task 41, Subtask A

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Abstract

The upcoming growing use of active solar technologies, photovoltaics and solar thermal, brings an important challenge for designers willing to keep a high architectural quality of buildings. The IEA Task 41 "Solar Energy and Architecture" brought together international experts to address key issues in this process.

Subtask A dealt with the specific architectural integration issues brought by active solar systems, solar thermal and photovoltaics. A description of the main criteria and of the various ways the architect can use each technology to satisfy these criteria has been produced.

The reasons for the limited use of such systems are presented, as identified through a large international web survey, pinpointing low architects knowledge and low products integrability as major barriers (deliverable T.41.A.1). Architectural integration criteria are defined, based on previous studies, and related guidelines for architects and products developers are presented in separate targeted deliverables (T.41.A.2 and T.41.A.3). Deliverable T.41.A.2 provides a comprehensive set of integration guidelines addressed to architects, highlighting all the integration possibilities offered today by both solar thermal and photovoltaics systems. Deliverable T.41.A.3 is intended to counter the lack of innovative products conceived for building integration, by addressing to manufacturers a detailed set of products development guidelines. Finally, already existing innovative products achieving good integrability characteristics are collected and presented in a new attractive website (T.41.A.6).

Keywords: Architectural integration; solar energy; solar thermal; photovoltaics

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1. Goals

The goal of IEA Task 41 “Solar Energy and Architecture” is to promote the use of solar energy into high quality architecture designs [1]. To achieve this goal the 30 experts participating to the Task tackled different key issues, according to the structure shown in fig 1 and following a 3 subtasks articulation. Sub task A, fully described hereafter, dealt with the definition of architectural integration criteria per technology, highlighting on one hand the need of improving architects knowledge, and on the other hand the need of enhancing the building integrability of the products available on the market. Sub task B has been focusing on the tools and methods available for the dimensioning and positioning of solar systems in buildings, showing that new, architects friendly, tools are also urgently needed [9][10][11][12][13][14]. Finally, sub task C has provided a wide selection of well documented case studies, demonstrating that energy efficient solar strategies can be the basis for inspiring high quality architectures (both in new constructions and in building renovations) [15][16][17].

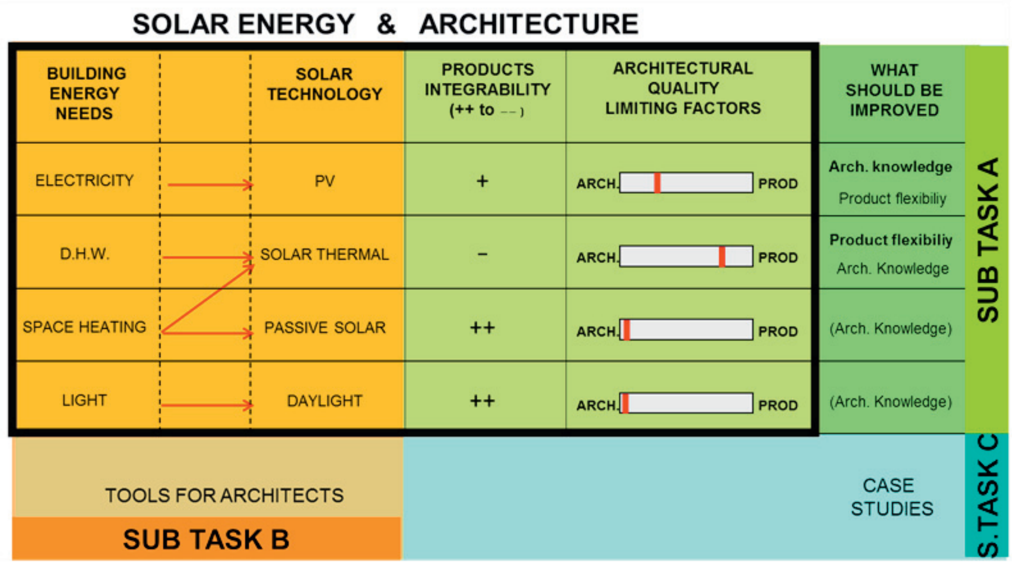

Fig.1. TASK 41 structure, credits: EPFL/LESO-PB)

Within this global structure, the work of sub task A has been articulated into the following activities, resulting in a set of deliverables addressed to architects, manufacturers and authorities [3][4][5][6][7]:

1- Identifying the barriers to a broader use of active solar systems by architects and identifying the most suitable promotion strategies;
2- Assessing architectural criteria for the integration of active solar systems in the building envelope;
3- Proposing integration recommendations to architects, based on these criteria, supported by good examples;
4- Issuing products development recommendations for the solar industry to improve the architectural integrability of products and systems;
5- Informing architects over the state of the art in innovative solar products conceived for building integration.

2. Deliverable T.41.A.1 "Building integration of solar thermal and photovoltaics – barriers, needs and strategies"[3]

This first report of subtask A describes the results of a large international survey (14 nations) on the reasons why architects do not use, or rarely use, solar technologies, and offers proposals to help overcome these barriers by identifying architects' needs in this domain.

The survey was organized into three sections, each one targeting a specific aspect of the relation architects have with solar energy:

- The first part analyzed the actual use of the different solar energy strategies in the current architectural practice. Architects where asked how often and in which type of building they are using photovoltaics / solar thermal / day lighting / space heating / space cooling. The answers showed a largely predominant use of day lighting and passive space heating (80% and 70%) versus a relatively low use of solar thermal for domestic hot water (18%), and a just emerging use of photovoltaics (7%).

- The second section aimed at identifying the main barriers to a larger use of these technologies.

Three main groups of barriers are identified, and analyzed in detail: Economic issues (product price, incentives, government. support); Lack of knowledge from various actors (architects, clients, consultants); Lack of appropriate products and tools for architects.

- The last section addressed the relevance of possible strategies to overcome the identified barriers.

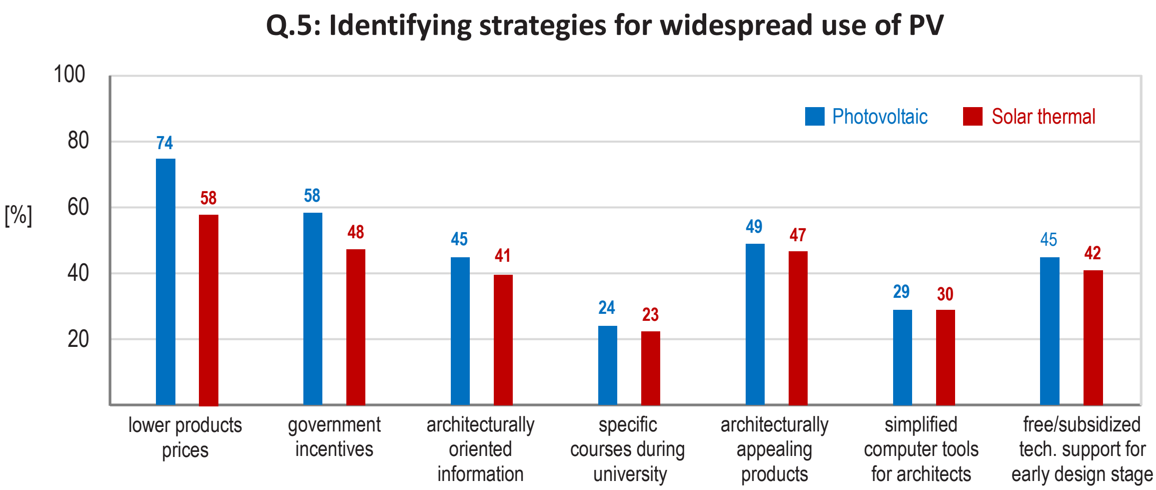

Fig. 2. Strategies for widespread integration of PVs ad ST in architecture (439 respondents, 1428 sel.for PV, 1267 sel. for ST)

As shown in the table (Fig. 2) the recommended strategies were very similar for the two concerned technologies PV and ST.

It was comforting to notice that, except for the financial aspects, all topics were addressed within the Task 41 work. In particular, sub task A contributed with:

- Architecturally oriented information (given in deliverables T.41.A.2 [4] and T.41.A.6 [7])
- Information for manufacturers for the development of architecturally appealing products (deliverable T.41.A.3 [5][6])
- Collection of available products suitable for building integration (T.A.6 [7]),
- Specific seminars (described in deliverables T.41.A.4-5 [18])

Additionally. the report has an final section with results sorted by country, to allow identifying regionally specific behaviors or barriers.

3. Deliverable T.41.A.2 "Solar energy systems in architecture-integration criteria and guidelines"[4]

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.

Fig.3. Examples of architecturally integrated solar systems (solar thermal left; PV right)

After a common section on general architectural integration issues and criteria, solar thermal and photovoltaic are treated separately, following a common structure:

a- Main technical information (technology working principle / available sub-technologies / related basic collector components / suitable energetic applications / energy yield / cost);

b- Constructive/functional integration possibilities in the envelope layers, supported by a collection of selected examples showing the different possible approaches (Fig. 4).

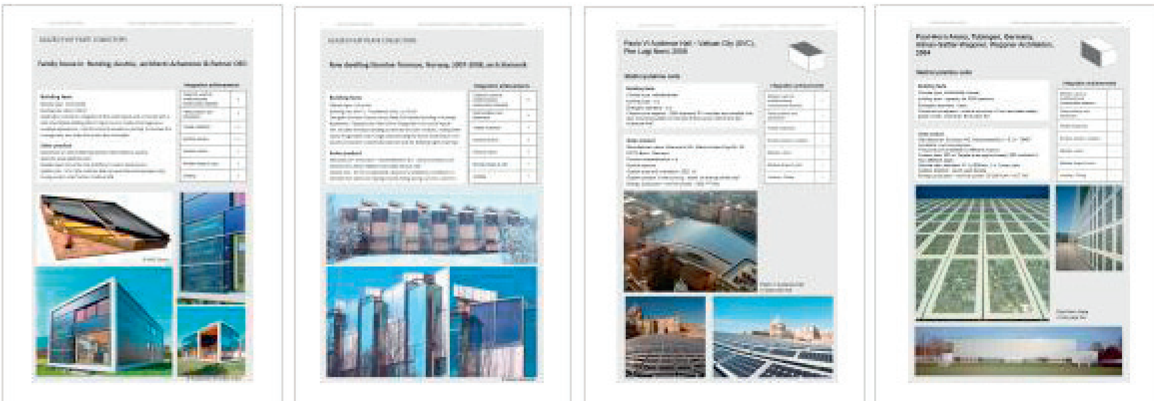

Fig.4. Good integration examples sheets (solar thermal left; PV right)

c- System sizing and positioning criteria (to help integrate the system, taking into account all design criteria - area and solar radiation availability - targeted solar fractions - storage issues).
d- Formal flexibility offered by standard products, and derived design freedom.
e- Available innovative products conceived for building integration (more than forty products collected) (fig.5).

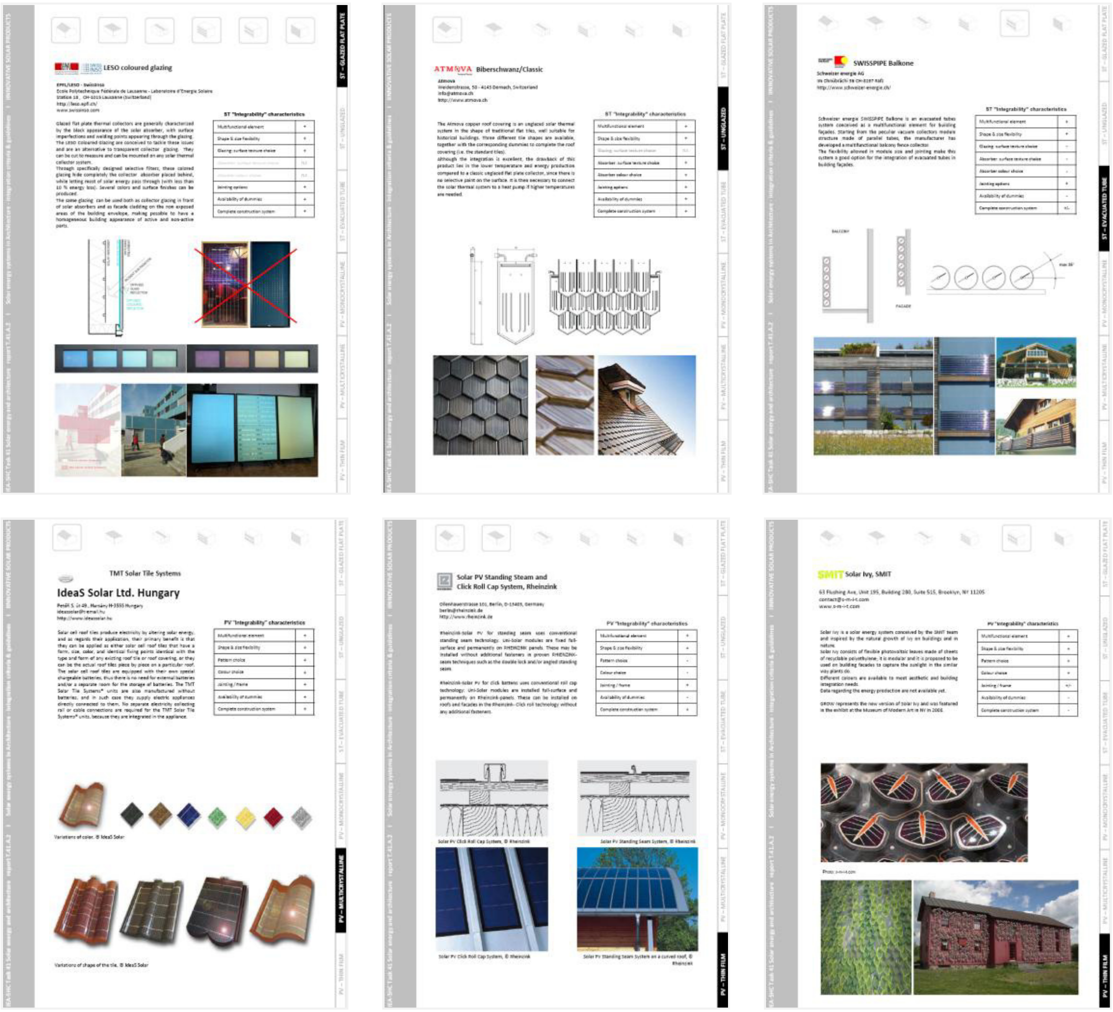

Fig. 5. Innovative products sheets

To complete the information, the manual ends with a short section highlighted the differences and similarities between solar thermal and photovoltaic systems. The difference in energy medium between photovoltaic and solar thermal (electricity vs. heat) implies very different transportation, storage, and safety issues, as well as different formal and operating constraints, resulting in different integration possibilities in the building envelope. These differences are described to help architects make an energetic and architecturally optimized use of the sun exposed surfaces of their buildings.

4. Deliverables T.41.A.3/1"Designing solar thermal systems for architectural integration: Criteria and guidelines for product and system developers" and T.41.A.3/2 "Designing photovoltaic systems for architectural integration: Criteria and guidelines for product and system developers" [5][6]

These two deliverables are separate publications addressed respectively to manufacturers of photovoltaic and of solar thermal systems. They 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 solar technology and sub-technology, they provide a comprehensive set of practical recommendations that should lead to new systems adapted to building integration and finally appealing to architects.

The initial parts of the documents demonstrate how, for both technologies, integration into the building envelope is much easier if the solar collector can be used as a multifunctional element, producing energy while replacing an envelope element.

Three progressive steps are proposed to manufacturers to help them conceive new multifunctional systems for building integration:

1/ enhancing collector's formal flexibility (shape, size, texture, finish, colour, jointing)

2/ offering dummies (non-active elements with appearance similar to collectors)

3/ offering a complete roof/façade system with active solar elements

This comprehensive approach is summarized in the schematic in fig.6.

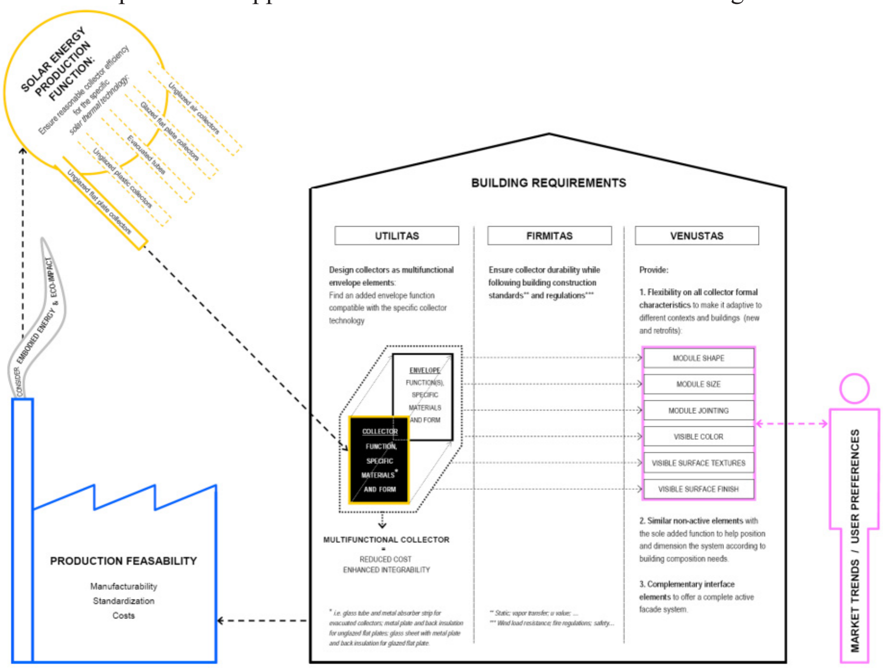

Fig. 6: Proposed development process for multifunctional building systems

In the second part of the document, the practical applications to the different technologies and sub-technologies are detailed. Examples of successful developments realized according to these recommendations are then presented, detailing the development process step by step.

The collected innovative products sheets complete this section of the document (Fig 5).

5. T.41.A.6 Web-site: “Innovative solar products for architectural integration”[7]

As shown by the survey described in deliverable T.A.1, one of the main barriers is the low number of products conceived for building integration, and the related lack of knowledge among building professionals. The website developed as deliverable T.41.A.6 has been set up to address these issues by presenting, on one hand, the innovative solar products available on the market today and, on the other hand, the information needed to optimally integrate them in the architecture of a building. The website has been conceived to be ergonomic and attractive to architects and their clients, and is structured around the three main active solar technologies: photovoltaic, solar thermal and hybrid systems.

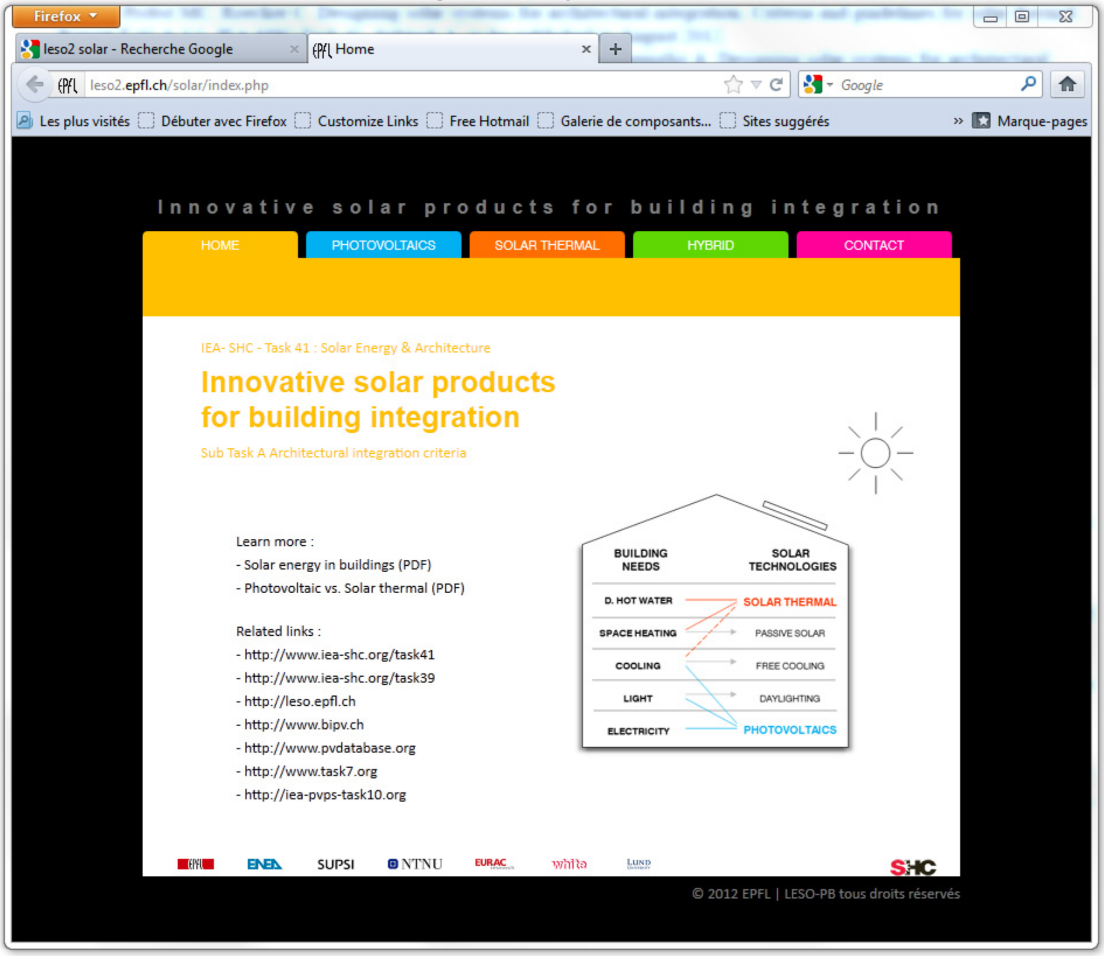

Fig. 7: homepage (http://solarintegrationsolutions.org/)

By choosing a specific technology and an integration type (roof, façade, balcony…) the user gets access to a selection of appropriate products, presented in the form of synthetic A4 sheets. These sheets include architect oriented information, contact details and pictures, both on the product alone and situation examples in buildings. The website is completed by a set of documents (extracts from other task 41 documents) on the specificities of the different technologies (Solar energy in buildings / Solar thermal / Photovoltaics / PV vs. Solar thermal /…

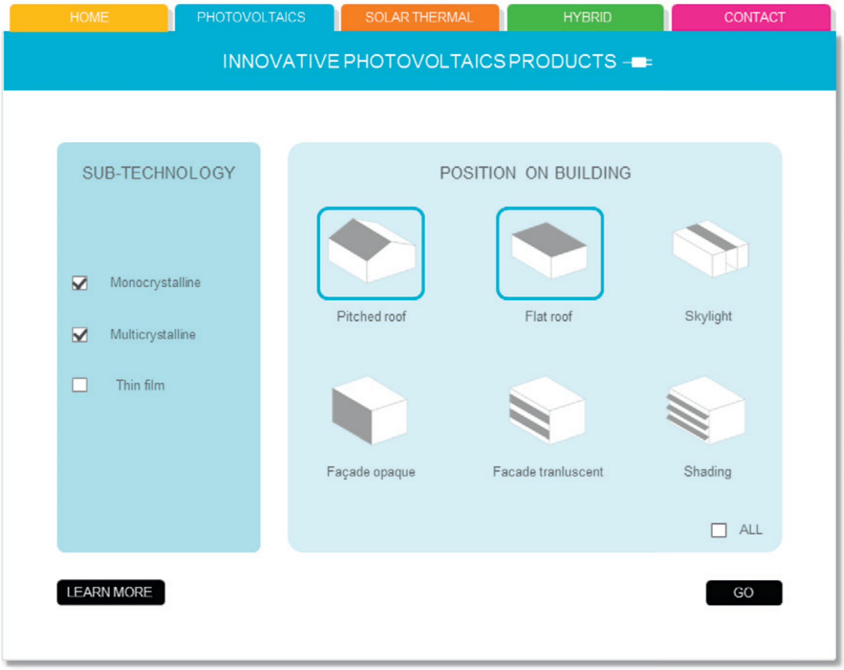

Fig. 8: Technology and integration typology selection

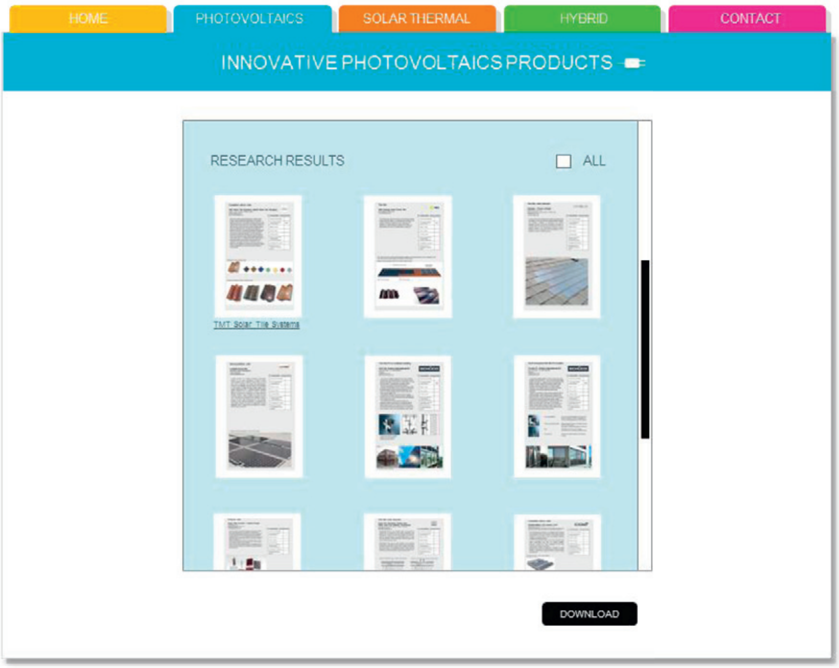

Fig. 9: Resulting relevant products sheets

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