IEA SHC Task 41: Solar energy and architecture 2009-2012

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Each year, the sun gives us 10,000 times the amount of energy used by humanity in a year (Roulet, Reeves)

Buildings use 40% of the energy resources of the Earth (WBCSD, 2009)

Cold climate: 70% of the energy used for heating (air, water)
Overview

BUILDING ENERGY NEEDS

- Domestic hot water (DHW)
- Space Heating
- Space Cooling
- Light
- Electricity

SOLAR STRATEGIES

- Active solar thermal
- Passive heating
- Free cooling
- Daylight
- PVs

After: IEA SHC Task 41: ST-A Innovative products online resource
• Important solar potential in Canada (in some regions twice as in Europe)

• Solar energy incident on the roof of a house (Quebec) far exceeds its energy consumption (SBRN)
• Toronto receives over 35% more solar radiation per unit of surface area than Berlin.
• Yet, Toronto’s installed photovoltaic capacity per capita is roughly 3% that of Germany (City of Toronto, NRCan).
• Despite all the potential and technical advances, solar energy is still untapped

WHY?
IEA: Untapped solar potential - reasons

- Economic factors
- Insufficient knowledge
- Resistance using new technologies
- Aesthetics and architectural expression
IEA SHC Task 41: Solar Energy and Architecture

Support the development of high quality solar architecture

- improving the skills of architects
- their design and communication tools
- interaction with engineers, manufacturers and clients
What is high-quality solar architecture?

Better integration of solar technologies / components

Source: Luc Saint-Martin, CRNC, Ottawa
Integration of solar components

• as a building envelope component

It is also of utmost importance that solar technologies stop being considered as something that is ‘applied’ as an afterthought, but rather as another material on the architect’s palette.

Michael Clesle, M.Arch, Ryerson
Integration of solar components
Integration of solar components
Integration of solar components

The Visionaire, New York City, Arch: Pelli Clarke Pelli Architects
Urban exposure

- Raising awareness with public
- Urban installations

Pedestrian Canopy

Silos Design Concept

Viktor Kuliskis, M.Arch thesis 2010, Ryerson
The metropolis today is a classroom; the ads are its teachers

Marshal McLuhan

Viktor Kuliskis, M.Arch thesis 2010, Ryerson
Researchers and architects from 14 countries: Australia, Austria, Belgium, Canada, Denmark, Germany, Italy, Norway, Portugal, Singapore, South Korea, Spain, Sweden and Switzerland

**Subtask A:** Architectural integration quality  
**Subtask B:** Tools and methods for solar design  
**Subtask C:** Case studies + communication
DEFINING ARCHITECTURAL QUALITY OF BUILDING INTEGRATED SYSTEMS

FUNCTIONAL QUALITY
Solar heat collection treated as an added envelope function. Collectors used as multifunctional envelope elements.

CONSTRUCTIVE QUALITY
Respect of building construction standards and regulations without compromising the original envelope quality (U-value, vapour transfer, statics...)

FORMAL QUALITY
Subjective? Objective? Definition?

Formal: functional element becomes expression

Subtask A: Outcomes

BUILDING INTEGRATION OF SOLAR THERMAL AND PHOTOVOLTAICS - barriers, needs and strategies

International survey of architects in 14 countries regarding issues related to successful integration of solar strategies available products, design decisions...

Subtask A - Outcomes

International survey: barriers and strategies

### BARRIERS - PV
- Not economically justifiable: 73%
- Lack of knowledge by client/developer: 54%
- Lack of interest by client: 50%

### STRATEGIES- PV
- Lower product prices: 74%
- Government incentives: 58%
- Availability of products: 49%

### BARRIERS - ST
- Lack of knowledge by client/developer: 45%
- Lack of interest by client: 42%
- Lack of suitable products: 36%

### STRATEGIES- ST
- Lower product prices: 58%
- Government incentives: 48%
- Availability of products: 47%

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**Bar Graphs:**
- **Passive**
  - Photovoltaic For Electricity
  - Solar Thermal (Domestic Hot Water)
  - Passive Solar Gains For Heating
  - Daylighting Utilization Strategies

- **Active**
  - Solar Thermal (Heating)
  - Solar Thermal (Cooling)

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29/11/2012

National Green Building Conference, MTCC, 29th November, 2012
Question #1 - In your current architectural practice, how would you rate the importance of the use of solar energy (e.g. use of passive solar gains, solar thermal, photovoltaics, etc.)?
SOLAR ENERGY SYSTEMS IN ARCHITECTURE
integration criteria and guidelines

Architectural integration quality: formal aspects

Application to technologies: PVs and ST

Photovoltaics vs solar thermal: Very different integration possibilities and constraints

Designing photovoltaic systems for architectural integration

Criteria and guidelines for product and system developers

PRODUCT DEVELOPMENTS AND DISSEMINATION ACTIVITIES
Coordinated by Subtask A

Subtask A: other outcomes

Web-site
INNOVATIVE SOLAR TECHNOLOGIES PRODUCTS
online resource

Subtask A: web site – innovative products

Web-site
INNOVATIVE SOLAR TECHNOLOGIES PRODUCTS
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Subtask A: web site – innovative products

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Subtask A: web site – innovative products

Web-site
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online resource

Subtask A: web site – innovative products

Search results as PDF documents


National Green Building Conference, MTCC, 29th November, 2012
Subtask B: Methods and Tools for Solar Design

1. Comprehensive **review of existing methods and tools** that architects currently use at early design stage (EDS)

2. **Identify current barriers** that prevent architects from using the existing methods and tools for solar building design.

3. A. Provide **guidelines for architects** about solar design digital tools and their capabilities

B. Provide **tool developers** with needs of architects regarding digital tools for solar design

4. Develope **digital modules** for AutoCAD and ArchiCAD for easier visualization of solar components

5. In collaboration with Subtask C, **collect output data, figures and facts produced by various tools in demonstration projects**, to be included in the Communication Guidelines.

6. **Dissemination**: seminars, lectures
Total of 56 software packages reviewed

- CAAD (Computer aided architectural design) tools: 23
- Visualization tools: 13
- Simulation tools: 20

International survey

14 participating countries:
Australia, Austria, Belgium, Canada, Denmark, France, Germany, Italy, Norway, Portugal, Spain, South Korea, Sweden, Switzerland

Objectives

1. Identify barriers of existing tools and methods
2. Identify needs for improved tools and methods

Results: Identified barriers

- Tools are too complex
- Tools are too expensive
- Tools not integrated in CAAD software
- Tools take too much time
- I don’t know / not applicable
- Tools not integrated in workflow
- Tools do not support concept design stage
- Tools are too systemic
- Other
- Tools satisfactory
- Tools too simplistic, info missing

29/11/2012

National Green Building Conference, MTCC, 29th November, 2012
Solar design of buildings for architects: Review of solar design tools

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

Communication with tool developers

Solar components 3D parametric CAAD objects

- for AutoCAD and ArchiCAD
- English, French, German, Italian
- The Swiss BIPV Competence Centre: www.bipv.ch

Subtask C: concepts, case studies

Will be available November 2012
Subtask C: Communication guidelines

Part 1: Convincing clients to request and commission solar buildings
- Introducing solar energy strategies
- Convincing the main stakeholders
  - Integration, technical, financial and other considerations
- Common project types and communication strategies
  - New buildings, Retrofit, Urban design
- Case Stories

Part 2: Communication strategies at the design/construction team level
- Design development
  - Anchoring solar energy strategies within the project team
- Working with manufacturers
  - The Design-Build Process
- Communicating with the client
  - Convincing the contractor
- Case Stories

Example: the use of tools

**SPATIAL**
- Geometry and orientation
  - *Compactness*
  - *Optimal placement and orientation according to solar radiation*
  - *Optimisation of room depths concerning natural ventilation*
  - 79 kWh/m²/yr

- Daylight
  - *Optimal use of daylight*
  - *Need-controlled mech. lighting*
  - 76 kWh/m²/yr

- Location of functions
  - *Optimal placement of functions and offices*
  - 75 kWh/m²/yr

- Facade design
  - *Non-moving exterior solar shading devices*
  - *Cantilevering of the 1st floor*
  - 74 kWh/m²/yr

**TECHNOLOGY (without renewable energy)**
- Mechanical ventilation
  - *Modern facilities with high efficiency*
  - *Demand-controlled ventilation*
  - 56 kWh/m²/yr

- Preheating / cooling
  - *Use of channels in the ground to preheat or precool fresh air*
  - 49 kWh/m²/yr

**TECHNOLOGY (with renewable energy)**
- Geothermal heat pump
  - *Renewable energy production for heating*
  - 41 kWh/m²/yr

- Ground water cooling
  - *Use of ground water for direct cooling*
  - 33 kWh/m²/yr

- Solar collectors
  - *Building integrated renewable energy with solar panels and solar cells*
  - 26 kWh/m²/yr

**MATERIAL**
- Green roof
  - *Reduction of necessary cooling need*
  - *Transforms CO₂ to oxygen*
  - *Reduction of sewage of rainwater*
  - 64 kWh/m²/yr

- Thermal mass
  - *Heavy materials for passive cooling*
  - *Reduces big temperature swings in the buildings*
  - 63 kWh/m²/yr
Example: using tools for communication

Visualization of proposal for evacuated tube collectors in front of listed building façade in Graz, Austria

Source: Institute of Architectural Typologies, Graz Technical University
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
All of these publications and links are available at

http://www.iea-shc.org/Task41
→ Publications / Outcomes

Criteria and guidelines for system developers
&
Case studies website:
November 2012
Team Canada

Support by:
NRCan - CanmetENERGY/Sustainable Buildings and Communities Group
Ryerson University

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29/11/2012
National Green Building Conference,
MTCC, 29th November, 2012
IEA SHC Task 51: Solar energy and urban planning

Team Canada in forming search for funding to secure participation
All of these publications and links are available at

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→ Publications / Outcomes

Criteria and guidelines for system developers

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Case studies website:

November 2012

THANK YOU!

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