Building integrated PV (BiPV)

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IEA SHC Task 41 – Australian Representative
Presentation overview

- Energy Efficiency & Buildings context
- BiPV versus BaPV
- IEA Task 41 Solar Energy & Architecture
- Cost of BiPV products versus conventional materials
- Value to client
  - Landlord/investor
  - Tenant
- Key role for architects, engineers & urban planners
Energy efficiency provides returns

- Australian Property Institute and the Property Funds Association of Australia

- Green Star rated buildings showed a premium in value of 12% and 5% in rents

- We must still pursue energy efficiency & operational performance improvements

- However, renewable generation is needed to achieve zero or near zero energy buildings

- Energy efficient solutions are proving more expensive than renewables as prices fall
IEA Project

IEA-SHC Task 41: Solar Energy and Architecture

Subtask A: Criteria for architectural integration
Leaders: Maria Cristina Munari Probst & Christian Roecker, Switzerland

Subtask B: Methods and tools for solar design
Leaders: Miljana Horvat & Marie-Claude Dubois, Canada

Subtask C: Case studies & communication
Leaders: Olaf Bruun Jørgensen, Denmark & Merete Hoff, Norway

Overall objectives of Task 41
1. Accelerate development of high-quality solar architecture
2. Improve qualifications of architects

Operating agent – A/Prof. Maria Wall,
Lund University, Sweden
Heritage considerations (APVA 2009 report)

221kWp of blessed Vatican PV

PV tiles- Solar Century, UK
Solar Precincts

- Solar access assets
- Thermal gain & liabilities
Optimise high rise design
SUBTASK B: Methods and Tools for Solar Design

CAAD 3D parametric objects

archiCAD 13

Artlantis 3.0

SUPSI, Switzerland / Kim Nagel, Isa Zanetti
SUBTASK C: Case Studies and Communication Guidelines

Objectives

- Present case studies for high quality architectural integration of solar systems by exemplary buildings and urban areas
- Develop “Communication Guidelines” with knowledge and strategies to promote an increased use of active and passive solar energy
Copenhagen Energy

The solar plant is located on slats at an angle of 20° in front of office building’s glass facade. The facility consists of 3,600 photovoltaic strips, of which 2000 are equipped with active polycrystalline solar cells. The facility is west facing and has shadows on parts of the solar shading a large part of the day, so 40% is done with silk screen, i.e. as dummies to provide a uniform exterior look. The solar cells are 10 x 10 inches and laminated to the top of the glass slats. Each of them is connected to a coupling box which is integrated and thus hidden in the brackets.
Thin Film (a-Si) 19.5 kWp. Monocrystalline 31.6 kWp facade integrated Monocrystalline 15.46 kWp at the roof
**IEA-SHC Task 41**

**PROJECT**

**SUNNY WOODS, ZURICH-HÖNGG**

**Technology (PV/ST)**

**SUNNY WOODS – A BUILDING LIVING UP TO ITS NAME**

Sunny Woods was the first multi-family house to achieve an annual zero energy balance by reducing the energy demand to about 10% of a conventional building and including active and passive solar design strategies. The building won the Swiss and the European Solar Prize in 2002. 200 m² roof integrated thin film PV cells cover about 80-100% of the electricity demand. 6 m² vacuum collectors integrated into the balcony balustrades support the production of domestic hot water and space heating.

**Diagram**

**South facing facade**

**North facing facade**

**PV cells integrated into the roof**

**Vacuum collectors acting as balcony balustrades**
This is BiST – aesthetically pleasing!
BIPV SOLUTIONS FROM Q-CELLS

Fronius Façade
Where: Melbourne  
Capacity: 2.85 kWp  
Product: Q.Smart 95

- Sophisticated design
- Highly efficient electricity output
- Minimises heat impact

Solibro Façade
Where: Bitterfeld-Wolfen, Germany  
Capacity: 177.8 kWp  
Product: Q.Smart UF
• BiPV forecast to reach $4 billion revenue by 2016 (Pike Research)
2007 BiPV costs versus conventional products

Source: adapted from Ingo Hagemann (2007)
2011 Comparative cladding costs

Source: Nigel Morris

**Graph: 2011 Comparative cladding costs**

- **Polished stone**: Lower cost/m2 at $3,500.00, Upper cost/m2 at $3,000.00
- **Stone**: Lower cost/m2 at $2,500.00, Upper cost/m2 at $2,000.00
- **Glass wall**: Lower cost/m2 at $1,500.00, Upper cost/m2 at $1,000.00
- **PV façade**: Lower cost/m2 at $1,000.00, Upper cost/m2 at $500.00
- **Stainless steel**: Lower cost/m2 at $500.00, Upper cost/m2 at $-
• Vertical façade = only suffers 37% reduction in energy yield
• 8.4kWp double-glazed ASI-glass, cuts the air-conditioning plant size by 40% and significantly reduced air-conditioning running costs.
BIPV ROOF

CRISTALLINE BIPV ROOF

125 MONOCRYSTALLINE BIPV MODULE (69% transmittance)
AREA: 3.41 m²/pane (1970 x 1730mm)
POWER: 180Wp No. of CELLS: 72

125 MONOCRYSTALLINE BIPV MODULE (69% transmittance)
AREA: 3.41 m²/pane (1970 x 1730mm)
POWER: 170Wp No. of CELLS: 68

125 MONOCRYSTALLINE BIPV MODULE (69% transmittance)
AREA: 3.41 m²/pane (1970 x 1730mm)
POWER: 176Wp No. of CELLS: 70

156 POLYCRYSTALLINE BIPV MODULE (49% transmittance)
AREA: 3.41 m²/pane (1970 x 1730mm)
POWER: 286Wp No. of CELLS: 76

125 MONOCRYSTALLINE BIPV MODULE (64% transmittance)
AREA: 3.41 m²/pane (1970 x 1730mm)
POWER: 300Wp No. of CELLS: 120

125 MONOCRYSTALLINE BIPV MODULE (64% transmittance)
AREA: 2.24 m²/pane (1554 x 1440mm)
POWER: 275Wp No. of CELLS: 110
PV rainscreen cladding/ louvres

- Daylighting and thermal control
- Reduce HVAC stress
- Improves comfort for workers
- Panoramic views do not need to be affected
Sub-optimal orientation

- Example of Sydney - % of performance based on tilt and orientation
- North West/West façades often have thermal gain liability
Semi transparent PV windows

3 section façade:
1/3 Upper section with semitransparent PV
1/3 Middle viewing section with blind
1/3 Bottom opaque section below workplane

Base case –
Single office located in Montreal
Suntech Green Energy HQ Building BIPV Project

Location: Wuxi, China
Completion: 2008
System Capacity: 710 kWP
Module Type: Light Thru™
Installer: Suntech Power
Suntech Green Energy HQ Building

World’s Largest On-grid Photovoltaic Façade System

1MW On-grid Photovoltaic Façade System
The 18,000 square meter Suntech Green Energy HQ Building incorporates the world’s largest on-grid photovoltaic façade system, with over 2,570 semi-transparent Light Thru™ solar panels and an annual power output of 730,000 kilowatt hours.

Suntech’s Light Thru™ Solar Glazing Product Chosen for its Environmental and Aesthetic Strengths
Suntech chose Light Thru™ for its ability to generate clean power and contribute to the elegant design aesthetic they envisioned for their office building. Light Thru panels form the impressive façade, covering over 6,900 square meters and forming the cornerstone of Suntech’s overall design strategy for an environmentally responsible headquarters.

Benefits
- 1,020,000 kilowatt hours annually
- Reduction of Suntech Headquarters’ carbon footprint by 29,000 tons of carbon dioxide over a 25-year period
- Installation demonstrates to the community how solar energy can be integrated into daily life
- Reduction of 3,186 tons of standard coal over a 25-year period
- Supplies 8% of total power demand for the whole building in combination with other energy-saving technologies

“...we believe that building integrated solar systems are the way forward for environmentally friendly architecture and our new headquarters is an excellent demonstration of how solar can be seamlessly incorporated into modern and attractive buildings.”

Suntech’s Chairman and CEO

Proven System
The Solar Roofing Just Roof™ system was initially released in 1994 and has already been installed on more than 4,000 homes and commercial buildings worldwide. It features interlocking panels mounted on specially designed rails to give a highly aesthetic, weatherproof building skin that can be installed quickly and easily.

Sunny Future Ahead
With a progressive solar policy, demand for solar products in France is growing rapidly and due to enhanced incentives for BIPV. French demand for integrated solar systems is particularly healthy. Suntech has one of the industry’s broadest solar product portfolios and, as a result of its acquisition of Japan’s MSK in 2006, also has an impressive range of BIPV products and solutions. Mr Westphal’s company, Hanau Energies Concept, has a multi-MW pipeline of further projects scheduled to be installed in 2011 and beyond.
PVT Construction

- 660 Wp PV array
- Air flow 400 - 2000 m³/h
Multiple functional elements of BiPV

• Electricity supply value
• Daylighting, shading, insulation
• active heat collection, ventilation
• aesthetic appeal - design, colour, transparency
• energy load management – peak load lopping
• Improved thermal performance & comfort
• Soundproofing
• Displaces conventional building materials
Planning considerations

- Solar access zoning or solar fencing to ensure PV systems’ right to light is protected
- Training on PV for Council staff
- Information on PV to ratepayers (including local accredited installers and components approved for use in Australia)
- Clear definitions of PV systems which do not require Council consent
- Simple guide to processes for approval of PV systems which do require DAs
- Standardise processes across Councils
- For heritage areas:
  - Consider pre-approved PV types
  - Define elevations from which PV should not be visible
- Support moves to standardise insurance of installers and systems, in line with normal building codes
Summary

- BiPV enhances and protects building asset value – competitive prices as PV reduces in costs
- Energy efficiency solutions take you only so far, then PV makes economic sense
- Sub-optimal BiPV can provide better thermal building performance outcomes
- Planning approval predicates future building heights if solar access is to be preserved
- BiPV is predicted to dominate PV market growth (2016 projected worth $4bn)
- Significant opportunities for engineers, architects and property developers.

“Solar architecture is not about fashion, it is about survival.”

Sir Norman Foster
Tools & Resources

Key sites

• Australian PV Association - [www.apva.org.au](http://www.apva.org.au)
  (Local Government guidelines, BiPV Best practice guidelines, other useful reports)

• International Energy Agency (IEA) PVPS Program - [www.iea-pvps.org](http://www.iea-pvps.org)

• International Energy Agency (IEA) Solar Heating and Cooling Program - [www.iea-shc.org](http://www.iea-shc.org)

• Solar Energy and Architecture IEA SHC Task 41 - [www.iea-shc.org/task41](http://www.iea-shc.org/task41)

• BiPV products and integration [www.bipv.ch](http://www.bipv.ch)

PV Databases

• [www.pvdatabase.com](http://www.pvdatabase.com)

• [www.demosite.ch](http://www.demosite.ch)

BiPV Simulation Tools


• PVsyst [www.pvsyst.com](http://www.pvsyst.com)

• PV design Pro-G [www.mauisolarsoftware.com](http://www.mauisolarsoftware.com)

• SAM (NREL Solar Advisor Model) [https://www.nrel.gov/analysis/sam](https://www.nrel.gov/analysis/sam)