Australian PV Association

The University of New South Wales
Sydney, Australia

AuSES Conference – Sydney
01 December 2011

Building integrated PV (BiPV)

Presenter:

Dr Mark Snow

Faculty of the Built Environment
The University of New South Wales, Sydney

IEA SHC Task 41 – Australian Representative

UNSW THE UNIVERSITY OF NEW SOUTH WALES

f|b|e FACULTY OF THE BUILT ENVIRONMENT

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

'Building Better Returns'

A Study of the Financial Performance of Green Office Buildings in Australia

Graeme Newell: University of Western Sydney
John MacFarlane: University of Western Sydney
Nils Kok: Maastricht University

September 2011

Details of Authors

Graeme Newell is Professor of Property Investment at the University of Western Sydney. Graeme is actively involved in applied property research and is a Fellow of the Australian Property Institute. He has researched issues relating to sustainable commercial property in Australia, Asia, US and Europe.
Email: g.newell@uws.edu.au

John MacFarlane is Associate Professor at the University of Western Sydney. He has strong links to the property industry and is a Fellow of the Australian Property Institute. John has strong empirical analysis skills for the analysis of property data.
Email: j.macfarlane@uws.edu.au

Nils Kok is Assistant Professor in Finance and Real Estate at Maastricht University, Netherlands. He has been actively involved in the area of energy efficiency and sustainability in the property sector, focusing on the economic implications of resource consumption in buildings. Nils was co-author in the landmark report "Doing Well By Doing Good", which was the first major US study on the financial performance of green office buildings.
Email: n.kok@maastrichtuniversity.nl

'Building Better Returns' 11

- 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

SHC
SOLAR HEATING & COOLING PROGRAMME
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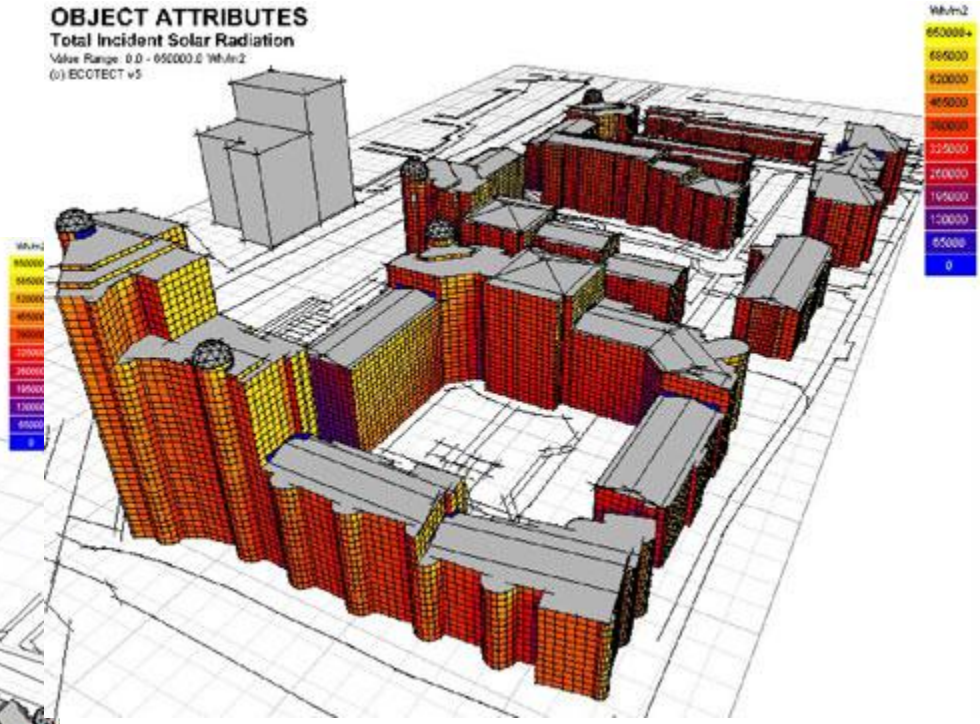
Heritage considerations (APVA 2009 report)

221kWp of blessed Vatican PV

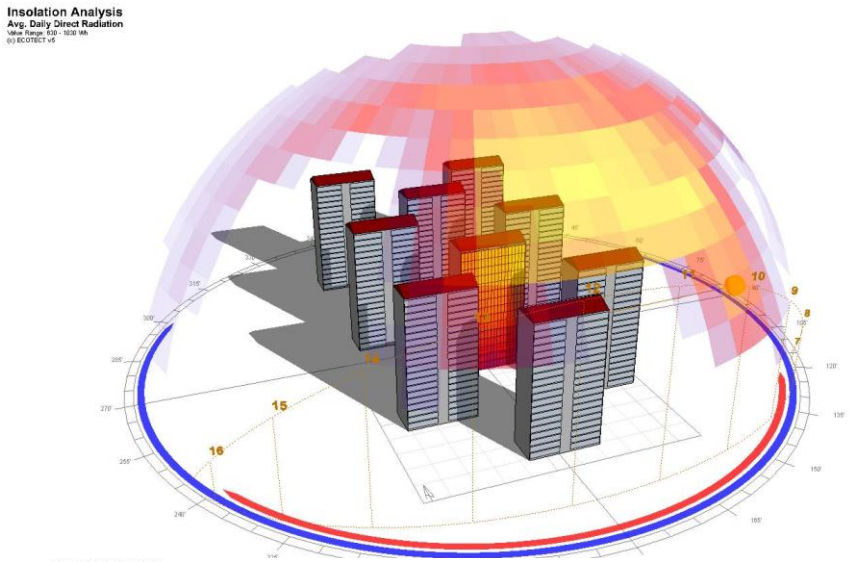
PV tiles- Solar Century, UK

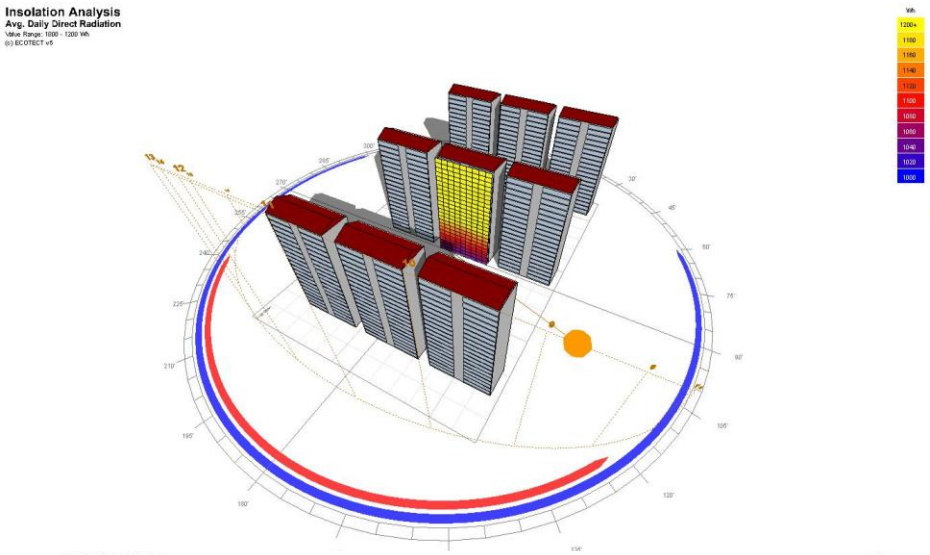
Solar Precincts

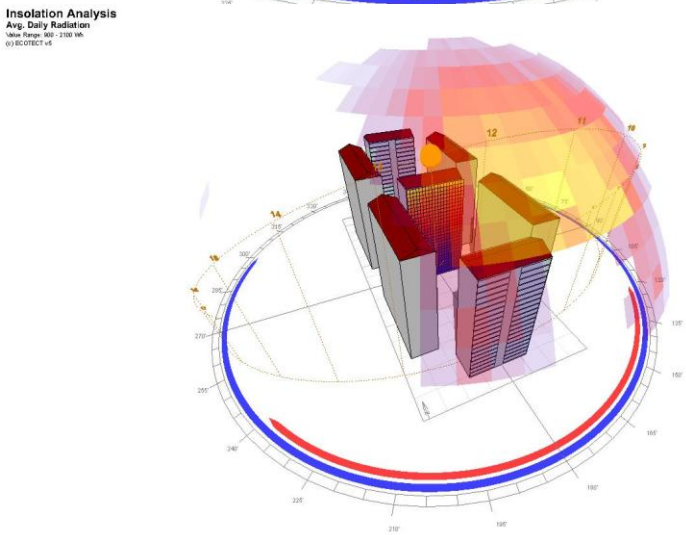
- Solar access assets
- Thermal gain & liabilities

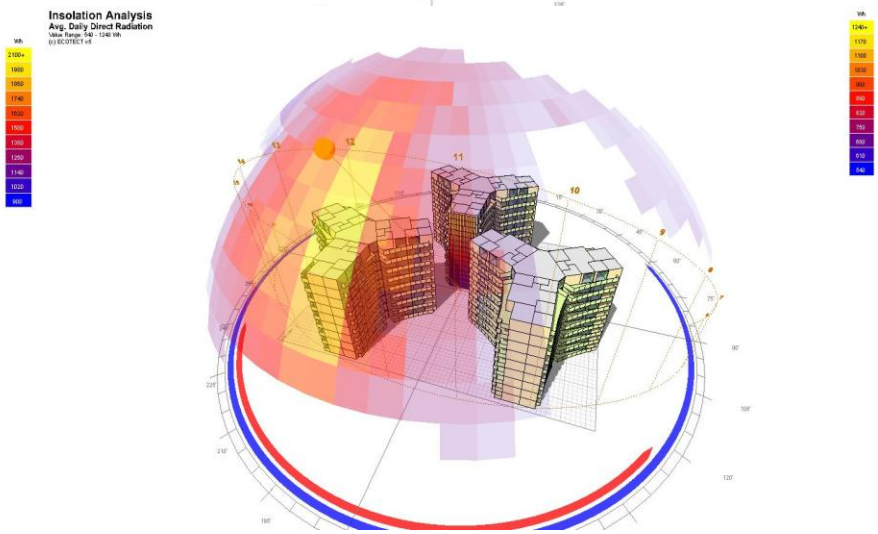


Optimise high rise design









SUBTASK B: Methods and Tools for Solar Design

CAAD 3D parametric objects

SUPSI, Switzerland / Kim Nagel, Isa Zanetti

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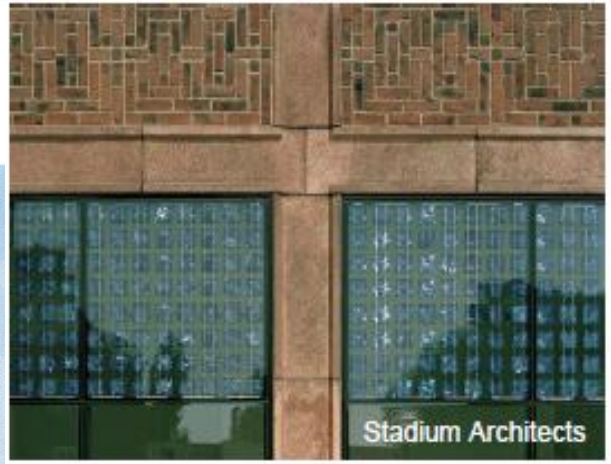
SUBTASK C: Case Studies and Communication Guidelines

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


Photo: Åke E:son Lindman & Kasper Dudrik


Stadium Architects

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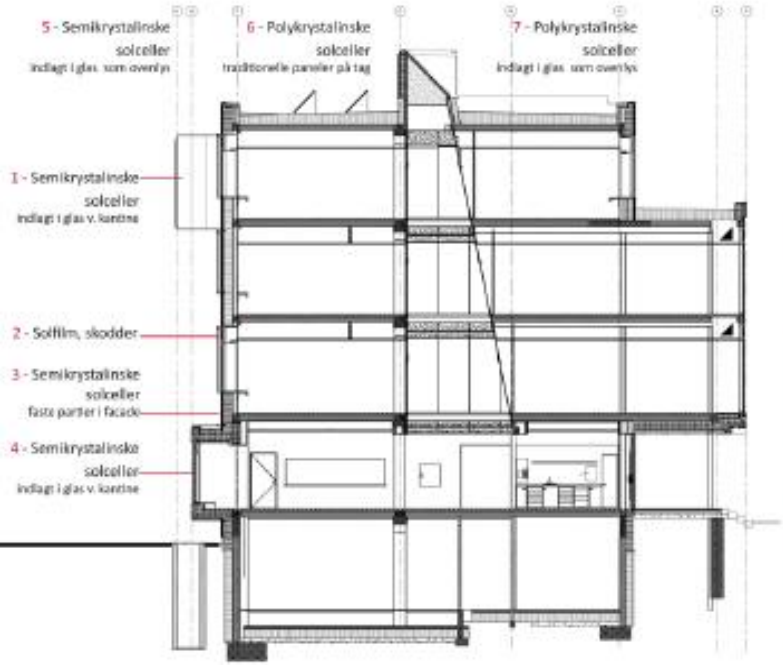
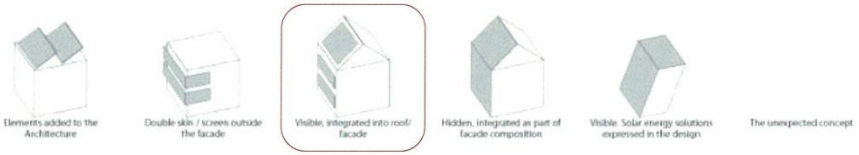
Copenhagen Energy

The solar plant is located on slats at an angle of 20 º 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, ie. 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 facadeintegrated **Monocrystaline** 15,46 kWp at the roof

SOLAR CITY COPENHAGEN

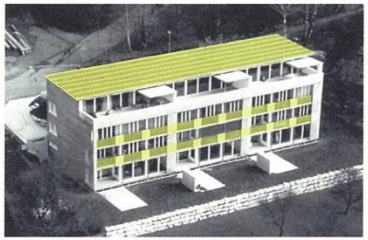


PROJECT	SUNNY WOODS, ZURICH-HÖNGG	Technology (PV/ST)

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.

Poor	Average	Good
		X

Diagram



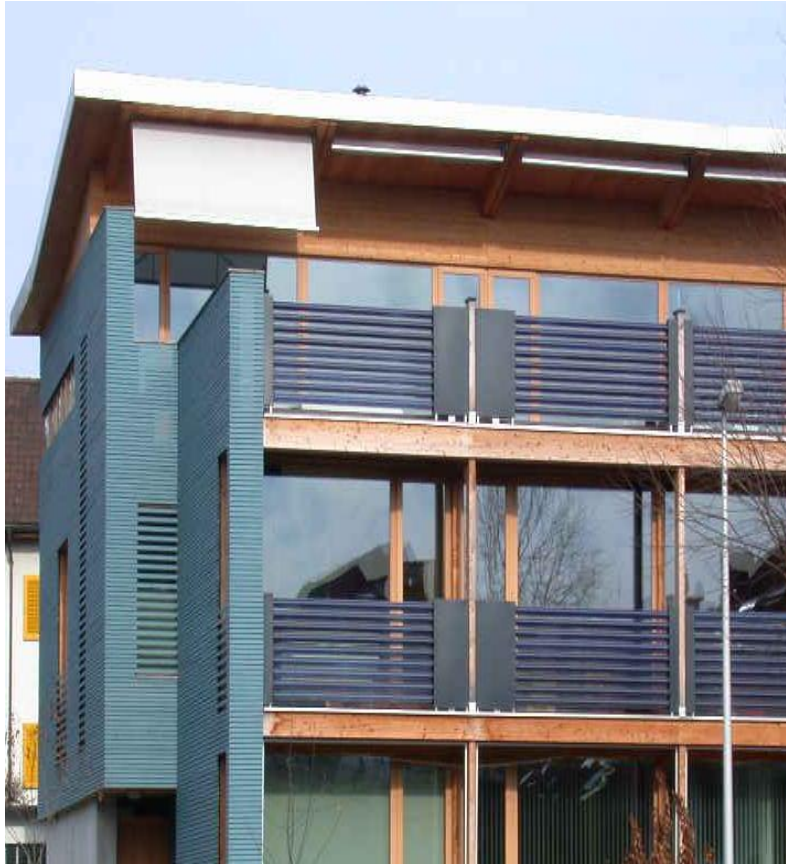
South facing facade

North facing fassade

PV cells integrated into the roof

Vacuum collectors acting as balcony ballustrades

This is BiST – aesthetically pleasing!



•BIPV SOLUSTIONS FROM Q-CELLS

Fronius Façade

Where: Melbourne

Capacity: 2.85 kWp

Product: Q.Smart 95

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

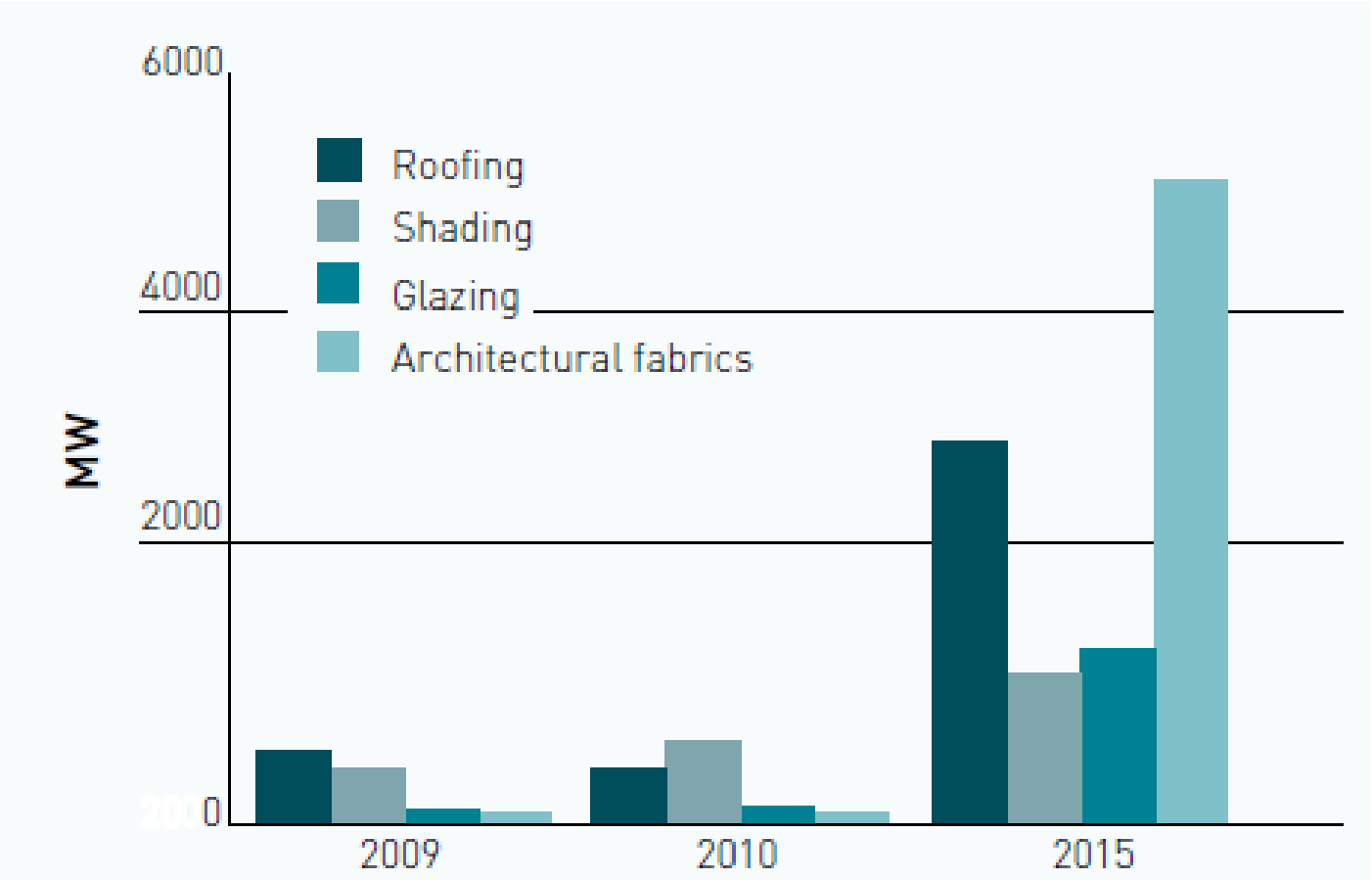
Solibro Façade

Where: Bitterfeld-Wolfen, Germany

Capacity: 177.8 kWp

Product: Q.Smart UF

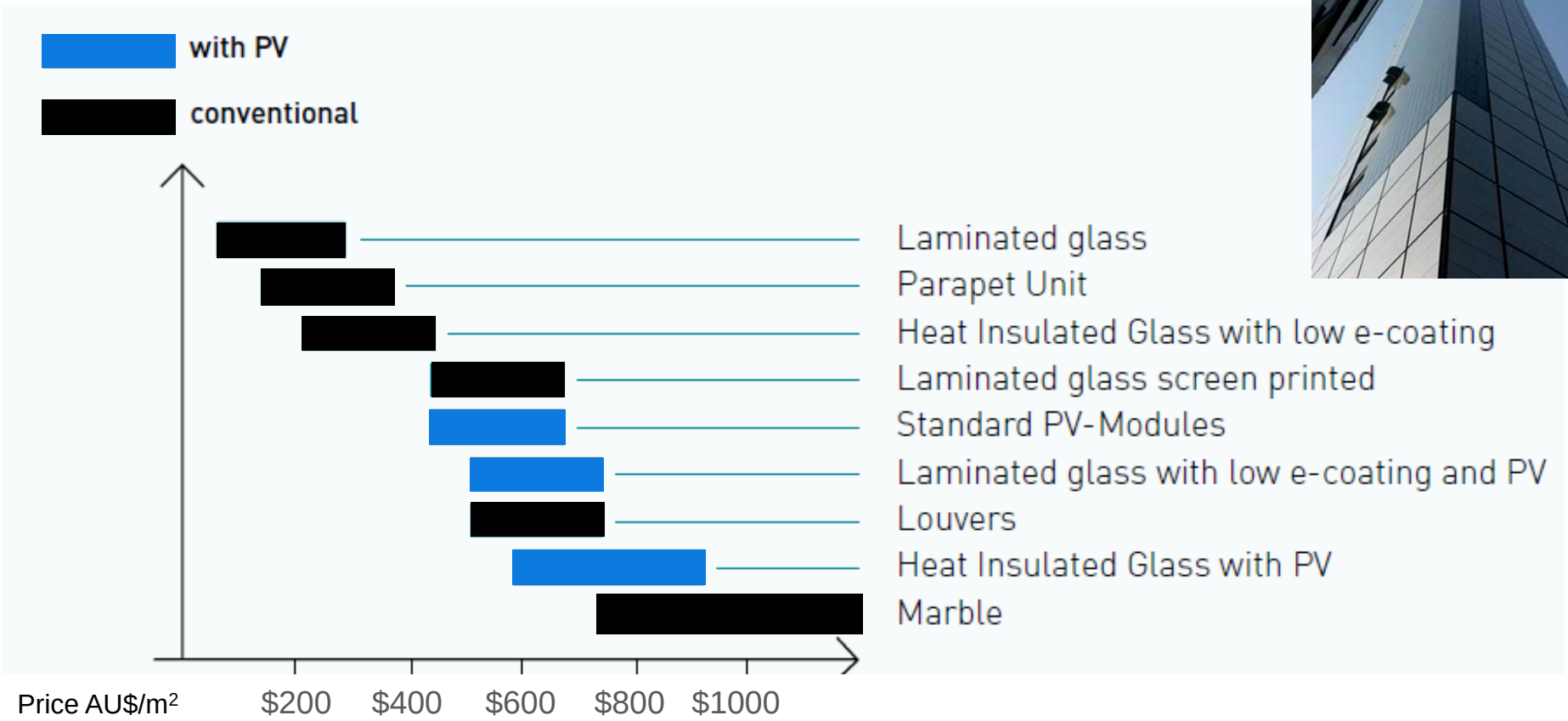
Growth for PV & buildings



Silex Solar 43kWp system
Parliament House, Canberra

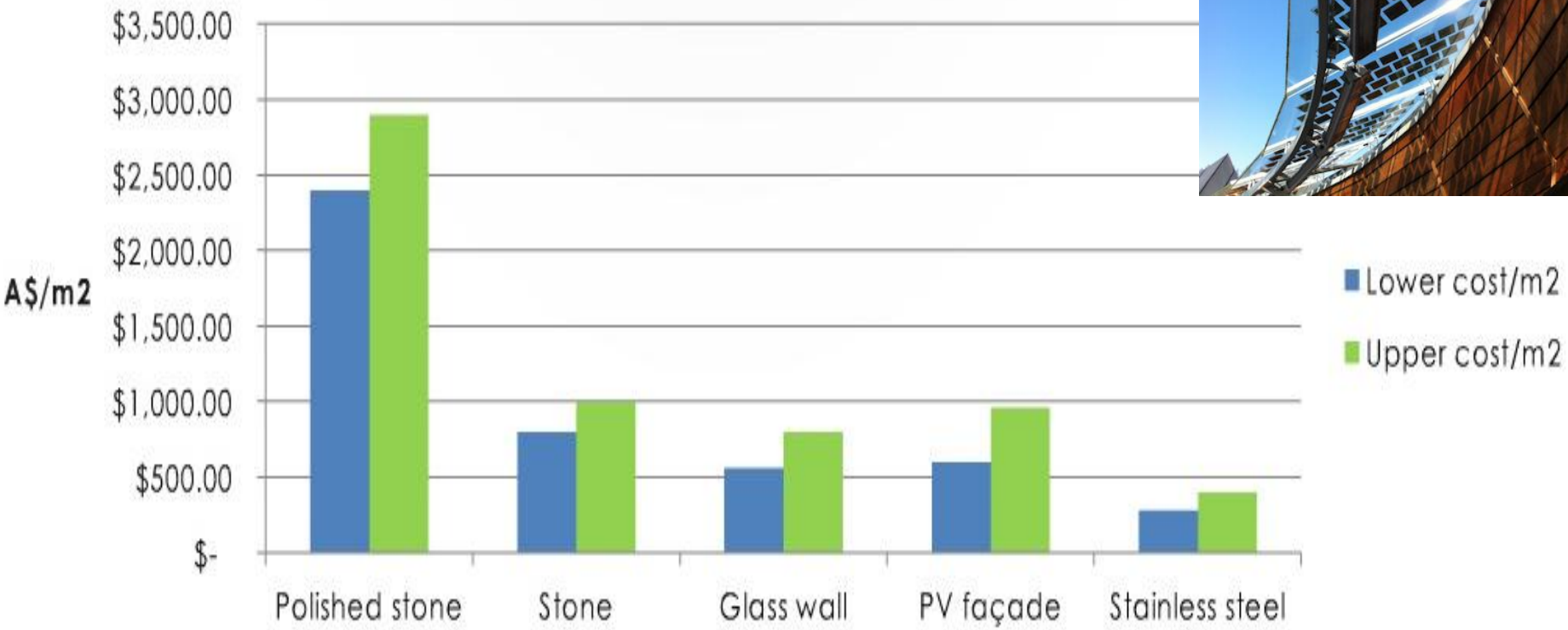
- BiPV forecast to reach $4 billion revenue by 2016 (Pike Research)

2007 BiPV costs versus conventional products



Source: adapted from Ingo Hagemann (2007)

2011 Comparative cladding costs



Source: Nigel Morris

Solar Business Services

Vertical translucent PV façade, Melbourne

- 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.


TENESOL
TOTAL & EDF GROUPS

BIPV ROOF

Artemis Building Systems

CRYSTALLINE BIPV ROOF

125 MONOCRYSTALLINE BIPV MODULE (66% transmittance)

AREA: 3.41m²/pane (1970 × 1730mm)

POWER: 180Wp No. of CELLS: 72

125 MONOCRYSTALLINE BIPV MODULE (68% transmittance)

AREA: 3.41m²/pane (1970 × 1730mm)

POWER: 175Wp No. of CELLS: 70

125 MONOCRYSTALLINE BIPV MODULE (68% transmittance)

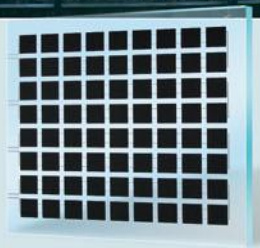
AREA: 3.41m²/pane (1970 × 1730mm)

POWER: 170Wp No. of CELLS: 68

125 MONOCRYSTALLINE BIPV MODULE (45% transmittance)

AREA: 3.41m²/pane (1970 × 1730mm)

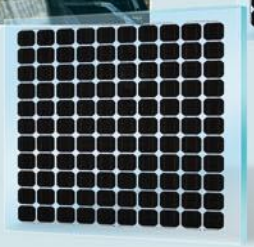
POWER: 300Wp No. of CELLS: 120



156 POLYCRYSTALLINE BIPV MODULE (49% transmittance)

AREA: 3.41m²/pane (1970 × 1730mm)

POWER: 288Wp No. of CELLS: 70

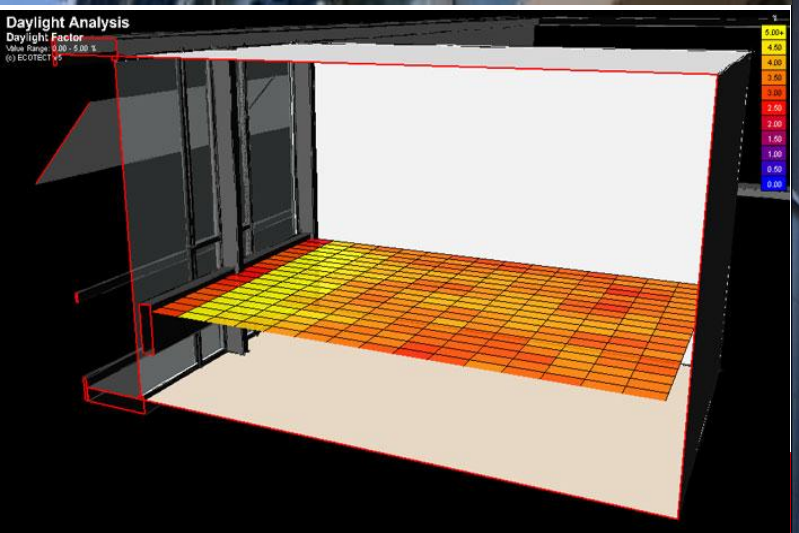


125 MONOCRYSTALLINE BIPV MODULE (23% transmittance)

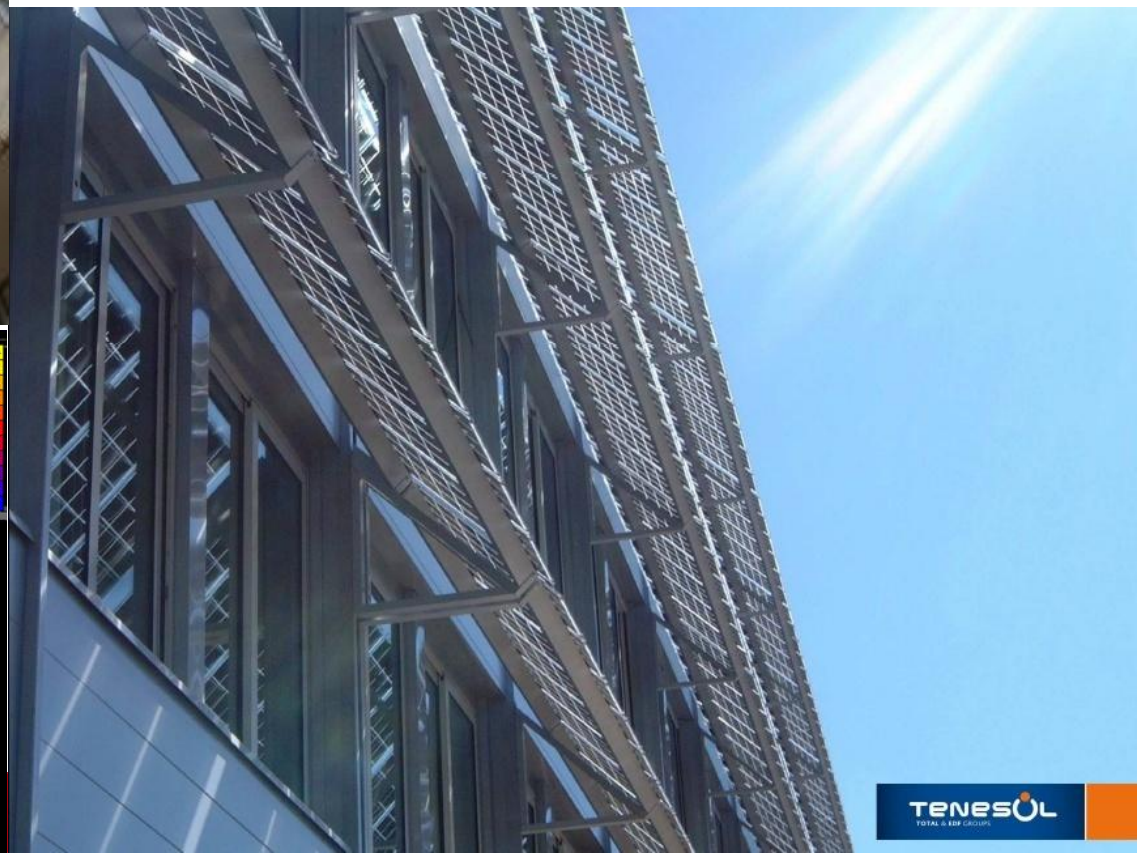
AREA: 2.24m²/pane (1554 × 1440mm)

POWER: 275Wp No. of CELLS: 110

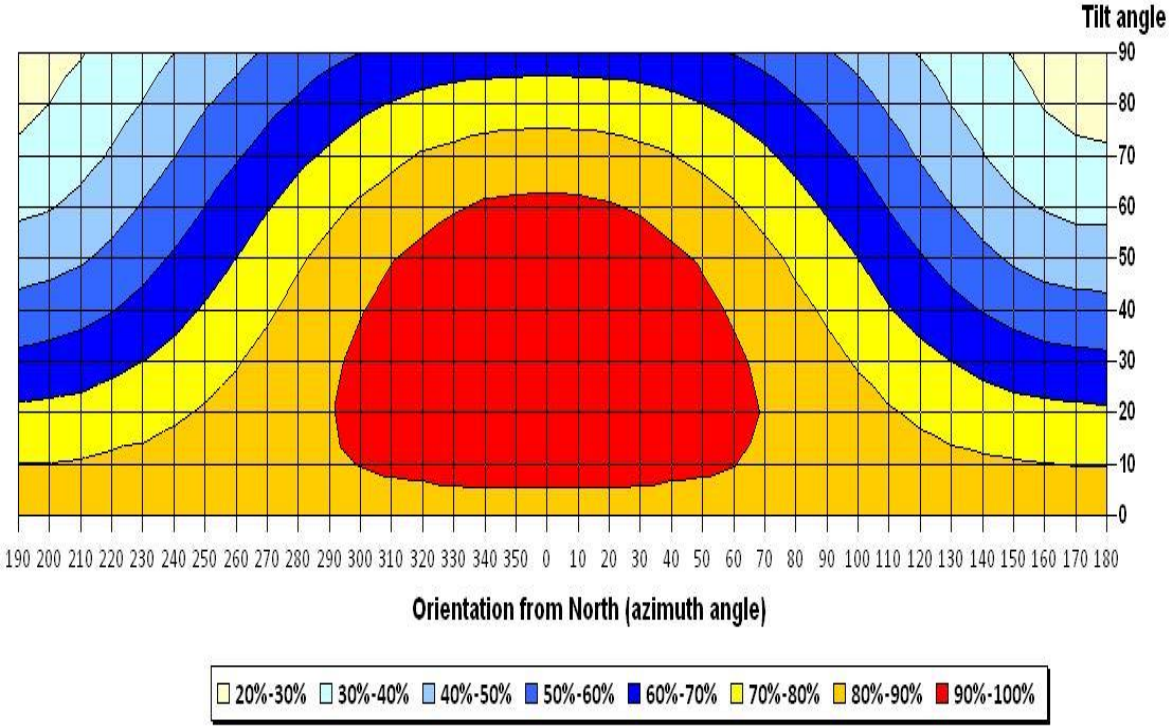
PV rainscreen cladding/ louvres

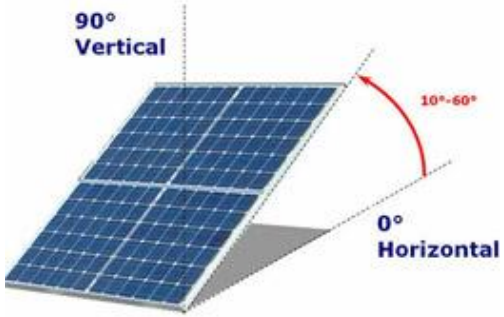


- Daylighting and thermal control
- Reduce HVAC stress
- Improves comfort for workers
- Panoramic views do not need to be affected



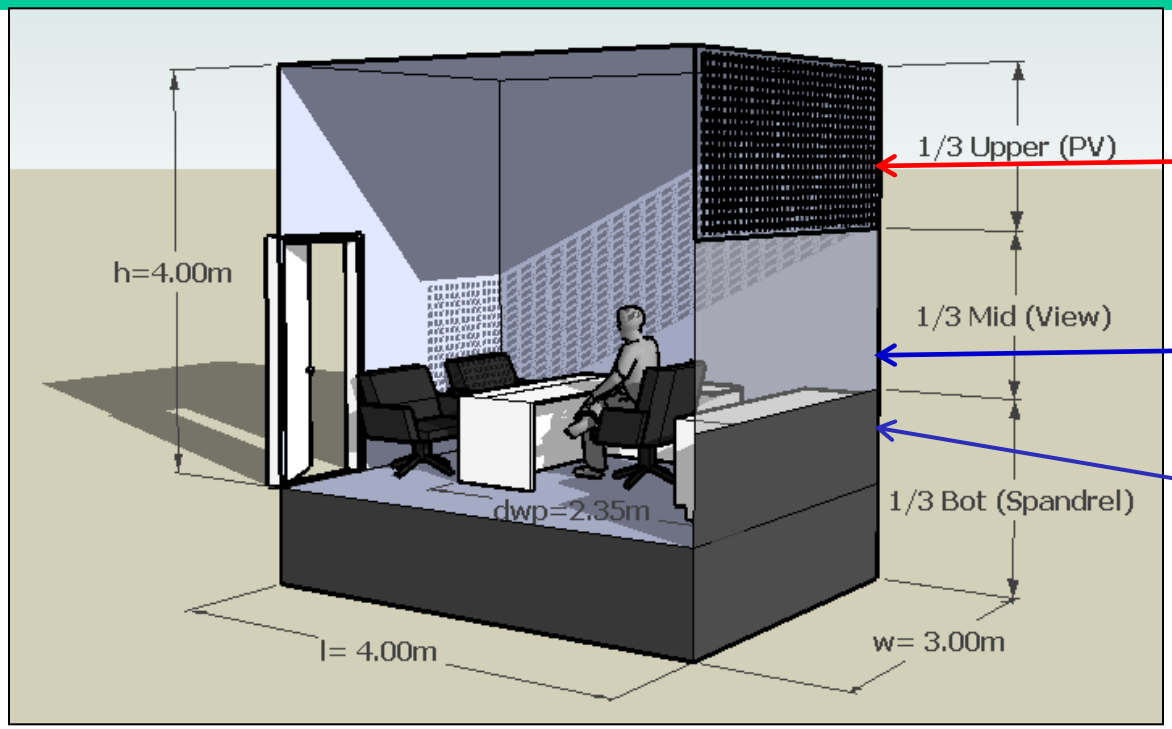
Sub-optimal orientation





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

Semi transparent PV windows



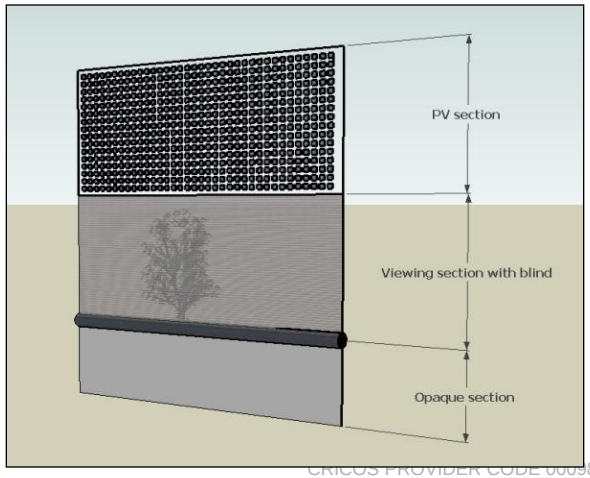
3 section façade:

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

Solar powering a green future™

SUNTECH

Case Study

Suntech Green Energy HQ Building

PROJECT OVERVIEW
Location: Wuxi, China
Completed: December 2008
Owners: Suntech Power Holdings Co., Ltd.
Architect: Wieser, Austria
Construction area: 18,000m²
Solar Façade Installer: Suntech Energy Engineering Co., Ltd.
Installed power output: 710kW (façade) + 300 kW(roof) = 1.01MW
PV Façade size: 6,900m²
Panel size: 2.2m x 1.12m (façade) , 1.482m x 0.992m(roof)
Number of panels: 2,574pcs(façade), 1800pcs(roof)
Product: Suntech Light Thru™ Solar Glazing Panel
Energy Saved: 730,000kWh + 290,000kWh=1,020,000 kWh annually

BENEFITS

- 1,020,000 kilowatt hours saved 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 9,180 tons of standard coal over a 25-year period
- Supplies 80% 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

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.

SUNTECH

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.

Suntech was founded on a passion for solar energy and its power to transform the way we live. Our dreams for tomorrow are BIG and our company has grown exponentially to realize our aspirations for a greener tomorrow.

Today we stand on the cusp of a revolution that will change the way the world generates electricity, and at Suntech we are working hard to introduce tomorrow's technology to the world today!

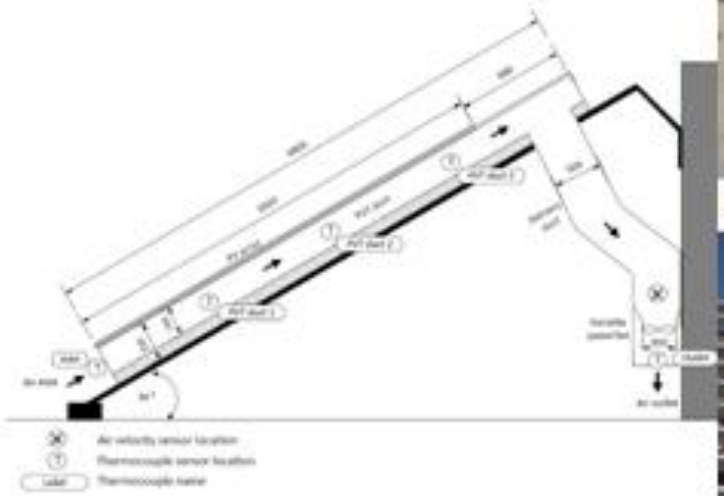
This is Suntech. We believe in the power of solar energy. ***It is what we do. It is all that we do!***

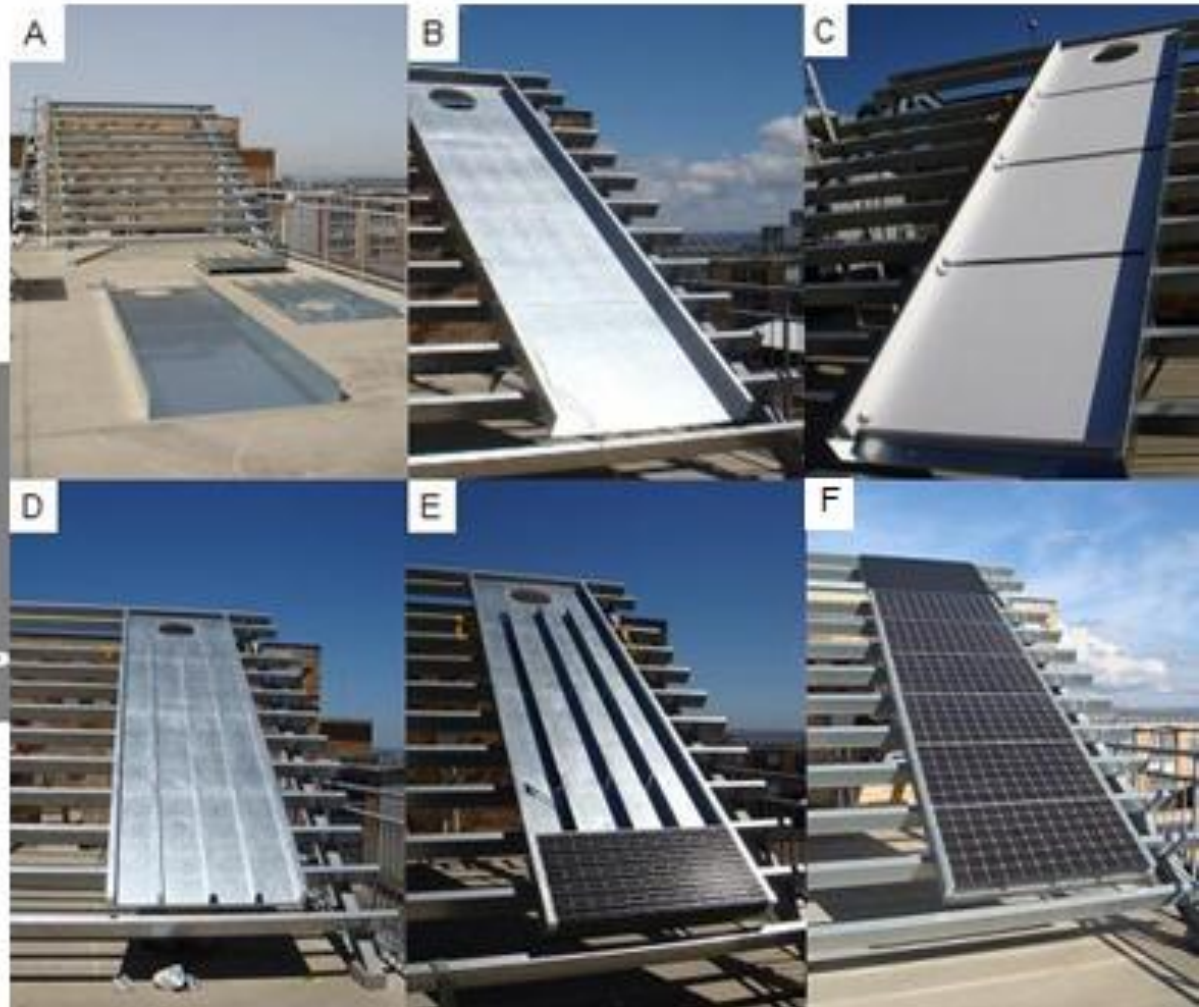
Sunny Future Ahead

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 m^3/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

Details: 1.1kWp PV Brain (source: www.ertex-solar.at)

Tools & Resources

Key sites

• Australian PV Assoication - www.apva.org.au
(Local Government guidelines,BiPV Best practice guidelines, other useful reports)

• International Energy Agency (IEA) PVPS Program - www.iea-pvps.org
• International Energy Agency (IEA) Solar Heating and Cooling Program - www.iea-shc.org
• Solar Energy and Architecture IEA SHC Task 41 - www.iea-shc.org/task41
• BiPV products and integration www.bipv.ch

PV Databases

• www.pvdatabase.com
• www.demosite.ch

BiPV Simulation Tools www.iea-shc.org/publications/downloads/IEA-T41_STB-DB1_SOA-DigitalTools.pdf

• PVsyst www.pvsyst.com
• PV design Pro-G www.mauisolarsoftware.com
• SAM (NREL Solar Advisor Model) https://www.nrel.gov/analysis/sam