ALTERNATIVE SOLAR CELL PATTERNS FOR LIGHT-TRANSMISSIVE PV PANELS

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1. Introduction

2. Study approach and aim

3. Solar cell patterns of crystalline silicon cells

4. 'W(e)AVE' – tilted and wave-like cell patterns

5. Conclusion
1. Introduction
From the point of architectural BIPV, however, it seems to be reasonable to distinguish between opaque modules and semi-transparent or translucent modules.
Opaque PV

Paul Horn-Arena, Tübingen, Germany

Fig. 1 © Allmann Sattler Wappner Architekten, München
Opaque PV ↔ Light-Transmissive PV

Paul Horn-Arena, Tübingen, Germany

Jaume University, Castellon, Spain

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Fig.2 © Scheuten Solar
2. Study approach and aim
'light-through'
'light-through' ↔ 'see-through'

Fig.3 © BSW Solar/Langrock

Fig.4 © Kaneka Corporation
'light-through' ↔ 'see-through'

Fig.3 © BSW-Solar/Langrock

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3. Solar cell patterns of crystalline silicon cells

3.1. rectangular PV panels – homogeneous cell patterns
round

Fig. 5 © Wichita Renewable Energy Group / Flickr
round → pseudo-square
Fig. 8 © Tobias Grau GmbH
Opera House
Oslo, Norway, 2007
architect: Snøhetta
Fig. 8 © Tobias Grau GmbH

Fig. 10 © n.a.
Fire Station
Houten, the Netherlands, 2000
architect: Samyn & Partners

Fig. 11 © Ch. Richters
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Heron Tower
London, UK, 2011
architect: Kohn Pederson Fox
Tobias Grau GmbH
Hamburg, Germany, 2001
architect: BRT

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London, UK, 2011
architect: Kohn Pederson Fox

Fire Station
Houten, the Netherlands, 2000
architect: Samyn & Partners

Opera House
Oslo, Norway, 2007
architect: Snøhetta

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3. Solar cell patterns of crystalline silicon cells

3.2. non-rectangular PV panels – homogeneous cell patterns
The Core, Eden Project
Bodelua, Cornwall, UK, 2005
architect: Nicholas Grimshaw & P

Fig. 15 © copperconcept.org
Café Ambiente
Bremen, Germany, 1997
architect: Mencke + Tegtmeyer

Fig. 16 © Romag Ltd
Fig. 17 © BSW-Solar / www.solar-integration.de
Gemini House
Weiz, Austria, 2001
architect: Erwin Kaltenegger
Pyramides, DEMOSITE
Lausanne, Switzerland, 1992
PV: Colt + Atlantis
The Core, Eden Project
Bodelua, Cornwall, UK, 2005
architect: Nicholas Grimshaw & P

Café Ambiente
Bremen, Germany, 1997
architect: Mencke + Tegtmeyer

Gemini House
Weiz, Austria, 2001
architect: Erwin Kaltenegger

Pyramides, DEMOSITE
Lausanne, Switzerland, 1992
PV: Colt + Atlantis
3. Solar cell patterns of crystalline silicon cells

3.3. *emerging heterogeneous cell patterns*
Solar Office Doxford
Sunderland, UK, 1998
architect: Studio E Architects
Fig. 24 © Dennis Gilbert / Studio E Architects
Christian Kindergarten
Dresden, Germany, 2003
architect: Reiter & Rentzsch

Fig.24 © Dennis Gilbert / Studio E Architects

Fig.25 © Lothar Sprenger / Reiter & Rentzsch
Ménara Airport
Marrakech, Morocco, 2008
architect: E2A architecture

Fig. 24 © Dennis Gilbert / Studio E Architects

Fig. 26 © Joe Morrissey / Atlantis Energy Systems

Fig. 27 © Benjamin Edwards / Flickr
Community College
Kankakee, IL, USA
architect: Legat Architects

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Fig. 26 © Joe Morrissey / Atlantis Energy Systems
Fig. 28 © junglepunk / Flickr
Fig. 29 © Legat Architects

Source: http://www.iea-pvps.org/cases/gbr_02.htm
Source: http://picasaweb.google.com/jomo13/AtlantisEnergySystemIncBIPVGlazing#5023391358870643586
Solar Office Doxford
Sunderland, UK, 1998
architect: Studio E Architects

Christian Kindergarten
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architect: Reiter & Rentzsch

Ménara Airport
Marrakech, Morocco, 2008
architect: E2A architecture

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Kankakee, IL, USA
architect: Legat Architects

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Fig. 29 © Legat Architects
3. Solar cell patterns of crystalline silicon cells

3.4. the quest for designed, parametric patterns
Patterns are

“a potent device for architectural articulation” (Schumacher, 2009),

“critical expressive devices” (Zaera-Polo, 2009).
“it is usually disguised by introducing an overlapped pattern or a 3-D manipulation of the surface”
(Zaera-Polo, 2009)

“substituting orthogonal matrixes with innovative geometries developed by means of complex generative processes, based on casualness”
(Scognamiglio et al., 2006)
4. 'W(e)AVE' – tilted and wave-like cell patterns
Fig. 31 Wikipedia
standard pattern

parallel cell-strings

linear cell-pattern

Fig.32 © Robert Baum

'W(e)AVE' pattern

parallel cell-strings

overlapped cell-pattern

Fig.33 © Robert Baum
To make this approach operational, 'W(e)AVE' is based on two parameters:

First, the spacing of the solar cells in cell-strings can have more than one distance. However, linearity is kept in cell-strings.

Second, interconnection between neighbouring cell-strings doesn't require the cells to lie exactly side by side, an offset between cells is possible. However, parallel position of cell-strings is kept.
Case study I

tilted pattern, rendering of a two-panel BIPV

Fig.34 © Robert Baum
Case study II

sinusoidal patterns

Fig. 35 © Robert Baum
Fig. 36 © Robert Baum
Fig. 37 © Robert Baum
Case study III
free-form pattern, rendering of a five-panel BIPV

Fig.38 © Robert Baum
Case study IV

'W(e)AVE' pattern as transition between standard patterns

Fig. 39 © Robert Baum
5. Conclusion
With the parametric approach 'W(e)AVE'
a wide range of solar cell pattern variations
akin to contemporary architectural design
become possible,
and enhance the options for individual designs
and architectural integration of PV
under the premise of “disguising” greatly.
A flexible change in the level of transparency enables the architect to set the visible connection between the interior space and outside of a building into a complex relation.
Thank you for your attention

Robert BAUM
Figure list

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