Bygningsintegrasjon av Solceller i Framtidens Bydel Bjørndalssletta

Product Presentations PV Facade Solution, Hybrid PVT and Solar Glass

Workshop 1 «Arkitektoniske og bygningsmessige løsninger for BIPV»
Kristiansand (N), October 8, 2014

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Many Similarities between Norwegian and Swiss Solar Market (PV):

- Snow & Ice, Wind Loads, Quality and Integration

Know-How Exchange on Product Innovation, successful Integration and Operation

Looking for Partnerships / Samarbeidspartnere

Agenda

Product Introduction

1. BIPV Facade Solution – Meyer Burger AG (CH)
2. Hybrid PVST – Meyer Burger AG, 2SOL (CH)
3. Solar Glass – g2e SA (CH)

+ Discussion
Building Integrated Photovoltaic and Solar Thermal Hybrid Systems

MB System Offering – Flexible Market and Cluster Offering

From Ingot to Solar Module to complete BIPV Energy System

- Cropping
- Brickling
- Squaring
- Texturing
- Coating
- Printing
- Testing
- Process Control
- Stringing
- Laminating
- Encapsulation
- Cleaning
- Separating
- Inspection
MegaSlate® II

- Simple: only 3 components
- Rapid mounting
- Adapts to any roof shapes

MegaSlate®
With integrated Solar Thermal Panels
MegaSlate®
Integrated Roof Window

MegaSlate®
Roof Integrated Solar System
Today approximately 500’000m² of MegaSlate® roof integrated systems are in reliable daily production of solar electric power.

… now re-designed for BIPV facade applications:

MegaSlate® Facade

- Curtain-wall with air space
- Tested on mechanical requirements, wind suction and pressure
- Up to 20 m
- Esthetical at reasonable cost
- Simple mounting

1) local building codes have to be considered
FaceDesign
The High End Facade

- Building envelope integrated energy generation
- Maximum energy yield, optimized self-cleaning and rear ventilation
- Homogeneous flush-mounted, weather-resistant PV facade
- No visible mounting components
- Narrow module joints
- Integrated drainage system
- Minimal installation depth of just 80 mm
- Frameless Meyer Burger black solar modules
- Swiss quality product
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2. Storage of thermal energy to reduce electricity need
“Seasonal shift of energy” Hybrid PVT

Workshop October 8, 2014 – Kristiansand, Norway
The Challenge

General problem with solar thermal systems in moderate middle European climate:

- unsuitable coincidence of need and gain
- To increase solar coverage in direct use of solar thermal power, significant oversizing of solar system is required

Typical Observation with geothermal heat probes:

- Soil cools down throughout several seasonal cycles \(\Rightarrow\) lower efficiency of heat pump

Remark: 100'000hrs approx. 11 yrs

source: Geowatt AG, 2010

Basic idea of Hybrid collector

- With higher cell temperature reduction of electrical efficiency
  - Typical PV module working temperature is at 65°C instead of standard measurement of 25°C:
    - minus 15% in Power
    - 270 Wp \(\rightarrow\) 230 W

- With a hybrid PVT collector the heat can be discharged in a controlled way and the cells can be cooled down
- Low temperature can be used
Advantages of PVT-collectors:

1. Highest yield in reference to usable roof area
2. Increase of electrical yield through cell cooling
3. Robust system (stagnation temperatures below 100°C)
4. No oversizing of solar system to increase solar coverage
5. Direct regeneration of geothermal probes
6. Integrated De-Icing Option
7. Works also in vertical mounting position

Meyer Burger Hybrid
270/900 - Performance

Electricity:
270 W at STC

Thermal:
> 900 W at T0

17% - 170 W Electricity
61% - 610 W Heat
22% - not usable
100% - 1000W/m² Irradiation at 25°C
Turnkey Solution Electric Power & Heat Supply in Buildings

In average > 60 W/m² constant (ca. 40W heat and 20W electrical power)

1 Hybrid collector
2 geothermal heat probe
3 heat pump
4 air-condition
5 regulation

0.06W/m²

Hybrid System – Heating:
Heat source: soil

Winter

soil cools down

heat pump
Hybrid System – Heating:
Heat source: PVT

Winter

heat pump

Hybrid System Heating:
Soil regeneration

Summer

PV is cooled down

soil temperature is regenerated
Suurstoffi – Rotkreuz (Switzerland)
PVT combined with low temperature heating grid

PVT System:
- 600 kWp electrical power
- 2000 kW thermal power
- Start of construction March 2014
- Biggest system using PVT for harvesting and regeneration of geothermal probes in Switzerland
More electricity, more heat or cooling capability

Annual average of ≈ 10% more electricity yield
Summer period (June 2013): + 20% more power

Comparison PV and PVT system – hot summerdays June 2013

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Glass as Energy Supply Source

The Situation
70% of the world’s population will live in an urban area by 2050

80% of the world’s carbon emissions are produced by cities

40% of the world’s energy is consumed by buildings

The challenge

Generate electricity in the heart of cities

- where people live and consume
- where space is scarce
- where esthetics are valued
- where environmental impact must be minimal
Our solution

Generate electricity from almost every glass surface you can imagine...

- facades
- windows
- balconies
- anti-noise barriers
- fences
- verandas
- bus shelters
- etc...

About g2e

Swiss company
- founded in October 2011 with the aim
- to industrialize the dye-sensitized solar cell (DSC) technology
- The only company in the world having mastered the industrialization: of the process of glass sealing and the scale-up of chemistry

Shareholders
- includes industrial companies from key branches of this technology
- façade construction, fine chemistry, utility provider (electricity) and telecommunication services: Swisscom, Sottas, Fibag (AT), Swiss Society of Explosives (SSE), Groupe E

Technology
- invented by Prof. Grätzel at EPFL, Switzerland
- awarded several times, winner of the Millenium Technology Prize 2010 (the Nobel Prize of the technology branch), winner of the Marcel Benoist Prize 2013

Management team
- CEO: Stefan A. Müller, MBA, long experience as CEO and director in the branches of banking, manufacturing and new technologies
- CTO: Asef Azam, dipl. ing. EPFL, 20 years of research and development experience in the solar (DSC) sector
- COO: Henri Favre, mechanical engineer specialised in manufacturing inks and quality management
Product

A glass panel that produces electricity
100 cm x 60 cm

Colors and design

Developed shades
Green: spring grass and olive,
Orange,
Red: Bordeaux and Ferrari,
Bleu: cobalt (in 2015)

Different colors have different photovoltaic efficiency
Changing or adapting colors is not possible
Separation lines between cells can be straight and colored
Logos and images can be printed into the cells (in the same color tones)
Colors and design

Current panel size: 100 x 60 cm
Future dimensions: 100 x 100 cm

Our technology

• **dye-sensitized cell** technology (DSC)

• leading-edge **nanotechnology** invented by Prof. Grätzel from the EPFL

• representing the **3rd generation** photovoltaics

1st generation: c-Si
2nd generation: Thin-Film, c-Si
3rd generation: DSC
The Technology

Dye-sensitized solar cells (DSC or DSSC)

- Developed by Prof Michael Graetzel at EPFL
  - Millenium 2010, Albert Einstein, Marcel Benoit 2013, etc....
  - If one company brings the technology to market .... NOBEL Prize

- Patented 1991, today over 500 patents

- Over 200 researchers world wide
  - EPFL : 50
  - Uppsala (Sweden) : 15
  - China, Japan, Australia

- Over time 15 companies took a licence, 7 today still active .... g2e latest

- g2e only with glass sealing, biggest in size, largest manufacturing capacities as of 2014

Think of it as artificial photosynthesis...

sun leaves energy to grow

glass2energy modules electricity
Principle of natural photosynthesis

\[
\text{CO}_2 + \text{H}_2\text{O} + \text{Solar Energy} \rightarrow \text{O}_2 + \text{Glucose} = \text{Energy to grow}
\]

Instead of chlorophyll
Various classes of dye sensitzers
**Working principals**

The technology of dye sensitive solar cells is often referred to as artificial photosynthesis, analogous to chlorophyll in leaves, where a sensitized dye absorbs light and generates excited electrons.

These electrons are injected into and transported via the conduction band of a high surface area semiconductor.

These cells are thin film devices that use a nanocrystalline carrier layer made of titanium dioxide (TiO₂) whose surface is chemically bonded with a monolayer of light-absorbing dye molecules. A small amount of gel electrolyte is used for the transport of the carriers.

The technology, invented at the EPFL by Prof. M. Grätzel, has been matured during 20 years of development and 17 licences distributed worldwide by the EPFL.

So far, stability of DSC was hindered by poor sealing. Recently, we have been able to develop a process for reliable sealing of DSC.

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### Advantages of the technology

**Energy production (kWh/Wp) in a day of 24h**

- **10 to 50% more kWh/Wp** energy production than with current technologies

- Significantly better performance at low light level and diffuse light situations (24h a day / 365 days a year)

- Higher equal transparency efficiency than c-Si or ThinFilm:
  - 50% transparency reduces the efficiency of other technologies in the same proportion
Main advantages of the technology

**Transparency:**
50% transparency reduces performance by 50% on any classic PV module.

**Heat:**
Other technologies lose performance up to 15% (c-Si) at increased operating temperatures. DSC increases by 5 -10%.

**Harvesting:**
over 24h / 365 days : + 5 (south) to 70% (north) kWh/kWp

Key advantages

- Efficient at diffuse light and cloudy conditions
- Can be mounted in any angle and orientation (360° efficiency)
- Double-sided
- Transparent
- Efficient in interiors and under artificial lighting
- Colored
- Improved efficiency at high temperatures
- 100% made of glass
- Not sensitive to shadow
- Easy recycling
- No toxic or rare materials
- 100% made of glass
Different & complementary uses...

focus on electricity generation only, mainly on roofs and solar farms

colors, transparency, design and electricity generation on vast range of applications

Annual energy production per m²

kWh/m² produced by g2e panels during the course of one year

2014

40 W/m²
South oriented, angle 35° (best position) 45 kWh/m²
South oriented, angle 90° 30 kWh/m²
East or West oriented, angle 90° 24 kWh/m²
Bifacial, both sides, 90° 38 kWh/m²
North oriented, angle 90° 14 kWh/m²

2016

55 W/m²
South oriented, angle 35° (best position) 60 kWh/m²
South oriented, angle 90° 41 kWh/m²
East or West oriented, angle 90° 33 kWh/m²
Bifacial, both sides, 90° 53 kWh/m²
North oriented, angle 90° 19 kWh/m²

Performance is continually improved.

By « bifacial » we mean an upright installation of 90° where the rising sun illuminates the Eastern and the setting sun the Western side of the modules. The modules are efficient on both sides. kWh / m² figures do relate to an exemplary project site in Switzerland.
Concept of installation into a façade

Security glass on the outside
Modules are laminated onto that glass

Front view

100 cm x 60 cm

Photovoltaic module

Window with triple isolation

Outside

Inside

Lateral view

Window frame

Wiring

Geneva Airport: Interior pilot project installed in 2013
Municipalities: “Off-grid” bus shelter (pv + battery)

Anti-Noise Barriers: double-sided efficiency
On flat vegetalised roofs with designs and motifs
Flat roof application with mirrors

Computations show that DSC modules of 1.5m height in this roof configuration will have the same kWp then modules of today’s standard crystalline technology for the same roof surface. Panel sizes over 1.5m will give higher values.

Moreover DSC technology gives 20% to 50% times higher kWh/Wp harvest. What customers want are kWh for self consumption or for grid feed-in at interesting tariffs.

Development by FIBAG, Austria

Vertical, movable sun shades

- Colored designs
- Sun or shadow, open or closed, you always get your kWh
Facades and colors, day and night (simulation, Bern)

Stages

2014: Pilot Projects
2015: Prestige Projects
2016: Industrialized Production
First major façade project

Smart City Graz, Austria 2015-2016

- Flagship project of the European Commission
- Outer shell made of 50% by g2e panels
- Project to be realised by Fibag
- [http://www.stadtentwicklung.graz.at/cms/betreff/10211896/2858471/?print=1](http://www.stadtentwicklung.graz.at/cms/betreff/10211896/2858471/?print=1)

Architektur: Markus Pernthaler Architekten ZT-GmbH

Summary on introduced products

1. **BIPV Facade Solution – Meyer Burger AG (CH)**
   MegaSlate® Facade, robust, esthetical at reasonable cost

2. **Hybrid PVST – Meyer Burger AG, 2SOL (CH)**
   Turnkey system approach for heat and electricity generation in buildings. Regeneration of soil temperature, geothermal heat probes.

3. **Solar Glass – g2e SA (CH)**
   The next generation solar glass as a building design element
Takk for nå!

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