Journalnr: 1936-0008

Building Adapted Solar Energy (BASE)

Slutrapportering for projektperioden 1. nov. 2013 til den 31. aug. 2016

Version: Udkast 4.0

31. maj 2017

Projektansvarlig virksomhed: Gaia Solar A/S

Projektleder: Anders Sørensen, Udviklingschef, Gaia Solar

Indhold

Final report

1.1 Project details

Project title	Building Adapted Solar Energy (BASE)
Project identification (program abbrev. and file)	EUDP J. nr. 1936-0008
Name of the programme which has funded the project	EUDP
Project managing company/institution (name and address)	Gaia Solar A/S, Hammerholmen 9-13, 2650 Hvidovre
Project partners	Gaia Solar A/S Kirt Thomsen ApS Københavns Ejendomme Krydsrum Arkitekter Cenergia Enemærke og Petersen Kuben Management Solar City Copenhagen
CVR (central business register)	19269280
Date for submission	31-05-2017

1.2 Short description of project objective and results

1.2.1 Short description of project objective and results

The purpose is to develop a low-cost, high performance BIPV solution that can be tailored to unique site requirements, with focus on multi-story buildings in cities. A supplementing business model will be developed to ensure customer acquisition as well as creating services for stakeholders in the value chain enabling and strengthening the market.

The project result is a new integrated solar roof solution that can replace a conventional red tile roof fully or partly depending on the customer need. The pv-panels and supplementary roof panels from Steni® have the same size and are installed and mounted using the same principles – thereby minimizing costs for mounting system and time.

We have managed to make an economic feasible BIPV solution that allows customers and owners of buildings with red tile roof to install solar on areas fully or partly limited to solar due to esthetics and building preservation rules.

1.2.2 Kort beskrivelse af projektmål og resultater

Formålet er at udvikle en priseffektivt højtydende BIPV løsning, der kan skræddersyes til unikke bygningskrav, med fokus på etage ejendomme i bymiljøet. En supplerende forretningsmodel vil blive udviklet sideløbende for at sikre behovsopfyldelse hos slutkunden, samt skabe services til interessenter i værdikæden, som muliggør og styrker markedet.

Projektets resultat er en ny integreret solcelle løsning, der kan erstatte en traditionel rødt tegltag helt eller delvist – alt afhængig af kundernes behov. PV-paneler og supplerende tagplader fra Steni® har samme størrelse og monteres efter de samme principper – hvilket spare montage tid og montagesystem.

Vi har formået at skabe en pris effektiv BIPV løsning, der gør det muligt for kunder og ejere af bygninger med røde tegltage at installere solenergi på områder helt eller delvist begrænset til solceller på grund af æstetik og bevaringsmæssige forhold.

1.3 Executive summary

1.3.1 Purpose

The goal of the project was to address the great potential for integration of solar energy in urban environment, using Copenhagen as a demonstration area for a new innovative and cost effective BIPV system solution.

The precise focus on which building and roof type the project wanted to focus on was not decided from the beginning. This decision was taken based on market research in the beginning of the project. The project team chose to develop a solar solution for the red-tiled roofs, which represented a roof type not addressed by solar industry and without any good solutions that made it possible to make an aesthetically acceptable integrated solar solution.

Initially, the project has primarily sought to develop an aesthetically acceptable solution that could be seen as an energy-producing alternative to a red tile roof. This led to the first version of BASE solution consisted of facade tiles and solar cells - a beautiful but very expensive solution. The following efforts in the project has been focused on reducing costs without compromising the aesthetics. Based on prototyping and economic calculations, we chose to replace the expensive facade tiles with a fibreglass reinforced polymer composite from Steni which supplemented the pv-panel and made it possible to make a energy producing roof solution that replicated some of the features of the red tile roof – color and horizontal lines. Besides the aesthetics, the roof cladding from Steni also offers 40 years of functional warranty which supplements the pv-panels long lifetime as roof – being glass.

The end result is BASE – a cost-effective solar solution for red rooftops. The solution demonstrates the potential of integrating solar energy in a high and densely populated area as Copenhagen without the necessity of compromising the property value. Our mission was to provide both cost-effective and aesthetic solar cells that are integrated in the already existing roofing materials while still achieving the high level of energy savings.

1.3.2 Main activities

1.3.2.1 Assessment and Analysis

The primary purpose of this activity has been to identify and collect detailed knowledge in relation to building types, functionality, aesthetics and requirements in relation to BIPV, including mapping of technologies, best-practice and cost-reduction perspectives.

The activity and the conducted research has led to the production of market research report[1] that provides an overview of market information as well as an associated survey of the four most commonly seen building types in the area of greater Copenhagen[2].

The following aspects has been identified as important market drivers and focus of the BASE solution, and function as a point of departure for the development of the solution in WP3:

Property and buildings established between 1920 and 1950

The majority of the existing building stock is established ml. 1850 and 1950. It is estimated that in the period around listed 30,000 buildings used for apartment housing.

1920-1930: 8,160 buildings (defensive set - can be larger)

1931-1950: 16.840 buildings

Of the 25,000 buildings, it is estimated that 20% of the buildings has such a bad u-value without any insulation worth mentioning and thus a great incentive to refurbishment. In total about 5000 buildings.

[1] Bilag 1: BASE Markedsrapport

[2] Bilag 2: BASE Eksempelstudie (del 1)

Energy Renovation Projects focusing on roof

Taking into account the large potential for energy renovate the roof, it would be obvious to include solar panels as part of the work and ensure saving on heat and energy production simultaneously. The following aspects are some of the key drivers and arguments:

- Large savings on materials (pv to replace roofing material) and montage (scaffolding, etc.), thus exploiting MULTI FUNCTIONALITY in BIPV.
- Ability to establish penthouses (increasing demand and lack of housing), which can pay for the solar roof.
- Good opportunities to receive funding from support and incentive programs supporting energy renovation of both private and public owners.

Pitched roof (vinkeltag) with red tiles

The dominating roof type in the period 1920-1950 is saddle roof (vinkeltag). In addition, in the period established Manzardtage and Flat roofs in wood, which we define ourselves from the project, as there is already available solutions to these.

Compared to roofing, the project focuses on the tiles, and more specifically the red tile roof. It is the most used roof material in the period, and at the same time the roof type with the largest potential and need for a new BIPV solution because there are no solutions on the market today that address this roof type.

It is estimated that of the 5,000 buildings, with a large incentive to refurbish their roof, a minimum of 80% has pitched roof and the rest Mansard and flat roof. Of the remaining 80% - 4000 buildings, it is estimated that approximately 50% - 2,000 buildings with roofs made of tiles and another 50% of these estimated to be red tile roof. This results in a potential of about 1000 buildings.

Multi apartment buildings owned by private property owners

Of all the multi-apartment buildings established in the period 1920-1950, 72% is owned by private (individuals, including I/S, A/S, Ltd. and private housing associations), 21% owned by General Housing Associations and the remaining 7% by public authority and other (undisclosed).

The above standing majority of privately owned buildings is a strong argument to focus our efforts on privately owned apartment buildings. Although this doesn't mean that neither general housing associations nor public buildings should be excluded from our focus.

The primary target group of the BASE solution will therefore be property owners, much likely focusing on CSR, where solar cells can help to meet the CSR ambitions.

The good overview of the client and the users

The developed solution is required to meet the growing demands of information and detailed knowledge expected by property developers. Increased knowledge contributes to greater interest in renewable energy. Including early cooperation on consulting, engineering, economics and aesthetics. These factors must be reflected in the way we address our target group. Visualization of the solution is estimated to help to create confidence among both developer and user.

The intelligent solution

Fix it all: There is a clear desire that the offered solution has to be a total solution, which means that the developer only to coordinate the work with one entity.

Synergy: There is a clear desire that the integration of photovoltaic is combined with existing technologies in the building whenever appropriate.

Economy: An important aspect is to increase the use of the energy produced in order to create the best possible economy and business case for the buyer of the solution. The price of the solution must be able to compete with alternative roofing and pv-solutions market.

The following concept scenario matrix sums up most of the results from this activity.

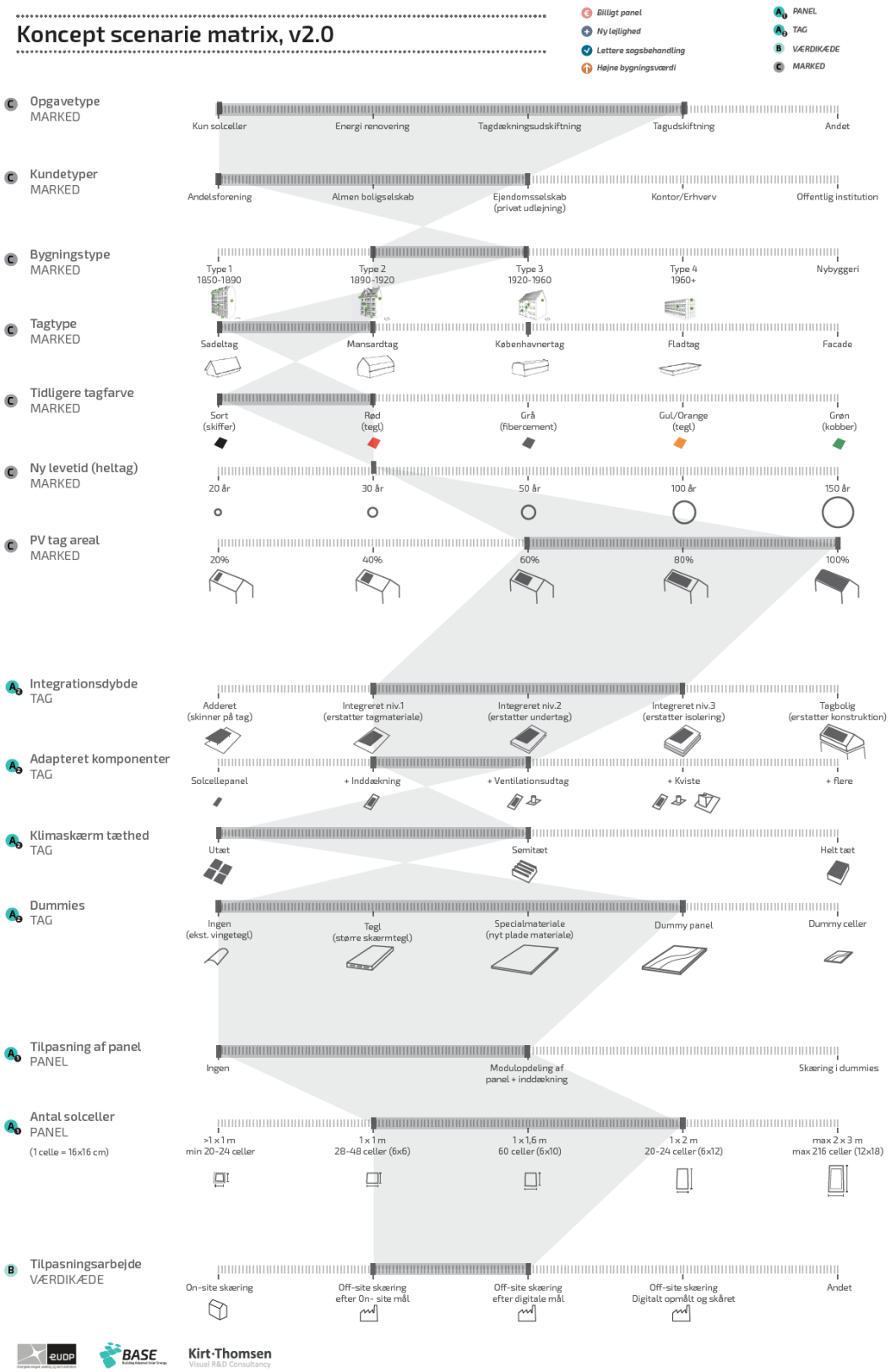


Figure 1: Concept scenario matrix

1.3.2.2 Development of Technology

The purpose of this activity is to develop the physical design of the BIPV concept focusing and reducing "balance of system costs". Tasks and expected results include documentation of requirements of the BIPV solution, evaluation of design and manufacturing options, sourcing of innovative components, design of prototypes, building and testing of prototypes.

Design roadmap & Technology report

Initially focus of this activity has been the development of a physical design roadmap and technology report[3]. The output of these documents form the requirement specification of the BIPV solution. A central part of this initial development of the technology has been the development of a series of pv-panels exploring the various possibilities of new components - types of glass, solar cells, polymer backsheet and different new combinations and geometries. These practical studies have given us valuable insights and knowledge that have been key to deciding which solutions to prototype and proceed with.

The results from design roadmap, technology report and pv-panel study are all reflected in the requirement specification. The central design drivers are summed up in the following figure:

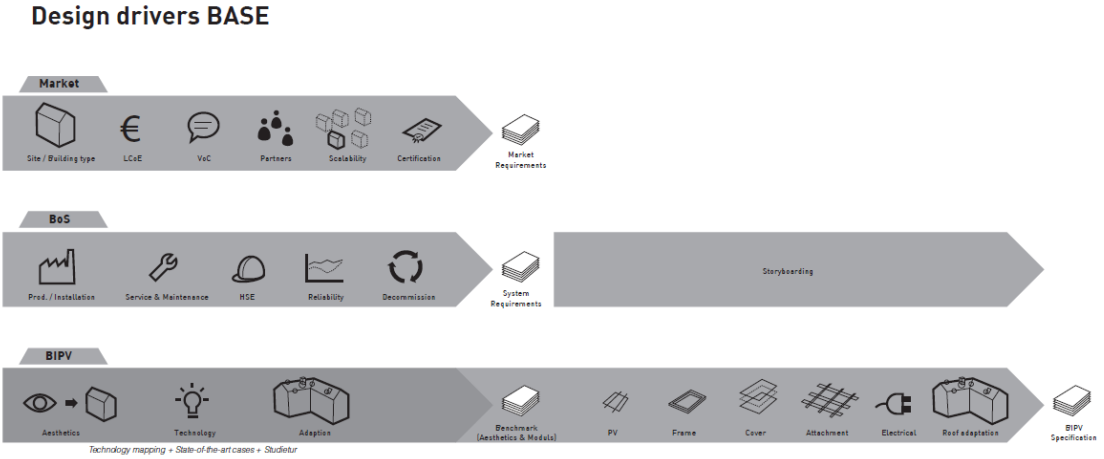


Figure 2: Design drivers BASE

The main focus of the BIPV design and first prototype to be produced and tested has been to make an aesthetically acceptable version of the red tile roof with solar panels and supplementary roof material.

Dialogue with key stakeholders

An important step in this development process has been the dialogue with key stakeholders and potential end-users, represented in the by project by Copenhagen Municipality, KEjd and Kuben Management. Based on design roadmap and technology report a series of visualizations and sketches of possible designs and solutions have been created and presented to end-users and stakeholders. The valuable feedback has been used to refine the designs before proceeding to prototyping. Central feedback points and conclusions:

- Continue with a re-interpretation of the red tile roof
- Very convincing visualizations
- Red tile roofs are the biggest challenge – we appreciate you focus one this
- Critical point is create to create a solution with similar texture and characteristics as tiles and their depth, variation and texture change.

[3] Bilag 3: WP3

The first prototype

The first prototype was based one using façade tiles typically used for rainscreen cladding one facades on a roof instead together with a supplementary solar module design that imitated the horizontal and vertical lines of the tiles. The solution as seen below was successful in terms of providing a aesthetically pleasing solution able that had some of the central characteristics of standard red roof tiles, but being very costly and therefore not cost-effective enough to become a new competitive solution and a serious alternative to standard PV-solutions.

Figure 3: First prototype, with facade tiles

The first prototype was launched and presented to a larger audience in early summer 2014. The event created a lot of attention and interest and dialogue about solar solutions for red tile roofs. Based on feedback and this dialogue with end-customers we concluded that we had to make a more cost-effective version of the first prototype.

The second prototype

The development of the second prototype had one overall goal: to reduce costs without compromising aesthetics – too much. The primary problem or challenge with the design of the first prototype was 1) the price and 2) the handling and mounting of the tiles. This made us look for alternative rainscreen and façade cladding materials that were cheaper and easier to mount and handle.

We made a screening of various façade cladding materials including high-pressure compact laminates (HPL), fiber cement and fibreglass-reinforced polymer composites. Our final choice was to proceed with the polymer composite from Steni ® because of its 40 years functional warranty and perfect fit with surface of the glass on the pv-panels.

The second prototype measures 395 mm x 1640 mm and consists of two rows of solar cells with 10 cells in each. The height of the pv-panel is considered to resemble the height of a tile including overlay. The width of the pv-panels is designed to be an acceptable size to be handled by one person – installing the pv-panels and making the roof.

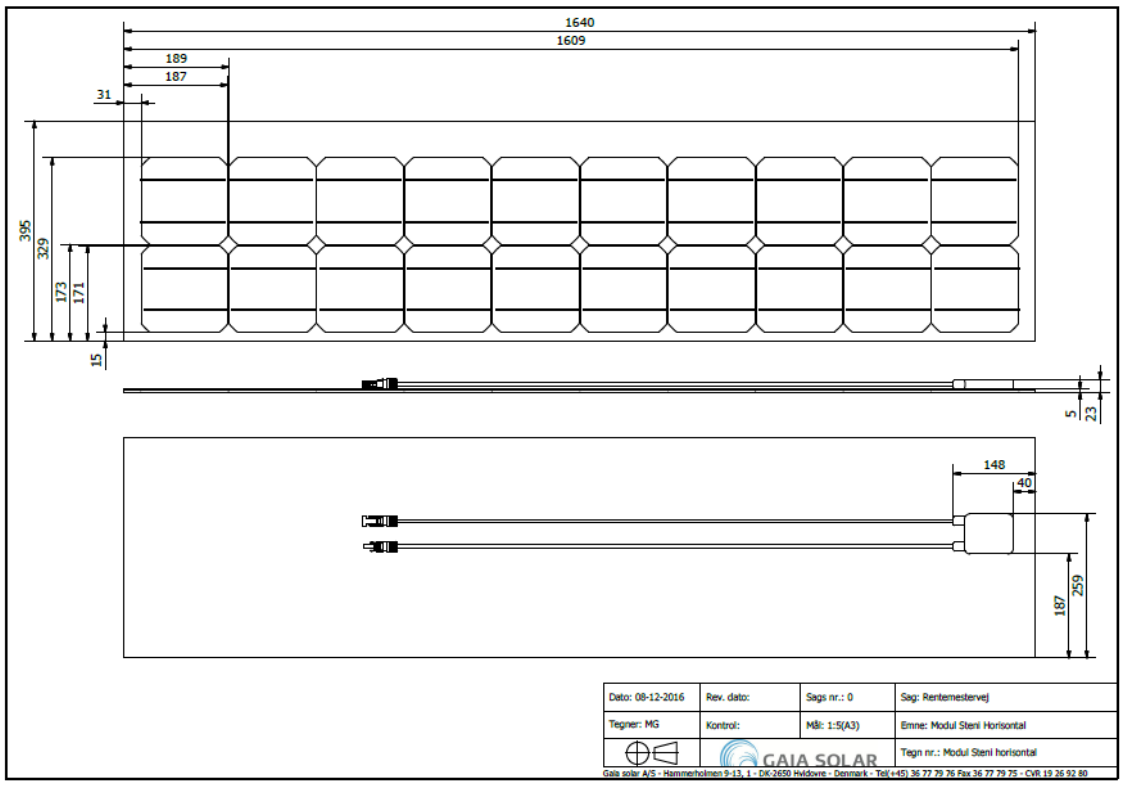


Figure 4: Second Prototype - PV-module specification

Having determined the specifications of the module, a series of prototype PV-modules were produced. The PV-modules were mounted on a mock-up at Gaia Solar to be used for further development of mounting brackets, handling of rainwater and testimonial of the solution to convince building owners to demonstrate the developed solution.

Mounting system

The mounting system and brackets have been developed in parallel with the second prototype. The initial designs have been prototyped and 3D printed and tested on the mock-up at Gaia Solar's demo-area.

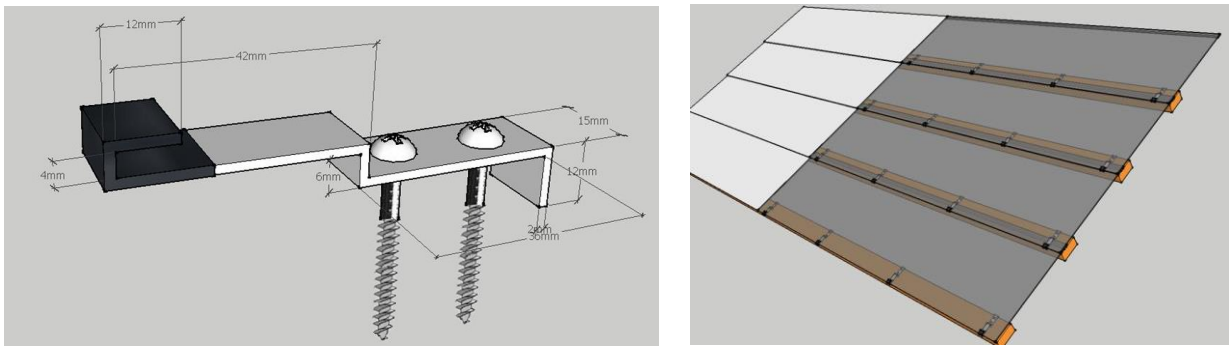
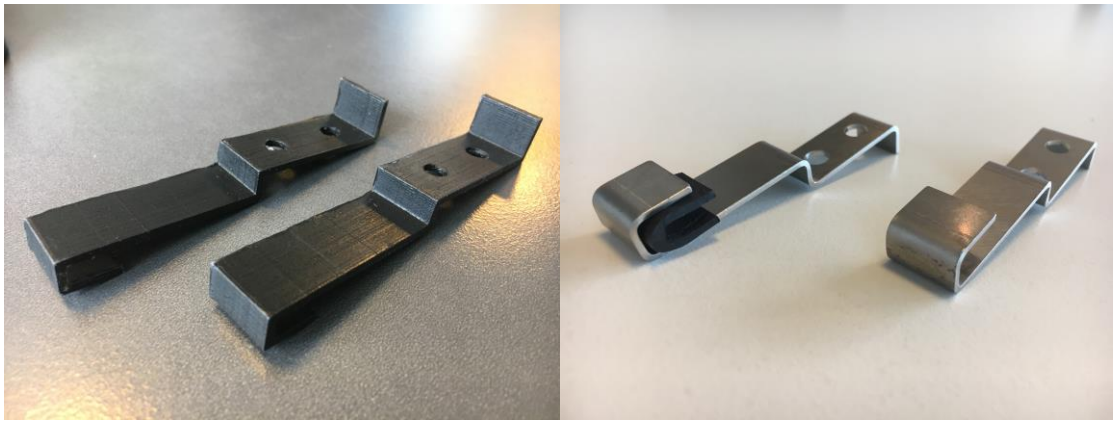


Figure 5: Mounting bracket – visualization and first design

One of the challenges have been to ensure a simple and cost efficient design, that allows for an easy mounting of the PV-panels.

Despite the fact that the roof-cladding from Steni is mounted using only screws, it was decided to develop a bracket in order to avoid having a PV-panel with 3-5 holes that would ultimately weaken the structure of the PV-panel and enhance the production costs of the PV-panel.

The final result was a mounting bracket in made of steel supplemented by rubber-clam. The final mounting bracket and 3D printed prototype can be seen below:



Testing

The purpose of the test was to determine whether Gaia Integra Line could be tested to comply with Euronorm test for façade-cladding and roof-solutions.

The test is theoretical, since the building envelope is ventilated and therefore cannot be tested according to blower-door test requirements.

In addition, the test was an opportunity to test the PV-panel designed in an already installed Steniroof, and test whether it was possible to remove and replace a PV-panel.

The test can be summarized as;

- Test of strength by suction Euronorm.
- Testing of the design, including brackets, hole and junction box location.
- Testing the disassembly / reassembly when replacing the PV-panel.

The conclusion of the test was revealed no deformations on either bracketts, PV-panels or screws upon visuel inspection. It also showed that it was unproblematic to replace a PV-panel by using a glass handler cup.

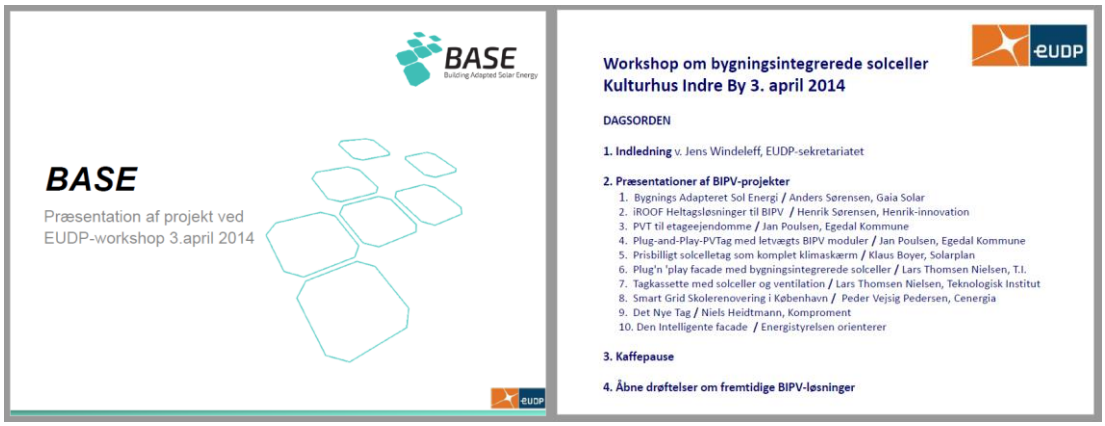
1.3.2.2.1 Communication and Dissemination

The project team initially have had their focus on developing internal project identity and communication material for the project (logo, templates for work and presentations). Secondly we developed a communication plan and launched a project website in Q2 2014 – www.projectbase.dk .

BASE
Building Adapted Solar Energy

Presentation at seminar

The project has been presented at a seminar hosted by Solar City Denmark and EUDP the 4th April 2014 with focus on communicating the scope of the project and inspire building owners to demonstrate the BIPV solution to be developed.



BASE

Præsentation af projekt ved
EUDP-workshop 3.april 2014

Workshop om bygningsintegrerede solceller
Kulturhus Indre By 3. april 2014

DAGSORDEN

1. **Indledning** v. Jens Windeleff, EUDP-sekretariatet
2. **Præsentationer af BIPV-projekter**
   1. Bygnings Adapteret Sol Energi / Anders Sørensen, Gaia Solar
   2. iROOF Heltagsløsninger til BIPV / Henrik Sørensen, Henrik-innovation
   3. PVT til etageejendomme / Jan Poulsen, Egedal Kommune
   4. Plug-and-Play-PVTag med letvægts BIPV moduler / Jan Poulsen, Egedal Kommune
   5. Prisbilligt solcelletag som komplet klimaskærm / Klaus Boyer, Solarplan
   6. Plug'n 'play facade med bygningsintegrerede solceller / Lars Thomsen Nielsen, T.I.
   7. Tagkassette med solceller og ventilation / Lars Thomsen Nielsen, Teknologisk Institut
   8. Smart Grid Skolerenovering i København / Peder Vejsig Pedersen, Cenergia
   9. Det Nye Tag / Niels Heidtmann, Komprement
   10. Den Intelligente facade / Energistyrelsen orienterer
3. **Kaffepause**
4. **Åbne drøftelser om fremtidige BIPV-løsninger**

Excursion

Just before summer the 19th June 2015 the project team arranged an excursion together with the other project PV Boost. The focus of the excursion was to introduce the participants to cases with integrated solar energy and establishing dialogue with potential building owners that could act as potential demonstrator of the developed BASE-solar solution.

EKSKURSION/

Integrerede solcelle-løsninger i praksis

Torsdag den 19. juni 2014 kl. 12:30-17

Kl. 12:30
Bussen afgår fra Københavns Hovedbanegård og holder foran indgangen mod Vesterbrogade

Turen går til nybyggeri og eksisterende bygninger, hvor integrerede solcelleløsninger i facader og tag gennemgås af arkitekter, bygherrer, solenergi-leverandører og andre fagpersoner. Ekskursionen fokuserer på den praktiske udførelse: detaljer, løsninger, udfordringer, forløb og økonomi.
Vi skal op i på taget på tre af stederne.

PROGRAM
Copenhagen Towers - facadeintegrering nybyggeri
Tanja Sjørup-Nielsen, Gaia Solar
Tagrenovering i bevaringsværdigt byområde
Arkitekt Klaus Dyhr, Krydsrum Arkitekter & Energi+
CPH University City Campus - nybyggeri
Arkitekterne Morten Ørsager og Steen Gissel, Erik Møller Arkitekter
Søpassagen- tagrenovering med solcelletag
Arkitekt Klaus Boyer, SolarPlan
Andelsboligforening - integreret i ex. tag
Kristian Sylvester-Hvid

Kl. 14-14:30 Kaffepause undervejs
Sandwich, kaffe og kage på Dansk Arkitektur Center
Deltagerne får 10% rabat i DAC's boghandel

Solar City Copenhagen
Arkitekternes Hus
Strandgade 27 A
1401 København K
T: +45 28 59 59 40
M: kk@solarcity.dk

Afholdes i samarbejde med projekterne:
'PV Boost' - støttet af Forsk.VE
'BASE' - støttet af EUDP

pvboost
EUDP
FORSK VE
BASE

SOLAR CITY COPENHAGEN MEDLEMMER
Akademisk Arkitektforening
Alectia
Amager Erhvervsråd
ATOPIA
Bjarne Schlüger Design Aps
Boligforeningen 3B
Bornebusch Tegnestue
By & Havn
Bæredygtige Byer og Bygninger
Cenergia Energy Consultants
Center for Byggeri KBH Kom.
Center for Miljø KBH Kommune
DanSolar
Dong Energy
Egedal Kommune
Ekolab
EnergiMidt
Energistyrelsen
Energitjenesten København
Entasis arkitekter
Esbensen Rådg. Ingeniører
Foreningen for Energi & Miljø
Furesø Kommune
Gaia Solar
Gentofte Kommune
GermanSolar
Glarmesterlauget i Danmark
Henning Larsen Architechts
In_situ arkitekter
Kolding Kommune
Kuben Management
Københavns Ejendomme
Københavns Solcellelaug
Lyngby-Taarbæk Kommune
Malmø Stad
MIKKELSEN Architects
Miljøpunkt Nørrebro
Outsider
PAEnergy
PlanEnergi
Rambøll
Roskilde Kommune
Saphire Group
SiCon
Skive Kommune
Solar City Malmø
SolarCell / Dansk Solenergi
SolarGlas
Solarplan
Teknologisk Institut
Vallby Lokaludvalg
Vedvarende Energi
ViaSol
Wissenberg Rådgivende Ing.
Øligaard Rådgivende Ingeniører
+ en række enkeltpersoner

1st Press release

In the beginning of January 2015 the project team published a press release about the project. The press release was published in 8 different news-sites. Creating a lot of attention and interest among housing associations, building owners and architects. The following article is from Byggecentrum. Se appendix for the results of the press-release.

HFB BYGGECENTRUM

SØG

HFB > Nyheder > Produkt nyheder

KONSTRUKTIONER
KOMPLETTERING
KLIMASKÆRM
INVENTAR
INSTALLATIONER
LANDSKAB

OPSLAGSSTOF
LINKS
NYHEDER
Bognyheder
Produkt nyheder
Generelle nyheder
Nyeste firmaer
BYGGEMESSER

< Hornsleth Bar: Specialbelysning til syndens hule

Cembrit opruster på rådgivning og projektsalg >

08.01.15 21:27 Kategori: Produkt Nyheder

SOLCELLELØSNING TIL RØDE TEGLTAGE

Det EUDP-støttede udviklings- og demonstrationsprojekt Building Adapted Solar Energy, der adresserer det store potentiale for integration af solenergi i bymiljøer, skal udvikle en solcelleløsning til røde tegltagsejendomme.

Projektet Building Adapted Solar Energy, BASE, har til formål at udvikle en priseffektiv højtydende solcelleløsning til integration i etageejendomme i bymiljø. Efter at have kortlagt arkitekturen i etageejendomme i bymiljø, stod det klart, at det var nødvendigt, at fokusere opgaven yderligere og valget er faldet på en af de mest udfordrende bygningstyper- ejendomme med røde tegltag.

De overvejende argumenter for røde tegltagsejendomme har været bygningernes store udbredelse på ældre Københavnerejendomme og at disse tage udgør en betydningsfuld del af Københavns historie og arkitektur. Men også netop fordi de er nogle af de mest vanskelige bygninger at opsætte solceller på, på grund af den store kontrast til solcellernes farve og struktur, og derfor udgør en spændende udfordring.

I dag vil man ofte løse opgaven med solceller på røde tegltage ved at opsætte et bånd af standard eller integrerede solceller i tagfladen. Dette er en hæderlig løsning, men ikke den mest optimale ud fra et arkitektonisk synspunkt. Projektgruppen arbejder derfor på at skabe en fuldtagsløsning, der vil være en nyfortolkning af de traditionelle tegltage og samtidig vil kunne fungere som en integreret løsning på dele af taget.

Efter at have kortlagt arkitekturen i etageejendomme i bymiljø, stod det klart, at det var nødvendigt, at fokusere opgaven yderligere og valget er faldet på en af de mest udfordrende bygningstyper- ejendomme med røde tegltag.

"Vi er fuldstændig klar over, at vi har påtaget os en vanskelig opgave, men det er samtidig en rigtig spændende udfordring, da røde tegltage er en meget udbredt bygningstype og en af de mest problematiske bygninger at opsætte solceller på.", udtaler Anders Sørensen, projektleder og udviklingschef hos Gaia Solar A/S.

"De første skitser af den nye løsning virker meget lovende og jeg tror, vi har fat i noget banebrydende her.", fortsætter han.

Projektgruppen har indledt flere dialoger med mulige demonstrationsejendomme, men hører stadig meget gerne fra interesserede boligforeninger, der kunne tænke sig at lægge tag til et testanlæg.

Projektet blev igangsat i april 2014 og koordineres af solcellevirksomheden Gaia Solar A/S. Herudover er følgende projektpartnere: Kirt Thomsen ApS, Københavns Ejendomme, Krydsrum Arkitekter, Cenergia, Enemærke & Petersen, Kuben Management A/S, Solar City Copenhagen. Projektet er støtte af EUDP.

Nærmere information:
Gaia Solar A/S
Anders Sørensen, Udviklingschef
tlf.: 60 66 00 89
web: www.base-projekt.dk

Til nyhedsarkiv

2nd Press release

In April 2015 the project was used as a case in another press release from EUDP about a new program supporting BIPV solutions from EUDP.

http://www.mestertidende.dk/article/view/201841/56_millioner_til_udvikling_af_bygningsintegrerede_solceller#

Presentation of PV-panel prototypes at seminar

At 28th of April the BASE-project was presented at a seminar hosted by Solar City Copenhagen at Rambøll. Besides a good presentation of the developed solution, the project team also had the opportunity to present prototypes of the developed PV-panels. The presentation gave us very good response from potential customers interested in demonstrating the developed solution.

Presentation of 1. mock-up - event

The 17th of June 2015 the project team presented the first mock-up of the developed solar-energy roof at the EOGP building factory. We had more than 50 participants from housing associations,

municipalities, architects and engineers interested in the solution. It was a successful event which subsequently caused great interest in demonstrating the solution. In connection with the event, various project and partner-specific brochures was prepared.

Building Green 2015 – presentation of prototype and seminar

One of the red prototype PV-modules was presented as part of Gaia Solar exhibition booth at Building Green October 28th and 29th along with datasheets. At the same time the project was presented at seminar at Building Green hosted by Solar City Copenhagen.


BUILDING GREEEN
TORSDAG 29. oktober
kl. 13-15
Seminarlokale 2 (1. sal)

Arrangør:
Solar City Denmark

PROGRAM/
seminar om solenergi

MEDLEMMER
SOLAR CITY DENMARK

13:00 / INTRODUKTION
Karin Kappel, Solar City Denmark

13:05 / DANSK EKSPORT AF ZERO CARBON BUILDING DESIGN TIL KINA
Kinesiske byer efterspørger dansk know-how indenfor udformning af energirigtige og CO_2-neutrale bygninger. Esbensen har sammen med kinesiske arkitekter tegnet en "Zero Carbon Energy School" i Haiyan. Bygningen indeholder danske energitekniske løsninger og produkter, og nu skal Esbensen designe et bycentrum på 62.000 m² i Haiyan, under overskriften "Danish Zero Carbon Street".
Torben Esbensen, Dansk Energi Management & Esbensen

13:20 / PV-ØSTLAND BORNHOLM: SOLCELLER PÅ SOLSKINSBØEN
Projektet fremmer opsætningen af solcelle-anlæg, både privat og kommunalt, og indsamler data om påvirkningerne af elnettet. Det skal understøtte arbejdet på Bornholm med at teste løsninger til fremtidens fleksible elnet, med el fra sol og vind. Med en fortsat udbygning af solcellekapaciteten i Danmark som resten af Europa, er der behov for at indsamle viden omdisse påvirkninger af stabilitetet. Projektet er støttet af ForskVE.
Mikkel Engset Hast, Energitjenesten Bornholm

13:35 / 'BASE'
Udvikling af prisbillige bygningsintegrerede solcelleløsninger til etagejendomme i byrnlje. Den første prototype - en solcelleløsning til rede tegltage - er lanceret, og der arbejdes også med udvikling af farvede solceller. Projektet er støttet af Energistyrelsens BIPV-særpulje.
Philip Göransson, Krydsrum Arkitekter, Anders Sørensen, Gaia Solar, Rune Kirk, Kirk-Thomsen

13:50 / SOLAR PARKING
P-pladser rummer oplagte muligheder for kombineret solenergi og overdækning. Danske solcelle-carports sætter nye standarder på markedet for P-pladser med solceller. Konceptet er nyt i forhold til design, lav vægt og frit spænd op til 15 m.
Ole Gregersen, Bluetop Solar Parking

14:05 / SOLCELLESYSTEM MED LAV EGENVÆGT. OPLADETÅRN MED SOLCELLER.
Solcelleprodukt som er tyndt, fleksibelt og monteret direkte på en membrantagflade, er nu på markedet i to nye versioner. Velegnet til projekter, hvor egenvægt og montagetid er afgørende.
Opladetårn til el-biler, beklædt med solceller og på toppen en vindmølle. Tårnet kan bruges til eksponering af grøn profil for virksomheder, forretningscentre, dagligvarebutikker, P-huse.
Kim Slavensky, Phenix Tag Artus

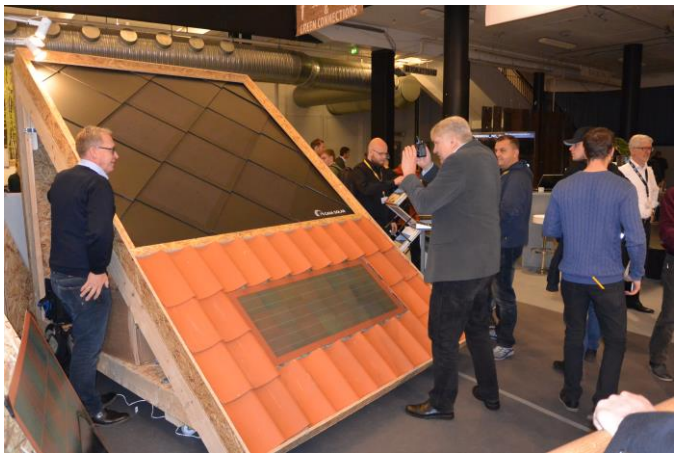
14:20 / SOLCELLEDREVET AIRCONDITION
At nedkøle luften med solenergi er et attraktivt bæredygtigt alternativ til traditionel airconditton. Hvor den traditionelle airconditton vil koste forbrugeren nel-tarif, er denne AirCooler gratis i drift. Den er inspireret af DanSolar's første produkt, AirHeateren. Udviklingsprojektet støttes af CleanTeknikfd og Danmarks Innovationsfond.
Joost Haugmark Jensen, DanSolar

14:35 / FACADELØSNING MED SOLCELLER
Fleksibelt facadesystem kombinerer el-produktion, termisk komfort og støjisolering. Om potentialet i facaden som energiproducerende. Resultaterne af de seneste undersøgelser vil blive præsenteret for at vise potentialet i facader som en kilde til energi. Præsentation foregår på engelsk.
Ruud Derks, Zigzagsolar, Holland

14:50 / 15:00 SOLCELLER OG BOLIGSELSKABER
Solar City Denmark sætter nu fokus på almene boligselskabers mulighed for solcelleanlæg som en integreret helhedsløsning. Man kan blive skrevet op til begge dele på seminaret.

- Gratis ekskursioner med bus til byggeter og solcellefabrik, med informationer undervejs om udfordringer og løsninger ved bygningsin-tegrering af solceller, økonomi og proces.
- Tilskud til ekstraprojekter for boligselska-ber som ønsker at kvalificeret grundlag at, træffe beslutning om evt. solcelleanlæg på. Ekstraprojektet afklarer hvordan arkitektur, in-vestering, ydelse og udbytte bliver bedst mulig.

De 2 initiativer indgår i projekterne 'BASE' og 'PV-Active Roofs and Facades', der støttes af EUDP og ForskVE.



Excursion for general housing associations 24th November


EKSKURSION/
for almene boligselskaber
Tirsdag 24. november 2015 kl. 9-12:30

PROGRAM

DELTAGERE PÅ EKSKURSION

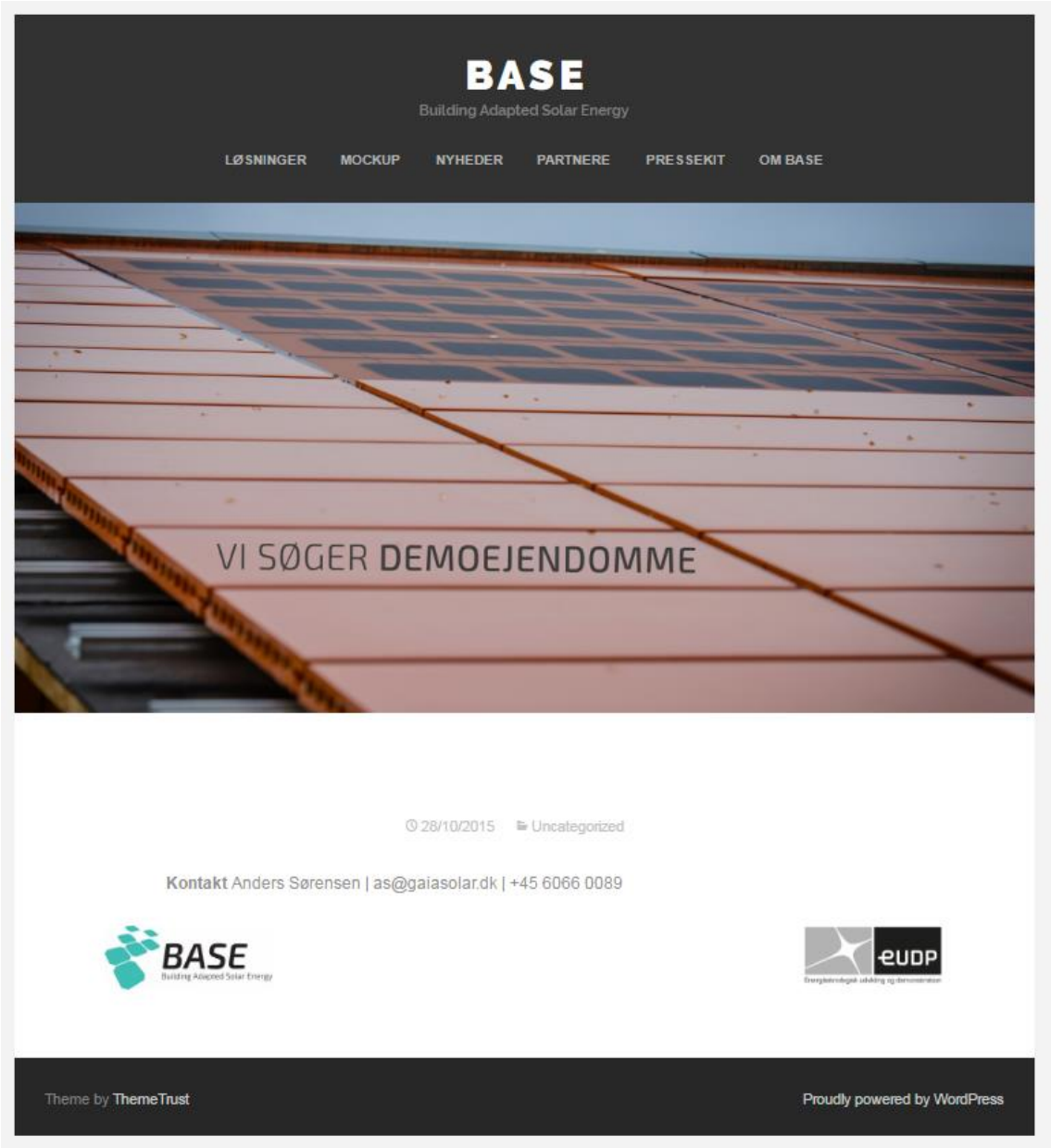
BASE

The project hosted an excursion for housing associations in November 2015. The program included presentation of the mock-up of the solar roof in Glostrup and visit and seminar at Gaia Solar with focus on the details of the solution and introduction to prototypes and the development process. The excursion had 20 participants from various housing associations.

Despite a lot of attention and interest in the innovative solar roof solution the project team still experienced difficulty in recruiting building owners able to demonstrate the developed solution. In December 2015 the project team launched a campaign to intensify the efforts to have a demonstrator. The campaign included update

and news on project website and dialogue with contacts from housing associations that the project had already been in contact with as wells as new potential demonstrators.

The campaign was a success and the project team were able to include the private property owner Rentermestervej 94 ApS as part of the project team in the beginning of Q2 2016.



Article in FBBB member magazine June 2016

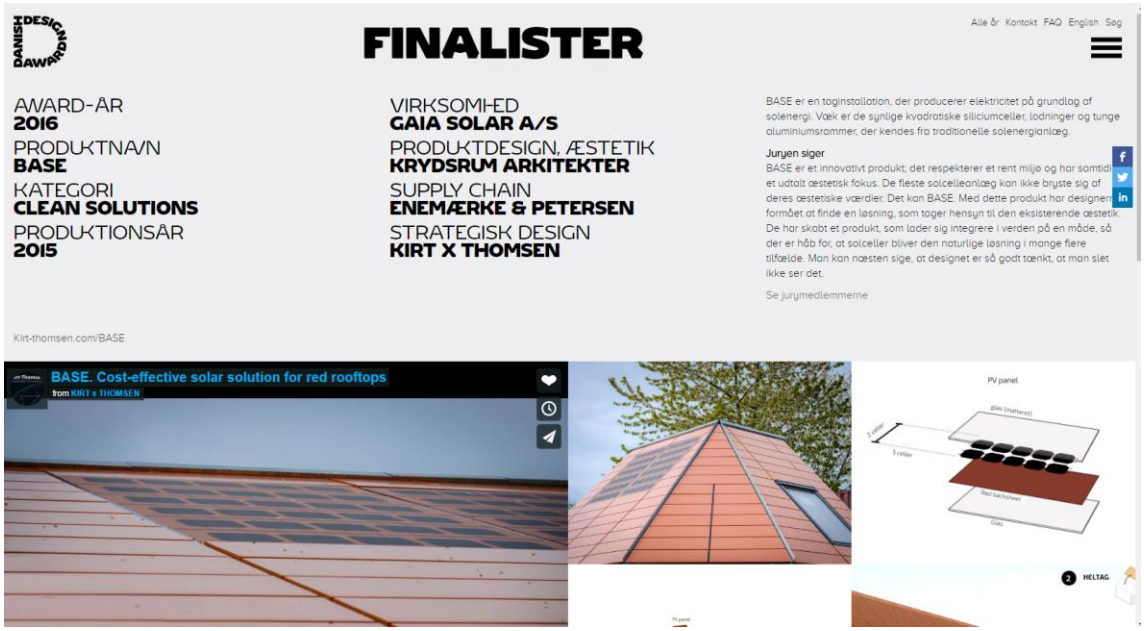
The project and the developed roof solution was also included in the member magazine by The Association of Sustainable Cities and Buildings / FBBB (Foreningen af Bæredygtige Byer og Bygninger) focusing on The Building Envelope of the Future.

Finally, the project will publish a brochure about the project, the developed solution and the development process. The brochure is expected to be finish in Q2 2017.

Danish Design Award 2016

In February 2016 we submitted the developed BASE BIPV solution for Danish Design Award 2016. The solution and project was shortlisted and later nominated for the Danish Design Award in two categories – Clean World and Peoples Choice. In relation to this a series of press-releases was sent out by the project team. Unfortunately the project didn't win the 1st prize but gained a lot of positive interest and publicity.

http://danishdesignaward.com/nominee/base/



1.3.2.2.2 Demonstration

The purpose of this work package has been to demonstrate the developed BIPV solutions and business models by installing a demo-BIPV system on a representative multi-story building. The installed PV system will be monitored in order to collect data that can be used to document the effects of the solution. Expected result is construction and commissioning of a BIPV solution – demonstrating all elements of the developed concept.

The project team has intensified the efforts on recruiting a demonstrator as the project has moved forward. A central element for this effort has been the design and visualization of the solution and supplementing prototypes of PV-panels and other components.

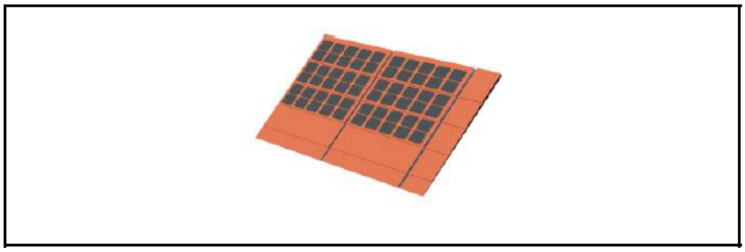
Initially the project team has focused efforts on contacting

already known potential customers and building owners in their network. This has been supplemented with various communication and dissemination activities (see prior chapter) aimed at inspiring potential building owners.

In order to accelerate and speed up the dialogue with building owners interested in the solution, the project team developed a configurator able to deliver the need calculations and economy of the new BIPV roof for red tiles. The result is that the project team has been in dialogue with more than 20 different building owners and housing associations about demonstrating the new roof-solution.

Despite an initial positive attitude towards the solution the customers chose a traditional PV-solution or none.

HELTAG: Lamel-pladeløsning



Tekniske specifikationer og m2 pris

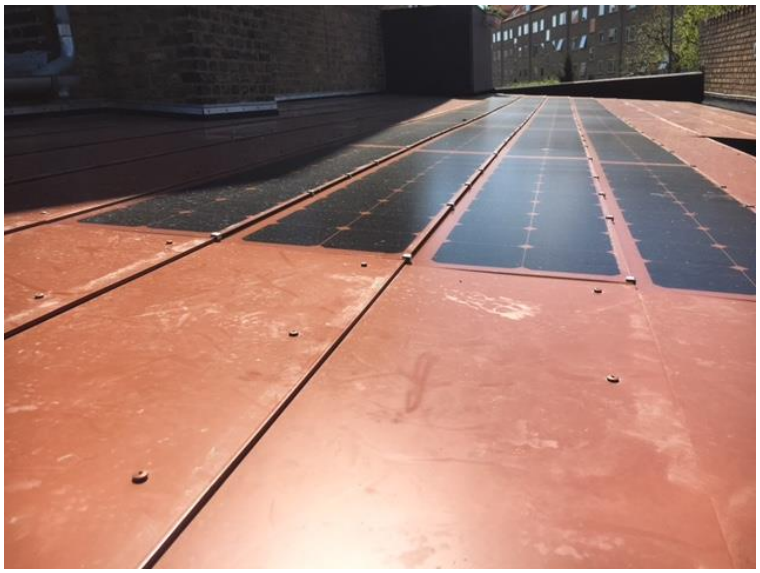
	enh.	Beskrivelse	Salgspris
PV-panel:			
Glasformat	mm	420x1156	
Størrelse (uden overlap)	m2	0,43	
Glas	type	Satineret/Mat/ Rød	
Ramme	type	Alu. Rød anodiseret Ral 8004.	
Backsheet	farve	Rød: RAL8004	
Celle	type	Monokrystallinsk	
Strenge	farve	Sorte	
Celler/m2	stk	27,6	
PV-panel/m2	stk	2,3	
Junctionbox/m2 PV-flade		2,7	
Invertere	stk	1	
El - Output peek/m2	kWh	??????	
Levetid	år	??????	
DKK/m2 eks.moms.			

The primary argument was that the solution was to expensive compared to a traditional tile roof or wrong timing (etc. their roof still had 5-10 years lifetime left).

In the beginning of 2016 the project team finally succeeded in finding a building owner that wanted to demonstrate the developed solution. The property owner was included in the project and the projection of the solution could begin.

These two pictures show the building before the project (small picture) and a rendering of the future look with the BASE solar roof (big picture).

The final result of the demonstration and building project was finished late august 2016. The following pictures show the final result.



1.4 Project objectives

1.4.1 Project objectives

The primary objective of the project was to develop a low-cost, high performance BIPV solution that can be tailored to unique site requirements, with focus on multi-story buildings in cities. A supplementing business model will be developed to ensure customer acquisition as well as creating services for stakeholders in the value chain enabling and strengthening the market.

1.4.2 Project risks

There has been a couple of risks that the project team has considered throughout the project. The first risk has been to develop a product that would be attractive enough to the market in terms of aesthetics, and secondly that the product would be possible to produce and sell at a competitive price. The project team therefore have had a continuous focus on having the developed solution approved by architects and municipalities in order to proceed with the development, and secondly worked intensively with lowering production and product costs. The second risk has been to successfully demonstrate the developed BIPV solution. No doubt that this been more difficult than expected to recruit a building owner. Most likely due to bad timing and because the market is relatively conservative when it comes to choosing an alternative roof material than tiles. But we managed. It is therefore our opinion that we have met the risks identified and have therefore successfully navigated through the project.

1.4.3 Implementation of the project

The project more or less developed as predicted. All development projects will have an element of uncertainty integrated in themselves. Therefore, there have also been unforeseen twists in the project. This has been expected, and it has therefore been possible to relate to these in a pragmatic way.

1.4.4 Did we experience any obstacles or changes?

The only obstacle worth mentioning is, that we during the design phase had planned to use a red type of glass for the prototype of the PV-modules in the solution, but choose not to. Product samples of the glass looked promising but larger glass samples for prototype modules differentiated too much in their color to create a consistent look. The project team consequently choose to create a more honest and simple design with standard glass, red backsheet and black solar cells.

1.5 Project results and dissemination of results

The project result is a new integrated solar roof solution that can replace a conventional red tile roof fully or partly depending on the customer need. The pv-panels and supplementary roof panels from Steni® have the same size and are installed and mounted using the same principles – thereby minimizing costs for mounting system and time.

We have managed to make an economic feasible BIPV solution that allows customers and owners of buildings with red tile roof to install solar on areas fully or partly limited to solar due to esthetics and building preservation rules.

A spin-off product from the project is the development of a red standard PV-module that can be used to replace a conventional black/blue standard PV-panel that are used when a customer have a relatively new red tiles roof that it doesn't make sense to replace, but only partly substitute the tiles with PV-panels.

The project as a whole must therefore be said to be successful in relation to the objective. It has been completed in accordance with the plan and provides a market-ready BIPV concept, brought to market in the end of 2016.

At the end of the project, none of the partners haven't yet registered increased revenue or employee staff. It should also be noted that the results of the project are made available to the public so that the overall impact is broader than just the participating companies. The main activities of the project are described above and have given the following results:

1.5.1 Assessment and Analysis

The results of the Assessment and Analysis phase have been successfully used and implemented in the technology development phase. Furthermore, the knowledge acquired has helped the project participants to develop new knowledge beyond the one used in the project. The Assessment and Analysis phase has been completed successfully. Milestones:

- KM1 Essential market drivers identified and specified

1.5.2 Development of Technology

The technology development phase has focused on the development of the BIPV concept itself. This involves an exploitation of known technology, where the challenge has been to develop a aesthetic pleasing solution that are also technically and economically feasible to implement. This has been successful. Milestones:

- M1 Physical design specifications and requirements completed
- M2 Physical design prototypes and mock-ups completed

1.5.3 Communication and Dissemination

The result of the communication and dissemination of the project have created a lot of awareness about the project. The efforts have contributed to signing up a demonstrator for the developed BIPV solution as part of the project as well as continuous inquiries and interest in the project and solution after the project has ended. In other words, successful. Milestones include:

- KM2 Marketing material ready

1.5.4 Demonstration

The developed solution has been successfully demonstrated on a building at Rentemestervej 94 in Copenhagen, and thereby successfully completed the demonstration phase. Milestones:

- M3 Prototype demonstrated on building

1.6 Utilization of project results

The partners in the project expect to commercialize project results in different ways.

1.6.1 Gaia Solar

Gaia Solar expects increased product and project sales related to their new BIPV solution. The knowledge and results from the project will also be used to develop a black version of the BIPV-solution focusing on black tile roofs – using the same mounting system, PV-module design specifications but with a black backsheet instead of red.

The knowledge gained in the project can be used in communication and dialogue with architects and engineers who consider integrating solar cells in their construction projects, and help to strengthen their project sales of integrated solar solutions.

1.6.2 Kirt Thomsen ApS

As a consultancy working with private companies and their product developments, the projects is an opportunity for a new business area to be a first-mover consultancy within the design professions.

1.6.3 Københavns Ejendomme / Københavns Kommune

Københavns Ejendomme has gained new and updated knowledge and insight in latest development in BIPV that the can utilize in their future demand for solar solutions on their buildings. The insights can be used to heighten their understanding of and demand for solar solutions with improved aesthetics.

1.6.4 Krydsrum Arkitekter

Krydsrum Arkitekter and the joint consortium Energi+ have, through the past 4-5 years, managed to establish a solid name as one of the frontrunners of innovative refurbishments of old multi-story buildings. Through material-, technical- and process- innovations the energy consumptions of these buildings can come very close to those of new build.

Utilization of the project results will further establish their position and the expected models for integration of PVs in this building type and will expectedly serve as a key element and add positively to the incentives for building owners total Return On Investment in the particular case.

Krydsrum expects that these models as part of an overall Asset Management Strategy could positively change more building owners' willingness to begin an ambitious refurbishment of their property to confront future demands of Facility Management and the demand of their renter as well as optimizing their profit in operation and sale.

The commercial value to the company, will be, that more of this kind of projects will be started with a following increase of turnover from their services. Furthermore their branding value on the marked with the various technical - and process related innovations will increase with the in-depth knowledge of this field added to their previous practical experiences.

All together they expect that their turnover will double every 3rd year in this area and over the next 6-9 years and their workforce will grow from 6 till 20 people.

1.6.5 Cenergia

Cenergia works to make a configuration system for BIPV with a focus on "red roofs" in Copenhagen. Besides development and tests of optimized BIPV systems of this type, incl. focus on using the BPS technical standard for solar thermal, also for BIPV. Cenergia expects to have more consultancy assignments helping housing associations with tenders for red solar energy roofs.

1.6.6 Enemærke og Petersen

This project and the results is in the center of their business and they expect to take part in the "first movers club" in this field implementing the developed solution in a large scale as part of their refurbishment tenders.

1.6.7 Kuben Management

The primary motivation for participation in the project and utilization of the project results is to find the challenge the demands of building owners and to be able to use and suggest the developed solution as a more aesthetic and economically feasible BIPV solution.

1.6.8 Solar City Copenhagen

Solar City Copenhagen is a non-profit organization with the aim of promoting solar energy in order to achieve high quality architecture and energy-optimized buildings. At present many buildings are facing an energy renovation where solar energy has to be established. Solar City Copenhagen will continue to communicate the results of the project and use the demonstrator on Rentemestervej 94 as case to inspire potential future customers and promote more aesthetically pleasing solutions.

1.6.9 Rentemestervej 94 ApS

Rentemestervej 94 is the demonstrator of the developed solution. The expect one of their tenants – a café to experience increased turnover due to the innovative solar roof, and strengthening of their CSR-profile. Rentemestervej 94 also expects to promote themselves as a green and innovative property owner and use this project as a stepping stone to create more solar roofs.

1.7 Project conclusion and perspective

1.7.1 Conclusion

The aim of the project has been to develop a BIPV solution for multi-story buildings in urban environment, and thereby address and solve some of the critical issues that many PV and BIPV solutions have had and have proved to be critical to the market penetration of integrated solar roofs.

The first critical issue that the project have solved is: design at the expense of efficiency. The developed design consists of a PV-module that measures 1640 x 395 mm and includes 20 cells, approximately 1/3 of a standard PV-module with 60 cells – and a 10 or 20 times as efficient as 1 or 2 cell solar tiles or shingles, and at the same time the PV-module resembles the height of a standard row of tiles copying the horizontal lines in a classic red tile roof.

The second critical issue that the project have solved is: the lack of adaption to building materials and techniques. The developed design introduces a PV-module with red backsheet, which haven't been seen or implemented on the Danish market prior to this project. The development process also introduced a series of other types of materials and components that have been delimited from this project, but might be relevant for other types of solar solutions. With respect to applying mounting systems and principles from other countries, the project team have chosen and succeeded in developing a mounting bracket that allows for a smooth, easy and flexible mounting of the solar modules and supplementing roof plates from Steni®, thereby avoiding the use of a mounting system that limits the use and deployment of the developed BIPV solution.

The third critical issue that the project have solved is: the lack of BIPV investment overview, tools and practical experience. The developed configurator introduces the possibility to benchmark various roof types – with or without solar against each other, thereby enabling the property developer, building owner, architect, engineer and installer to gain an overview of investment economy and potential. The configurator the communication of the technical solution it provides thereby accommodate the need for more knowhow and experience in BIPV as an option when refurbishing a building.

One aspect of the developed solution differs from the expected outcome described in the application for EUDP. We had expected to achieve a faster mounting and optimal integration by using an "intelligent" PV-module frame that also acted as flashing. Initial studies in WP2 indicated that that this would be too costly, and at the same time we chose to focus on a complete roof solution instead of part of the roof using Steni® roof plates.

Appendix

Bilag 01	Project handbook
Bilag 02	Market research report
Bilag 03	Example study
Bilag 04	Physical design roadmap and Technology report
Bilag 05	BASE mock-up invitation
Bilag 06	BASE teaser
Bilag 07	Configurator
Bilag 08	Pictures
Bilag 09	Product material and data sheet
Bilag 10	Result of press release dec 2014