Photo © Gerry Kapow

Solar Facades

Facade cladding for new construction and refurbishment

Anders Smith tells in the film:

'At SolarLab, we develop and produce innovative facade solutions which can be delivered to buildings worldwide. They replace traditional and environmentally damaging materials and enable the invisible integration of sustainable facades into both restorations and new buildings.

The facades are produced in Denmark with renewable energy and designed to be part of a circular economy. During its lifetime, the solar facade is the only building material that will pay back its cost many times over, both financially and environmentally.

The energy-producing solar facades form a maintenance-free rain screen that combines high efficiency and durability with a unique freedom of design in terms of both colour and architectural expression.'

EUDP

solar city denmark

KUBEN MANAGEMENT

SolarLab

This publication presents results from the project **EnClose - facadebeklædning til nybyg og renovering** supported by the Danish Energy Technology Development and Demonstration Program (EUDP).

The solar facades are developed and implemented by SolarLab and in the related film architect Anders Smith talks about the projects.

Publication og film can be found at www.solarlab.dk and www.solarcity.dk.

They are created in collaboration between:

SolarLab / **www.solarlab.dk**
Anders Smith, Architect maa, Industrial designer mdd

Solar City Denmark / **www.solarcity.dk**
Karin Kappel, Architect maa

Kuben Management /
Jakob Klint, Chief Advisor

EnClose

- facade cladding for new construction and refurbishment

The solar facade at Copenhagen International School was the first large-scale construction project to implement a full solar facade, with structural colour, mounting geometry with individually angled panels and a resilient electrical systems that ensure resistance to shadows and future defects while still utilising the entire buildings's many facades in the energy production.

The EnClose project set out to explore whether the newly developed technologies, solutions and processes would be generally applicable to both new construction and restoration projects.

The purpose of the project was to generate and test installation solutions for building-integrated photovoltaics (BIPV) for facades. However, it soon became clear that architectural diversity could not be satisfied with one standard solution. It was necessary to develop custom-made solutions that could fulfil both the clients' vision and the architects' design intentions and at the same time ensure that the energy production could be seamlessly integrated into the geometry of the individual building.

Various solutions were developed and implemented for refurbishment and new construction projects, to provide the best solution and best approach within the architectural limitations of each individual building.

One of the challenges was to establish a collaborative environment with architects allowing them to stay true to their design intent and without compromising their vision.

Solar facade solutions

All solar facades are light, ventilated claddings consisting of 4 mm tempered glass and seaworthy aluminium. Structural colours are achieved by using nano-coatings that are vapor-deposited on the rear of this glass. This allows up to 90-95% of light to pass through to the solar cell and just a small fraction to be reflected as colour. The nanocoating are often anisotropic in nature and allows different colours to appear depending on the viewing angle and light incidence. The result is a dynamic and constantly changing facade, depending on the light.

The project developed a flat-mounted lightweight system that mounted directly on the weatherproof insulation, a facade solution where the architects assist in developing a unique solution for their building, and a mounting solution for low construction height.

The publication is divided into refurbishment and new construction. All examples are building-integrated photovoltaics (BIPV) mounted either planar, tilted or curved, which is specified for each project.

refurbishment

Aarhus Kommune
Det Grønne Hus

Aarhus Municipality's office building is a demo host for the development project EnClose.

The refurbished facade demonstrates the results, which involve the development and demonstration of a competitive facade cladding system with built-in solar panels that may be used for both new construction and as new cladding on top of re-insulated facades.
The new solution replaces a facade made of recycled glass from 2013, which turned out not to be durable. The developer subsequently wished to replace it with an active solar panel facade.

It was important that the new solar facade not only contribute free and sustainable electricity to the building's operation and compensate for its environmental investment, but also that it has a long, maintenance-free service life.
In collaboration with the building architects, a unique facade solution was developed with visible fittings, designed to retain the architectural heritage in the new facade material.
The building-integrated solution includes both active and passive panels that are identical and thus create a uniform facade expression.

Refurbishment
2020 - build 2013

Adres
Grøndalsvej 1B, Viby J, Denmark

Architect
SHL Architects

Client
Aarhus Kommune

Area active/passive
950 m^2 / 1400 m^2

Effektiveness
160 kWp / m^2

Estimated production
93.000 kWh / yearly

Inverter capacity facade
136 kWp

Photo
SolarLab
Martin Gravgaard

RH Bornholms Hospital

Refurbishment
2018

Adres
Ullasvej 8, Rønne, Denmark

Architect
Bjerg Arkitektur

Client
Region Hovedstaden

Area active/passive
1.322 m^2 / 93 m^2

Effektiveness
160 kWp / m^2

Photo
Nikolaj Beyer
SolarLab

During the energy upgrade of the hospital, the building was re-insulated and given new coloured solar facades on three facades, along with black panels on mechanical penthouses and square and individually angled panels on the gable.
The extensive solar facade areas in the parapets are designed as claddings that, due to its low construction height and flat installation, makes it possible to maintain a uniform facade profile
As part of the EnClose project, a flat-mounted lightweight system was developed that sits directly on the insulation. Thus, the facade cladding is mounted on the insulation, and due to its low weight, there is no need for additional load-bearing fittings.
One challenge of restoring the facade of an existing building is that there is a built-in complexity of the building´s eccentricities acquired during its use.
As it happens, the hospital building had several distortions that had arisen over the years, and as the glass is very precise, 28 different panel formats had to be developed. The project documents that it is possible to integrate solar panels into buildings, even when they have slight distortions.

Trifolium

Refurbishment
2019 - build 1965

Adres
Bådehavnsgade 44, Copenhagen, Denmark

Architect
Alex Poulsen Arkitekter

Client
Sjatox Ejendom

Area active/passive
155 m^2 / 75 m^2

Effektiveness
160 kWp / m^2

The former dairy in Sydhavnen was converted into shared offices, and in connection with this, it received an energy upgrade and was refurbished with solar cladding in the facade parapets to replace the old, coloured panels.
The new coloured panels consist of structurally coloured glass with photovoltaics on the back, which are tailored to the various dimensions and original colour of the old facade. The developer wanted the panels of the new energy-producing facade to retain the old colour.
The facade consists of 32 sections. The two lower panels are active panels, while the upper row, just below the parapet, consists of panels without photovoltaics.
A new mounting system was developed to mount the facade cladding directly onto the weather barrier. Due to the very restricted construction height and low weight of the cladding, facade restoration did not require any additional load-bearing measures.

Refurbishment mock-up
2021 - build 1958

Adres
Glostrup, Denmark

Client
Region Hovedstaden

Mockup
46,2 m^2

Glostrup Hospital

The prototype installation on the hospital facade strives to provide the 60-year-old building with a contemporary solar facade refresh and an environmental payback that doesn't sacrifice the award-winning building, originally imagined as an iceberg, of its singularity.
The intention was to achieve this by using a solar facade cladding that adhere to the existing modularity of the building and through the cladding material, which uses nanocoating to achieve a light grey shade that varies according to light incidence and viewing angle.
Only a single panel size is used. Furthermore, this is optimised for the maximum number of active solar cells.

Refurbishment gable
2021 - build 1980

Adres
Trige Parkvej, Trige, Denmark

Client
Boligforeningen Ringgaarden

Area
109 m^2

Effektiveness
190 kWp / m^2

Trigeparken

The housing development, Trigeparken, has undergone an extensive restoration, which provided the dilapidated dept. 20 with a new and modern expression – as well as an energy boost.
The gable solar facade consists of large costom panels in full floor-to-floor height and invisible mountings. The facade appears elegant due to the hidden mounting solutions and full-height panels with a brilliant finish in which high-efficiency photovoltaics are invisibly integrated.
Only a single panel size is used. Furthermore, this is optimised for the maximum number of active solar cells.

AAB Kolding

The public housing facility AAB, dept. 71, is undergoing an extensive restoration where custom solar cladding is integrated in both facades and roofs.
The EnClose project is carrying out a development project with experiments and testing custom coating and mounting systems that can be implemented on both roofs and facades within the constraints of the existing buildings design.
The electricity production is expected to significantly exceed consumption, and in the long term, the photovoltaic system may be combined with battery storage.
The project is expected to be completed in 2022 and is also supported by Landsbyggefonden Innovationsmidler.

new construction

Student Experience International

The 3,000 m^2 solar facade consists of large wide panels that are individually angled and of varying height. All panel surfaces are identical, but due to the structural colour provided in the PVD coating, the visual expression is varies.
Effective standardisation of the cladding with relatively few panel formats and a flexible mounting system ensures a durable and service-friendly facade cladding.
Electrically, the facade is designed to ensure a high resistance to shadows from the surroundings and possible damage through monitoring at panel level.
The building contains 596 rooms, a restaurant, and a parking garage. Calculations show an estimated annual energy production of 172,747 kWh.

New construction
2020

Adres
Amsterdam, Netherlands

Architect
VUPB architects

Area active/passive
1770 m^2 / 1148 m^2

Effektiveness
160 kWp / m^2

Photo
Egbert de Boer

Breidablikk gården

New construction
2021

Adres
Haugesund, Norway

Architect
Asplan Viak

Client
Breidablikkgården Eindom

Area active/passive
315 m^2 / 86 m^2

Effektiveness
160 kWp / m^2

Photo
Christoffer Steinsvåg

The solar facade of this office building appears golden with characteristic reliefs of light and shadow that, regardless of the weather and light, make a significant contribution to the cityscape. The sculptural complexity of the facade solution is the result of a close collaboration with the architect.

The aim is to utilise solar energy on the east- and west-facing facades by angling the panels toward the south, while also using this angling as partial sun and wind protection near the windows. The facade zigzags 30 cm in and out at each window, and it has a diagonal cut at the top and bottom.

The light, ventilated facade cladding is specially designed to produce energy and withstand rain and snow. Hidden fittings and invisible electrical components are integrated into the energy-producing facade cladding.

Ruseløkka School

New construction
2020

Adres
Oslo, Norway

Architect
GASA
Arkitektkontoret

Client
Undervisningsbygg Oslo KF

Area active/passive
296 m^2 / 28 m^2

Effektiveness facade
160 kWp / m^2

Photo
SolarLab

This integrated facade solution consists of identical panels shingle mounted on rails in the parapets and narrow panels in the window bands.
The satin surface and shingled angling of the bronze-coloured solar panels compliment the brick facades texture and visual depth.
Ruseløkka School is a FutureBuilt pilot project with requirements for almost zero energy consumption. To achieve the energy goal, 320 m^2 of building-integrated solar panels are installed on the facade as well as 370 m^2 solar panels on a green roof. The estimated total production is 75,000 kWh annually.

ZEB Flexible Lab

New construction
2020

Adres
Trondheim, Norway

Architect
LINK arkitektur

Client
NTNU og SINTEF

Area
360 m^2

Effektiveness
55,3 kWp / m^2

Photo
M.Herzog / Visualis

The combined laboratory and educational building comprise a black crystal with facades of building integrated solar panels that enable the production of more energy than the building consumes.
The polished surface of the facades and deep black colour with invisible photovoltaics support the architectural vision of a crystalline and optimised building volume.
The panels of the ventilated solar facade are tailor-made to follow the sculptural form of the building and use a mounting system developed within the EnClose project. There are also integrated photovoltaics in the transparent facade panels, which enable a partial influx of daylight into the interior of the building and let the residents know about the electricity-producing exterior cladding.
The construction must live up to the ZEB certification, which means that the CO_2 emissions in the total life cycle of the building are compensated for by its energy production. Over a 60-year period, the production from solar panels will thus compensate for the emissions from construction, materials, and operation of the building.

Power House Telemark

New construction
2020

Adres
Porsgrunn, Norway

Architect
Snøhetta

Client
R8

Area facade integrated
372 m^2

Effektiveness
65 kWp på facade

Photo
Per-Kåre Sandbakk NRK

The sculptural volume of the building is mathematically optimised to ensure maximum utilisation of solar energy on the roof and facade. The smooth anti-reflective treatment on the solar facade optimises production by omitting the use of colours.
The high-efficiency photovoltaics, electrical connections and mounting systems are all invisible to make the facade appear uniform and crystalline. The facade uses a system developed within the EnClose project.
The building sets a new standard for the construction of sustainable buildings by reducing its annual net energy consumption by 70%, compared to similar newly constructed office buildings, and by producing more energy than it will consume throughout its lifetime.
Together, the south-east facade and the roof will generate 256,000 kWh per year, approximately 20 times the annual energy consumption of an average household, and excess energy will be sold back to the electricity grid.


AKMAN

Red River College Innovation Center

New construction
2020

Adres
Winnipeg, Canada

Architect
Diamond Schmitt Architects
Number TEN Architectural Group

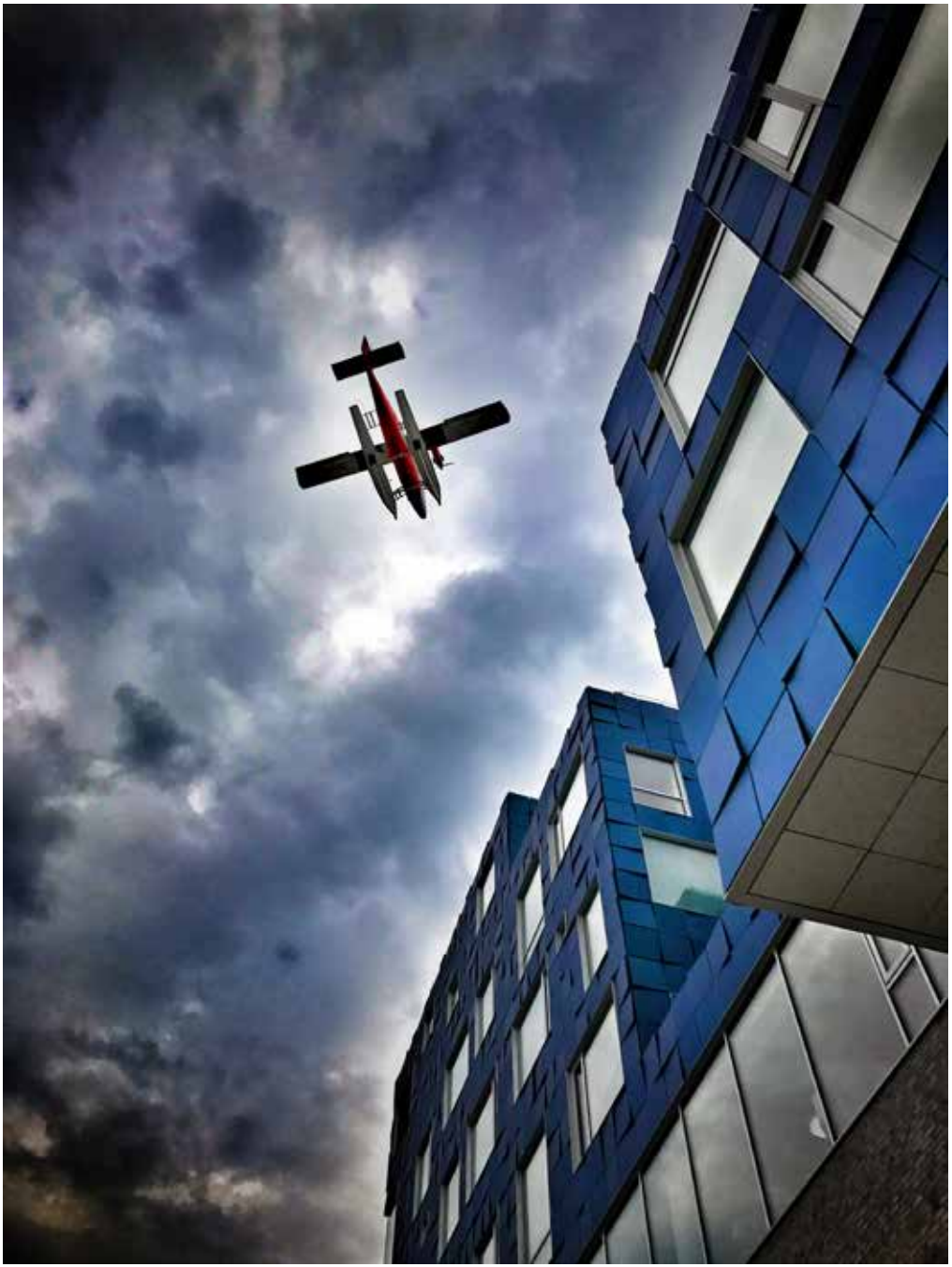
Client
Red River College

Area active facade
750 m^2

Effektiveness
160 kWp / m^2

Photo
Gerry Kapow

The facade solution is composed of large-scale solar panels that wrap around the round corner of the building with a vertical angling of the panels that accentuates the curve.
The tailor-made panels are up to 1400 x 2400 mm and combined in sections that are up to 4000 mm tall. Concealed, angled suspension systems allow for tool-free mounting, fire protection and optimal ventilation.
The tempered glass of the facade panels is satin and nanocoated to achieve the desired materiality. It changes colour depending on the viewing angle and weather conditions. The storey-high building-integrated sections are designed and produced in close collaboration with the architects of the building.
The Innovation Center is targeting zero energy consumption and will have little to no net CO2 emissions.



Copenhagen International School

New construction
2016

Adres
Nordhavn, Copenhagen, Denmark

Architect
CF Møller Architects

Client
Ejendomsfonden CIS

Area active/passive
6.000 m^2 / 36 m^2

Effektiveness
160 kWp / m^2

Photo
Lars Duncker

The solar facade of Copenhagen International School was the first large building to work with cu stom panel sizes, nanocoated colouring and mounting geometry. This resulted in individually shaped and angled panels and a resilient electrical system that are resistant to shadows and future defects.
The 6,000 m^2 facade is clad with 12,000 identical and individually angled panels, which are designed, produced, and installed by SolarLab. This is based on the SolarLab Sequins system, which allows for individual angling of multiple panels.
The blue-green colour of the satin and nanocoated panels matches with the location of the building by the harbour and constantly changes based on daylight, season, and the onlookers' point of view.

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