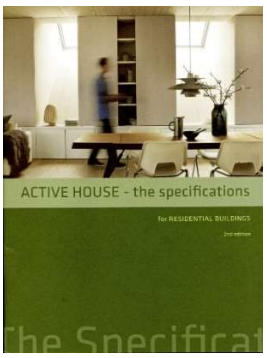
Final Report

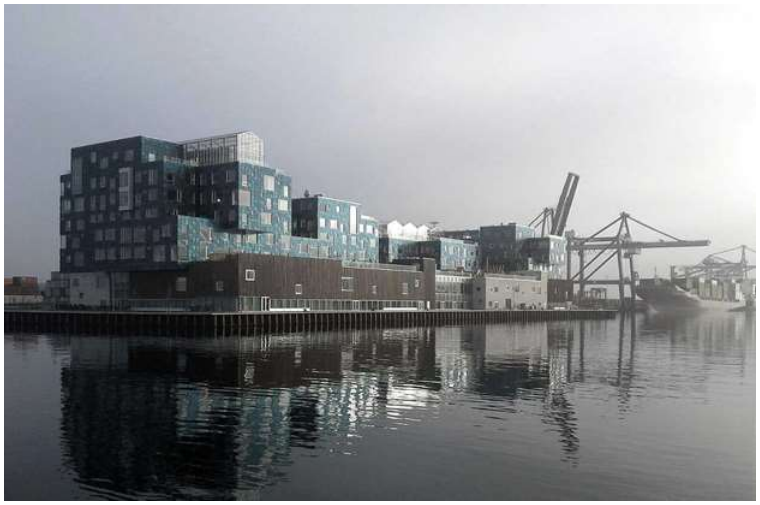
Nordic Built Active Roofs and Facades in Sustainable Renovation

EUDP sag nr: 64013-0578









Peder Vejsig Pedersen and Vickie Aagesen
Cenergia part of Kuben Management
November 2018

KUBEN MANAGEMENT

EUDP
Energiteknologisk udvikling og demonstration

NORDIC BUILT

1.1. Project details

Project title	Nordic Built Active Roofs and Facades in Sustainable Renovation
Project identification (program abbr-and file)	EUDP-2013, j.nr.64013-0578
Name of the programme wich has funded the project	EUDP and Nordic Innovation
Project managing company/ institution (name and address)	Cenergia (DK) Ellebjergvej 52,2450 Kbh SV Peder Vejsig Pedersen
Project partner	
CVR	71195414
Date for submission	1. Decemnber 2018

Project partners

Cenergia (DK) project leader, represented by Peder Vejsig Pedersen
Gaia Solar (DK)
SBi (DK)
Solarplan (DK)
Copenhagen City Properties (KEjd) DK)
KAB (DK)
WSP Group (SE)
VTT (FI)
Zizzo Strategy (ZED Consulting) (FI and Canada)
University of Iceland (IS)
AVENTA (NO)
Hoyer Finseth (NO)
Ecovent (DK)
Gate21 (DK)
Kuben Management (DK)
Foreningen bæredygtige byer og bygninger, FBBB (DK)
Demos (FI)

1.2. Nordic Built Active Roofs and Facades in Sustainable Renovation

Short description of project objectives and results

The project has been realised in a cooperation between all 5 Nordic countries from 2014 to 2018 with Cenergia as project leader.

Information and results can be seen in the website, www.activehouseroofsandfacades.com, where you can also find a copy of this report.

Nordic Built is an initiative to join forces in the Nordic countries and capitalise on common strengths to deliver the sustainable solutions, the Nordic Region and the world demands. And the Nordic Built Charter has been designed to lead the way.

The Nordic Region has benefits of a unique common culture, which makes a cooperation much easier than what is the case for European countries as a whole.

The Nordic Built Charter is based on 10 common principles that supplement each other in a good way and at the same time reflect the common cultural background in the Nordic countries.

There is no doubt, that "The Active Roofs and Facades in Sustainable Renovation" project have had most focus on the principles 4 and 5, aiming to:

- Achieve zero emission over its lifetime
- Is functional, smart and aesthetically appealing, building on the best of the Nordic Design traditions.

Besides support of important demonstration projects like the Nordic Built Challenge winner project Ellebo Garden Room and use of decentralised ventilation in connection to school renovation with the city of Copenhagen, a lot of work has been made in relation to building integrated solar energy mainly focussing on BIPV. Here was supported the transformation towards building materials, which are low cost as well as electricity producing (e.g. can be mentioned the cooperation between Gaia Solar from Denmark (today replaced by Solartag) and Norwegian producer Steni, leading to a product that was nominated for the Danish Design Awards 2017).

Also can be mentioned the realisation of a BIPV Demosite at the Technological Institute in Tåstrup near Copenhagen, with hands-on examples as well as the Living in Light Box, which is a small CO_2 neutral Active House with BIPV.

Since 2016 activities were made to support further Nordic implementation by help of the developed database www.bæredygtigebygninger.dk, now also in a version in English, and by creating a campaign for use of BIPV and the development of Smart Energy CO_2 neutral Active House City Areas.

Active House is both an international alliance covering Europe, America and China as well as a sustainable building standard focusing on Energy, Comfort and Sustainability and is in this way giving a practical way to implement most of the Nordic Built Charter principles in practice. In 2016, a new Active House labelling scheme was launched. As a very important quality, there is here also a focus on performance documentation, so you will have to prove in practice, that the aimed qualities are met. (www.activehouse.info).

The partner group in Denmark also reached an important result in relation to BIPV design for Copenhagen International School (CIS), which was supported by an Active House labelling, which in November 2018 lead to the Active House 2018 Award, and initial work on Active House city area projects in, for example Køge in Denmark, where very low temperature operation for the district heating becomes possible partly based on an innovate heating and cooling element from Lindab in Sweden.

Peder Vejsig Pedersen

1.3.Project objectives

1.3.1. The challenge

In the Nordic market there is a lack of solutions for sustainable renovation that are possible to integrate in existing buildings with respect to both architecture, comfort and energy efficiency.

Here there is a special need to showcase the benefits of integrated prefabricated solutions including a view to an integrated use of solar energy, and that such solution has benefits for both building users, owners, renovation companies and advisors.

1.3.2. The solution

The Nordic Built "Active Roofs and Facades in Sustainable Renovation" project, supported by Nordic Innovation, has allowed a strong development of leading Nordic competences in the area of building renovation. This has been achieved by creating transnational Public Private Partnership models to support the development towards nearly zero energy building solutions and associated performance documentation – which is required in the EU building directive.

The proposed cooperation with the building industry on developing models and the demonstration of "Active House" based sustainable renovation has helped to create a strong Nordic alliance, also involving companies from the international Active House Alliance.

The project has focused on the development of integrated solutions for renovation. This has included prefabricated solutions such as facades or roof elements that will be brought to the building and can be tailored to the specific needs of the building. The concept here both involves the Active House Specifications and follow the ten parameters in the Nordic Built Charter together with Active Roofs and Facades solutions in general.

A number of both apartment buildings projects and school projects in the Nordic countries represented in the project has been renovated and used as showcases using the concept. A high-level assessment with Performance Documentation has been included the showcases.

In connection to the Nordic Built Active Roofs and Facades in Sustainable Renovation project, the EUDP project Smart Grid School Renovation have been driven in parallel and supported the Danish building projects. For more detailed information about the work and the obtained results in the EUDP project Smart Grid School Renovation, it is possible to go to a special section of the website, www.activehouseroofsandfacades.com

1.4.Project results and dissemination of results

In the following is given a short overview of project results, which all can be studied more in detailed in the project website: www.activehouseroofsandfacades.com, where there is both shown results from the partner meetings as well from the realized work packages.

As a special results can be mentioned the development of the Active House testhouse with both solar heating and BIPV, which was coordinated with the " Living in Light" Nordic Built project and named " The Living in Light box".

This was exhibited at the final conference at the Architectural School in Copenhagen in May 2017 and later moved to a permanent address in Valvy in Copenhagen. Here Aventa from Norway as the leading solar thermal company provided the solar façade and solar heating system with electrical backup and besides 5,5 kWp BIPV modules and a battery was provided from the Danish Company Racell, see enclosed page from the website, where you can also find a real brochure in English.

1.4.1. Partner meetings

There has been held kick off meeting in Copenhagen in June 2014, partner meeting in Oslo in April 2015, partner meeting in Malmø in May 20116, partner meeting in Helsinki in October 2016 and final project conference in May 2017 in Copenhagen, where also a project video was presented. (see enclosed pages from the website)

1.4.2 Project Reports

In the following is shown examples of reporting from the project, which all can be found in the project website, www.activehouseroofsandfacades.com. And besides also information of partner meetings from the website.

Overview about Nordic residential building stock for renovation

This report is presenting the buildings stock in the Nordic countries for the construction years 1960-1990 and for the building type "residential". It is considered that those construction years represent most of the building types, which are now in need of renovation, and also for the integration of active roof and façade solutions.
The data on amounts of buildings, total built square meters have been collected from national statistics in every country. Information about load bearing materials, façade and roof types are presented when those can be found in statistics.
As a result it can be said, that the residential building stock correlates quite good with the amount of population. Finland, Norway and Denmark have approximately the same amount of residential building square meters, as the amount of population is in the same magnitude. In Sweden and Iceland, were the population is much higher or much lower than in other Nordic countries, also residential building square meters are correspondingly higher or lower.
The Nordic residential building stock, constructed in 1960 – 1989, comprises 626 million floor-m2, in which a higher part represent detached and attached building types. Brick and wooden walls are used mainly in attached and detached buildings and concrete façade in multi-story buildings.
In total built floor area, the main façade type in the Nordic residential buildings is a brick façade (41 %) even though the amount of brick walls in Norway is almost non-existing. The second main type is a wooden facade (32%).

Knowing the size of the stock, with the location and structure, with the use of building material types in facades and roofs, can assist researchers in the creation of new solutions for renovation and gives an idea for detailing. Availability of this information helps also overcome the problems which otherwise might have risen concerning installation and use.

Industrial building stock for renovation in Nordic countries

In this report, the building stock of industrial buildings in the Nordic countries is presented for the years 1960-1990. The data on amounts of buildings have been collected from national statistics in each country. Also information on building structures is presented. Information of structures is based on the knowledge by the researchers and also the interviews of professionals in construction areas.
As a result it can be said, that Finland, Sweden and Denmark have approximately the same amount of industrial buildings compared to the amount of population. In Norway, the amount of industrial buildings is lower.
In Finland, Sweden and Norway the building materials and structures remains the same. In Finland the most common building materials are concrete and steel, in Sweden the steel is lightly more common than in Finland and in Norway the concrete is the dominating material. In Denmark, the brick is the main construction material.

Report on Active roofs and facades
(English version, see below)

Dokumentet ”Active Roofs and Facades” er en eksempelsamling over bygningsindpassede solceller eller BIPV som det også kaldes. er gennemgås en lang række dansk produkter på området. I teksten gives der en kort introduktion til et nyt BIPV Demosite, som opbygges på Teknologisk Institut i Tåstrup frem til sommeren 2018. Endelig er der angivet generel information om solcellemarkedet og visioner for det fremtidlige marked for Aktive Tage og Facader i forhold til den internationale AktiveHus Standard.

(English)

The Active Roofs and Facades report includes a collection of examples of best practice BIPV technologies in the Danish market. There is at the same time a short introduction to the new BIPV Demosite at the Technological Institute in Denmark, which was established and presented in June 2018. Besides there is included general information on the PV market and visions for the future market for Active Roofs and Facades also with a possible link to the international”Active House” Standard.

Green building certification system in the Nordics (Interview report)

The report includes interviews with relevant stakeholders in the Nordic building industry to determine the current state of the market, including:

- Understanding the stakeholders' challenges, goals, and driving values with respect to green building certifications.
- Interviewees should also be asked about specific green building strategies that they think work best in their country, and which ones are not well suited. This helps to inform on the compliance strategy for each country.
- Summarize the key goals, values, barriers, and overall impressions about certifications, from the perspective of the builders and property owners interviewed. Including discussions of renovation projects.

Besides two reports from work package 2 "Evaluation Methods for Sustainable Renovation"

1- Overview, Guidelines & Recommendations for Primary Certification systems(still draft version)
2- Guidelines & Recommendations for secondary certification systems

(see also Appendix)

Living in Light Box

Udgivet den 31. maj 2017 af Admin,V Aagesen

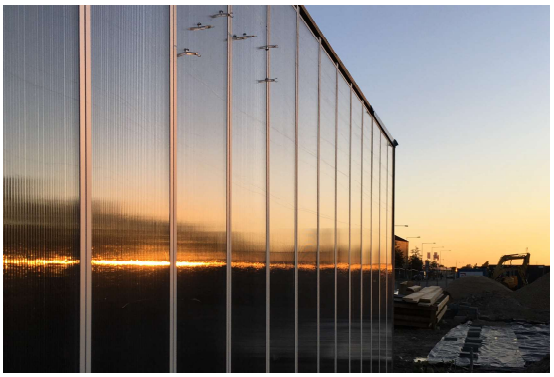
The purpose of the Living in Light Box

The Living in Light Box, a CO_2 neutral Active House test-housing unit demonstrating innovative Active Roofs and Facades technologies.

For more information about the vision, thoughts and technology, please have a look at the project brochure.

The Living in Light Box is arriving at KADK.

The Living in Light Box was moved in 2017 to Kulbanevej 14 in Valby, Copenhagen where the Living in Light Box is going to house "Områdefornyelsen Kulbanevejkvarteret" which is a department in the municipality that is responsible for revitalization of the area. The Danish state railways earlier used the area that is close to a neighborhood. Now there is going to be a green park with football courts for the kids in the neighborhood.



The video includes a small presentation in Danish of the different technologies that is going to be tested in the Living in Light Box. In the video, there is a special focus on explaining the concept "Summer garden".

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Kick off partner meeting in Copenhagen

Udgivet den 5. april 2016 af Admin,V Aagesen

Nordic Built Active Roofs and Facades, Kick-Off meeting in Ballerup and Copenhagen, 19. – 20. June 2014.

Illustrations from the two days.

The kick-off meeting was on the 19. June held at the community house of the Ellebo Housing Estate in cooperation with KAB housing association and local tenants in Ellebo, who were a great help in the arrangements.

During the meeting at Ellebo there was, besides different presentations, good time for discussions between the partners, and at the same time a small best practice technologies exhibition gave inspiration for the work. There was also time for visiting 2 existing apartments, the Nordic Built Challenge competition winning architect Adam Khan also gave his view on the coming renovation project and besides a presentation on the Active House Specification was made.

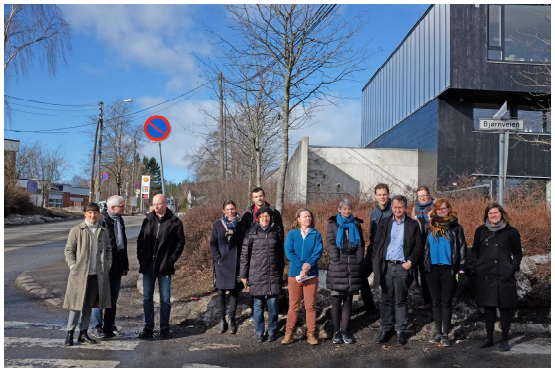
Partner meeting in Oslo

Udgivet den 5. april 2016 af Admin,V Aagesen

The second partner meeting was held in Oslo from the 9th to the 10th of March 2015. On the second day there where a study trip where the project partners from Norway presented some of their earlier project. We went out to see the following projects:

Bjørnveien 119 - Multi-family house

Awarded multi-family house with solar heating (facade integrated)



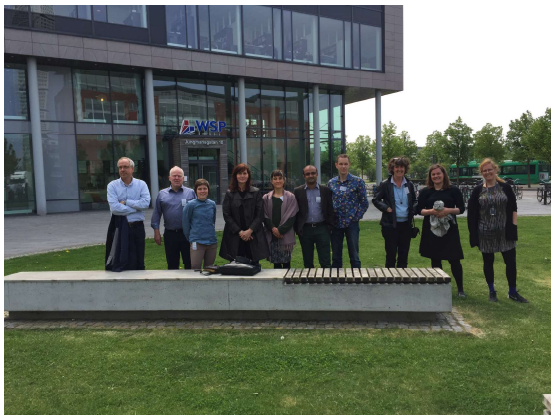
Stenbråtlia Row houses

34 low energy/passive houses with solar heating (OBOS project)

Partner meeting in Malmö

Udgivet den 31. maj 2016 af Admin,V Aagesen

The third partner meeting was held in Malmö from the 19-20th of May 2016. We started with a site visit at Vårsången, which is the Swedish building project.



Renovation of around 400 apartments in Vårsången included change of windows, use of exhaust ventilation air by staircase heat pumps as a supplement of heating of the apartments, use of LED lighting and electricity saving lifts and use of PV modules on the roofs.

Besides each apartment got an internal renovation each time a tenant was moving out.

1.5 Utilization of project results

The Ellebo project- status by 2018

For the Nordic Built challenge winner project, Ellebo in Ballerup, Denmark the actual realization has not been easy. The reason for that is that basic problems with the building construction was identified after the renovation works were started. The result was increased renovation costs and drastic changes in the renovation plans to be able to stick with the agreed budgets.

By the end of 2018 the plan is only to make a full renovation of one of the housing blocks and a partly renovation of another.

The other two housing blocks will be demolished and exchanged with new built.

Cenergia's work on roof integrated PV together with new individual electricity meters will be maintained based on the tenants clear vote to have this.

Work on BIPV follow up and Active House labelling at Copenhagen International School and Active House Award.

An agreement of cooperation was made with the Copenhagen International School (CIS), which both secured Active House labelling as well of realization of an online Active House Radar by the Danish company Leapcraft. See enclosed brochure and "performance visualizer" on this.

Based on this the CIS project was given the Active House Award 2018 at the International Active House symposium in Lecco, Italy in November 2018.

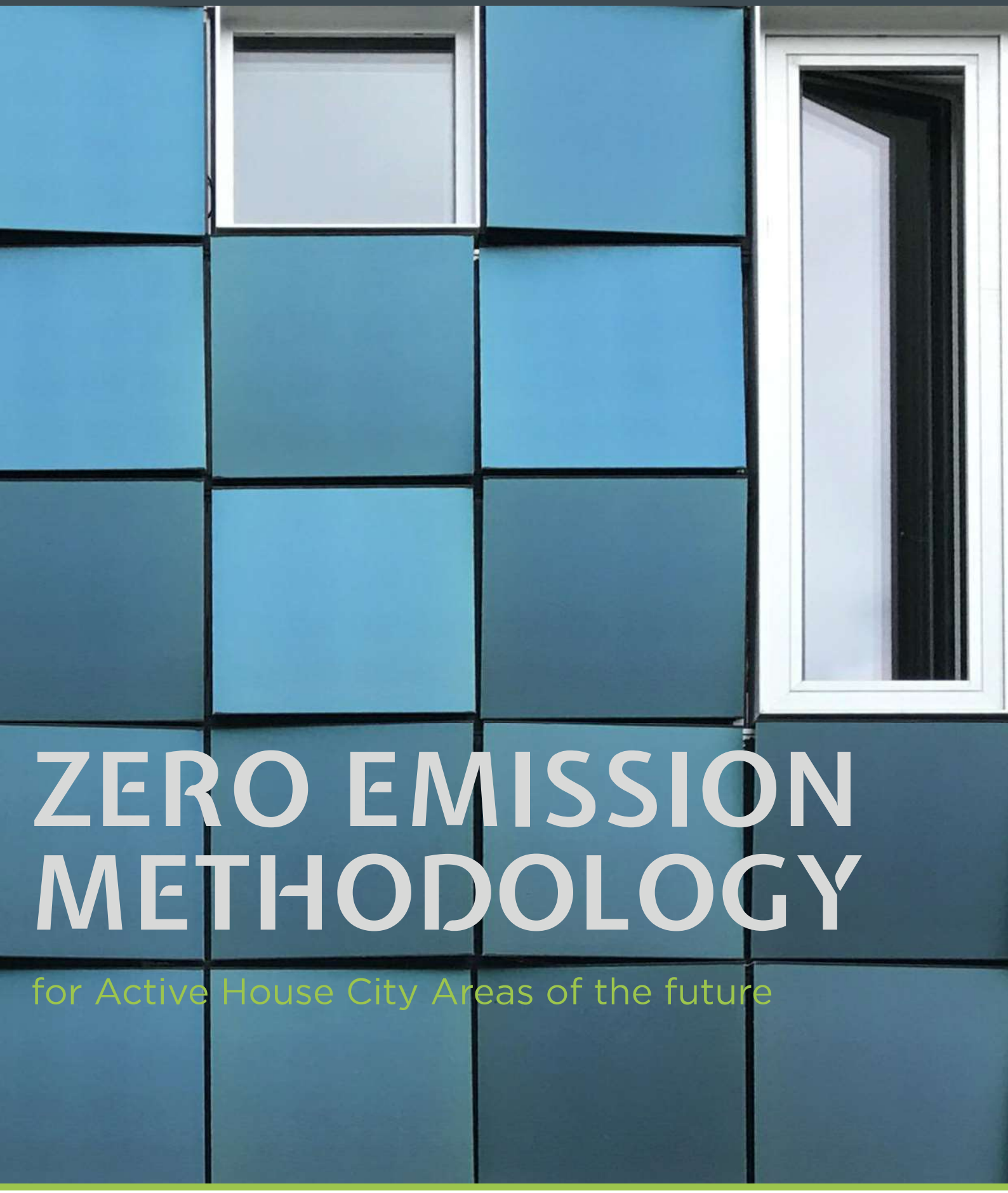
Besides Ramstad Architects from Oslo gave an input to BIPV facades for a new city development in Køge Nord inspired by this, and this has lead to the proposal of a visionary Smart Energy Solution for Køge Nord south of Copenhagen (see enclosed material)

www.europeangreencities.com

FROM VISION TO REALITY

Copenhagen International School (CIS) in Nordhavn, Copenhagen has the largest building integrated PV installation in Europe. It was delivered by Solar Lab and covers all facades and supplies 50% of its yearly electricity use with solar energy, and was a request from a dedicated builder (ECIS) to C.F Møller Architects.

Cenergia, which is now part of Kuben Management, has made Active House labelling, and an online Active House radar. Based on this, an application for the Active House 2018 Award secured CIS as the overall winner and labelling catagory winner (see www.activehouse.info)



ZERO EMISSION METHODOLOGY

for Active House City Areas of the future

norden Nordic Innovation
NORDIC BUILT
eUDP
CENERGIA
part of KUBEN MANAGEMENT
European Green Cities

ZERO EMISSION METHODOLOGY FOR ACTIVE HOUSE CITY AREAS OF THE FUTURE

13th Conference on **Advanced Building Skins**
1-2 October 2018, Bern, Switzerland

IMPLEMENTATION OF 100% ZERO ENERGY BUILDING STANDARDS

How is it possible to obtain a common standard for energy efficient buildings, which both aims high for new buildings, and can also be used on existing buildings.

The best source for this discussion is the EU-Building Directive and the connected "Nearly Zero Energy Building" standard.

For new building projects, in many cases, it is possible to establish a 100% zero energy building standard. Even though it is demanding with respect to optimising the architecture, it is possible with the help of new types of energy producing facades and roofing materials.

For renovation projects, similar solutions will in many cases also be possible, especially if you are dealing with significant renovation involving the updating of roofs and facades.

THE INTERNATIONAL ACTIVE HOUSE STANDARD

If the above-mentioned policies are to be implemented in the best way, then it is an obvious choice to combine these with use of the international "Active House" standard. This has a combined focus on energy, comfort and sustainability, based on 3 criteria for each of these areas, and with possible use both for new buildings as well as renovation projects.

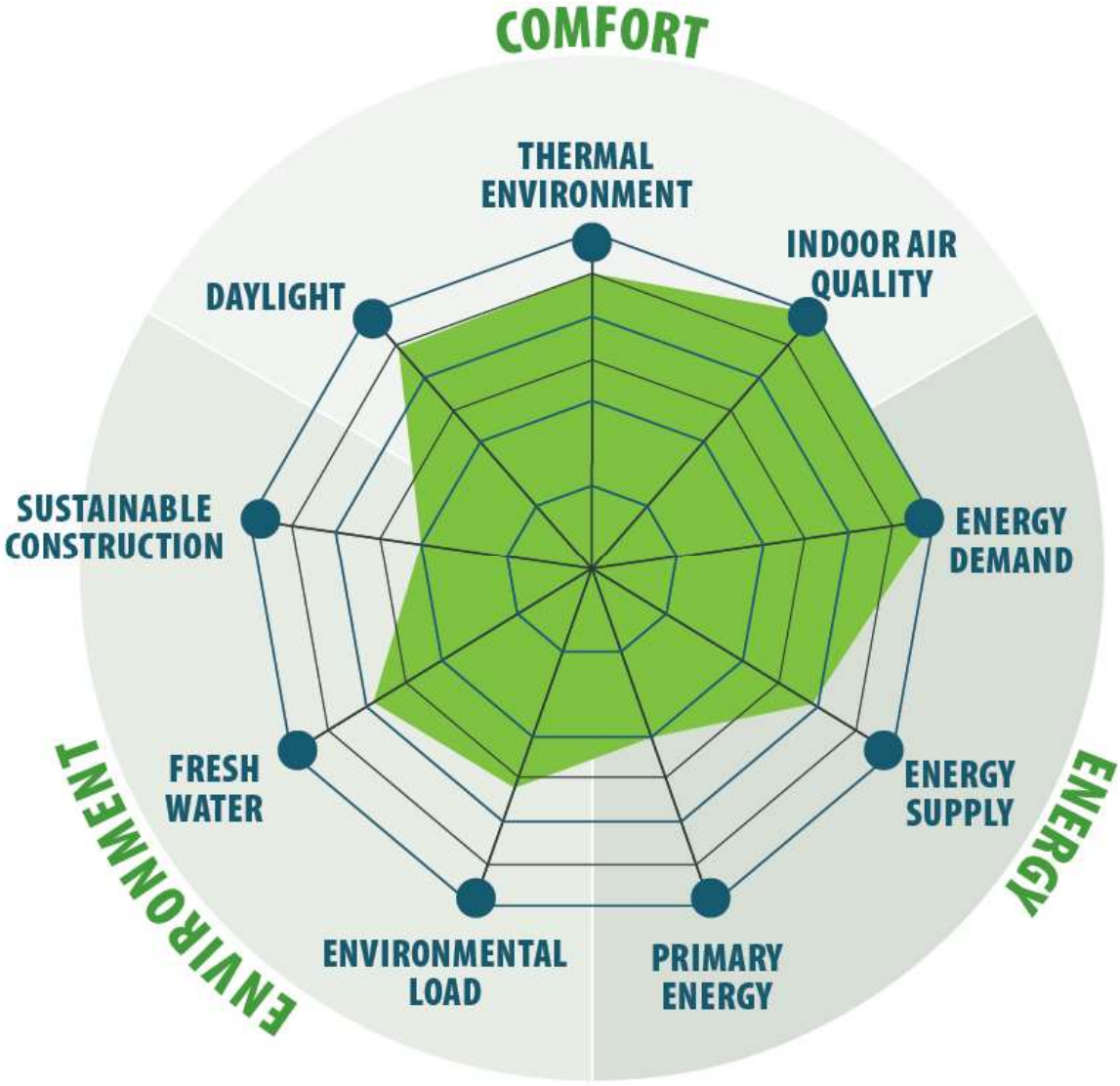
Before a building can get the official Active House label, the Active House standard demands that all parameters are evaluated and verified. See also www.activehouse.info and www.aktivhusdanmark.dk, where the benefits of working with a global oriented standard is illustrated, with a strong focus on indoor air climate – something which is not handled effectively in the EU building directive.

It could be suggested to adapt the Active House Standard to include a focus on user satisfaction and performance in practice, as well as different levels of zero emission standards using renewable energy.

And what could really have a large impact is the development of a methodology concerning how to organise such a standard, not only for one building but for whole city quarters as part of a Smart City and Smart Grid development.

In connection to the Nordic Built Active Roofs and Facades project (www.activehouseroofsandfacades.com) example projects with BiPV and Active House labelling has been documented. These are also possible to find in the European Green Cities database in English (www.bæredygtigebygninger.dk)

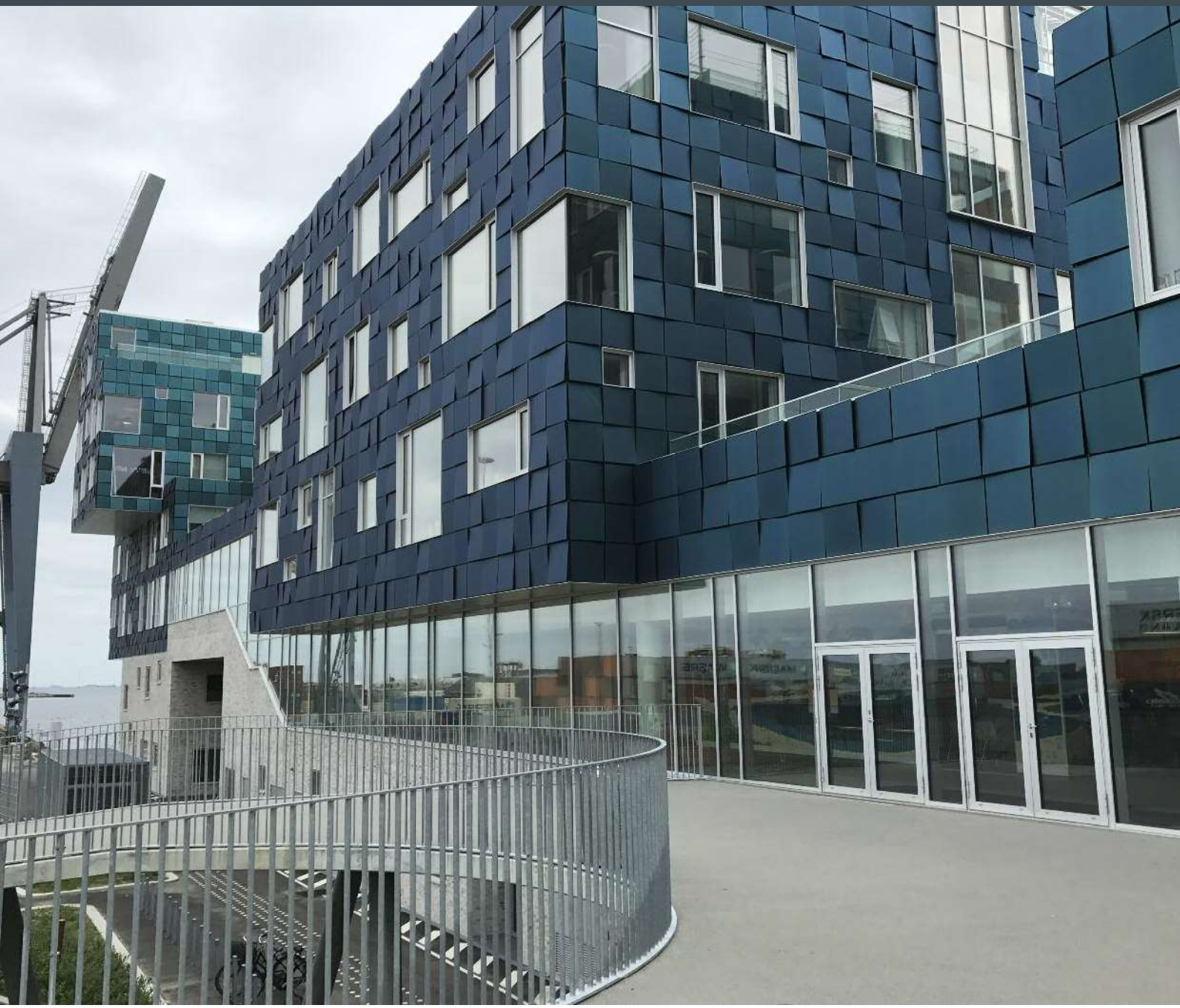
ACTIVE HOUSE RADAR FOR COPENHAGEN INTERNATIONAL SCHOOL



USING DIFFERENT LEVELS OF ZERO ENERGY BUILDINGS AS A DRIVER FOR PRACTICAL IMPLEMENTATION OF BUILDING INTEGRATED PV SOLUTIONS (BIPV)

Here it is suggested to use f.ex. prosumer level 1,2,3, and 4, to show how much your building measures up to the zero energy building standard alongside the general energy quality of the building.

RESULTS	
Comfort	
1.1 Daylight:	5,1%
1.2 Thermal environment:	Better level
1.3 Indoor air quality:	≤ 500 ppm
Energy	
2.1 Energy:	30,1 kWh/m²
2.2 Energy supply:	21.7 kWh/m²
2.3 Primary energy:	14,9 kWh/m²
Environment	
3.1 Environmental loads:	Good level
3.2 Freshwater:	28% savings
3.3 Sustainable construction:	Good level



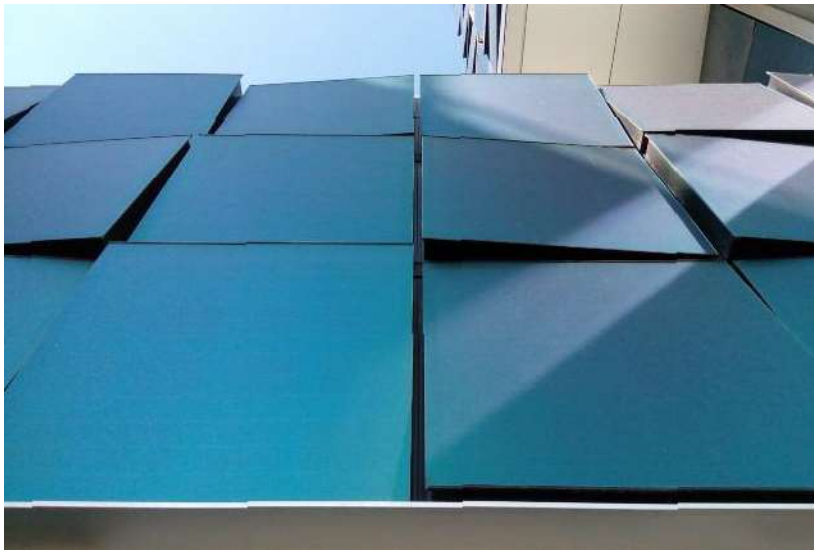
COPENHAGEN INTERNATIONAL SCHOOL, CIS

Copenhagen International School, CIS in Nordhavn, Copenhagen has the largest building integrated PV installation in Europe, covering all façades above ground level helping it to generate 50% of its yearly electricity from solar energy. Cenergia which is now part of

Kuben Management has made Active House labelling and combined this with the implementation of an online Active House Radar. See this at: http://labs.leapcraft.dk/cis/.

CIS is a good example of the Prosumer building of the future. It has BIPV on all facades and is also an aesthetically pleasing piece of architecture due to the specially designed PV panels. With around 39% of the total electricity use (inclusive el-apparatus) produced by the PV modules, CIS is a good example of an almost zero energy building.

The randomised tilt of the PV panels on the facades of CIS. The PV modules were produced by SolarLab as 60 W green chromatic coated hardened glass panels 700mm x 716mm, with 16 monocrystalline PV cells (6") and bypass diode. Each group of 8 panels is coupled to a micro inverter which is easily accessible through the ceiling of the rooms. Architectural design was by C.F.Møller Architects.



THE ACTIVE HOUSE ALLIANCE

IN DETAILS

The **Alliance** was established in 2011, following a roundtable in 2009 which set a first vision for the Alliance and several processes which put the spotlight on the acceleration of climate change and the need to use resources more carefully.

Today the Alliance is a global partnership of more than 40 knowledge institutions, designers, engineers, industries and developers. The members have tested the Active House principles and specifications in full-scale demonstration projects, more than 75 in 20 countries from 2009 to 2018, and established an Active House label in 2016 for the broad market on housing and smaller buildings.
There are 6 national alliances, multiplying the membership into a global community of partners who aim to scale sustainable cities.

82 ACTIVE HOUSES
IN **20** COUNTRIES
38 MONITORED
17 WITH LABEL

AUSTRIA
BELARUS
BELGIUM
BULGARIA
CANADA
CHINA
DENMARK
GERMANY
HUNGARY
ITALY
LITHUANIA
MALAYSIA
NORWAY
POLAND
PORTUGAL
RUSSIA
THE NETHERLANDS
UKRAINE
UNITED KINGDOM
USA

ACTIVE HOUSE MEMBERS:

KNOWLEDGE CENTER:

PARTNER ORGANISATIONS:

NATIONAL ALLIANCES:

secretariat@activehouse.info www.activehouse.info

ATES GROUNDWATER COOLING AND HEATING

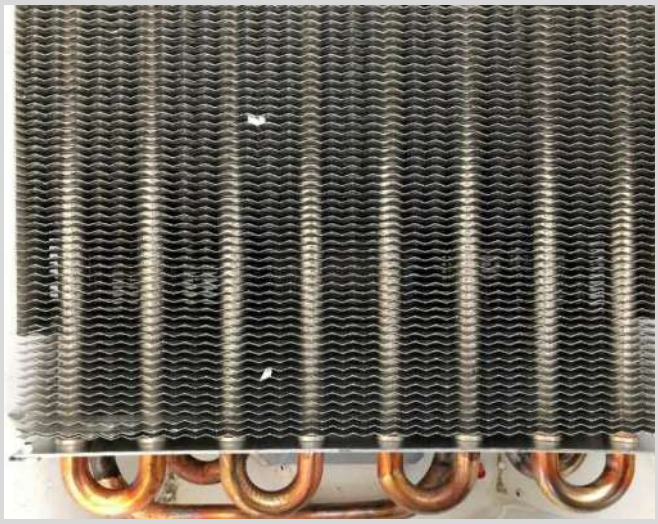
The Bisperberg Hospital in Copenhagen uses Aquifer Thermal Energy Storage or ATES groundwater based cooling as a cheaper alternative than district cooling from HOFOR, the Copenhagen Energy Company.

The yearly energy saving is 75% and more than 90% of heat stored during the summer can be recovered. 2 stage heat pumps from Sabroe are used. In winter, district heating is base load and heat pumps deliver the peaks. (Only from November to March).

In Denmark it has been proven that ATES systems can be used in close proximity to drinking water pumping stations, but it is a requirement that the ground water temperatures are never heated by more than 0.5°C in the vicinity.

Two important positives – there has never been any net consumption of water, and there is no noise from the system, compared to normal compressor cooling systems, which have a clear noise problem from the condenser in the roofs during the summer.

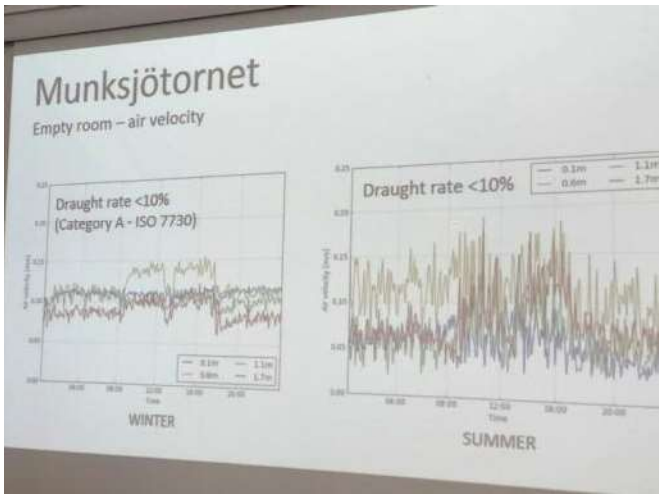
From the ATES system developer Enopsol's point of view, the new and innovative SOLUS heating/cooling system, from Lindab with 19°-24°C operation temperatures, is really interesting. This means a large part of the heat pump operation, with its quite high electricity use, can be avoided, if the ground water temperatures can be raised somewhat in summer periods, and still with a thermal balance over 1 year.

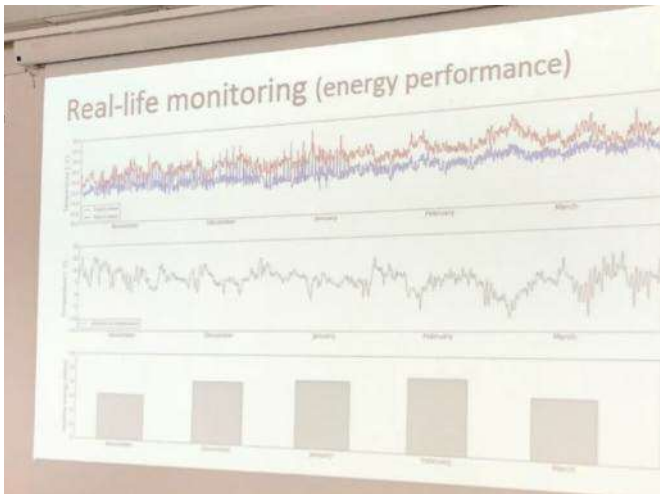


The very efficient Solus heat exchanger from Lindab

Munksjøtårn in Jønkjøbing, Sweden was used for a full scale demonstration

Solus beams in Munksjøtårn

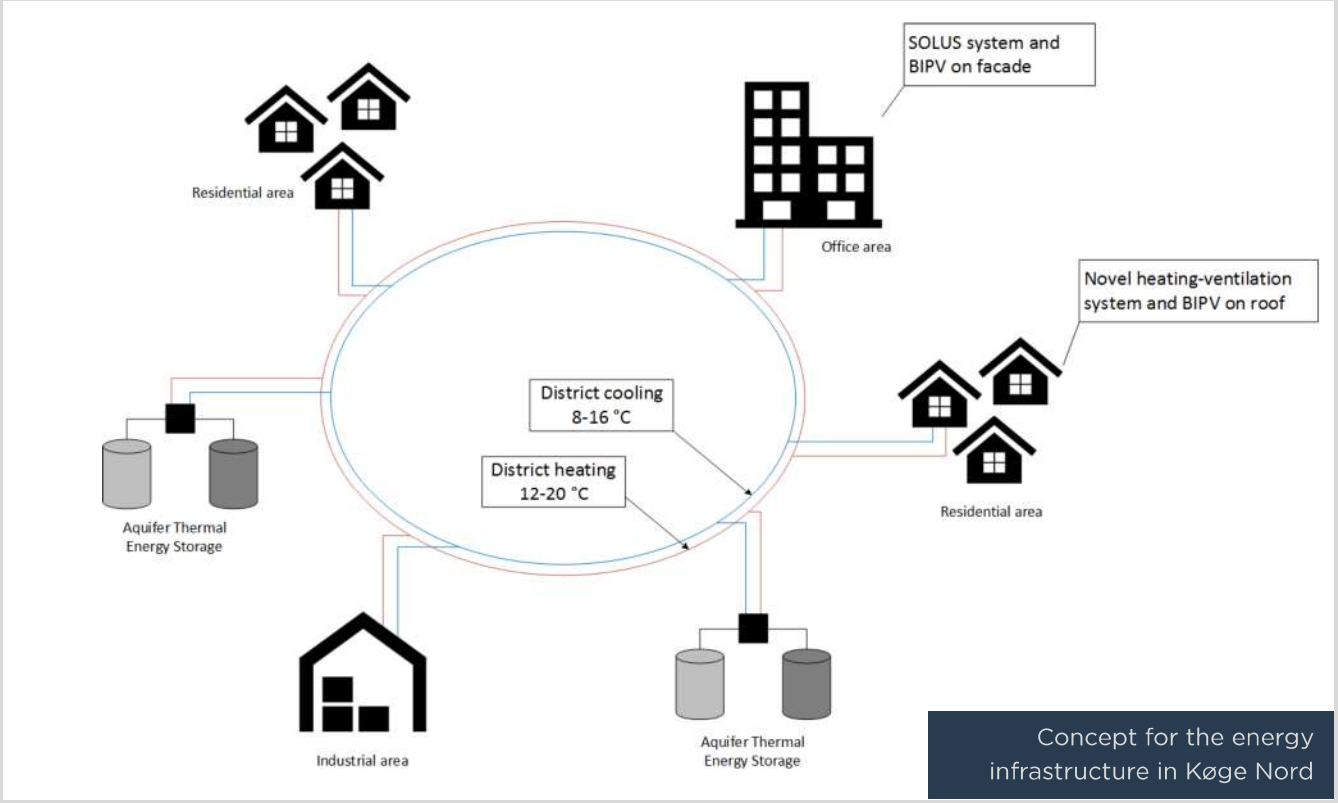




Solus measurements by SBi/Aalborg University confirms good operation in practice

Masterplan of Køge Nord in Denmark, south of Copenhagen. Here a new railway station along the motorway is the base of new city development

For a new city development area, Køge Nord, south of Copenhagen it has been agreed to implement an advanced low temperature bidirectional district heating solution, which can be ideally combined with the above mentioned technologies, and new types of BIPV facades for a large commercial building development area.



Concept for the energy infrastructure in Køge Nord

REALISATION OF BIPV DEMOSITE AT THE TECHNOLOGICAL INSTITUTE IN TÅSTRUP

BiPV companies in Denmark have exhibited their building integrated PV solutions at a common demonstration area at the Technical Institute in Tåstrup near Copenhagen. This includes: Komproment, Solarpartner, Solar Elements, Solar Lab, Ennogie, Danish Solar Energy, Racell, Solar Opti and Solar Tag.

New BIPV technology from Danish Solar Energy, with light grey panels in the middle and with Rock panel façade, was demonstrated by Solarplan, showing PV production quite near normal crystalline PV modules

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Active House Live

Performance Visualiser for Copenhagen International School

Vinay Venkatraman
vv@leapcraft.dk
April 2018

KUBEN MANAGEMENT

leapcraft

Project Summary

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THE GOAL:
The goal of the project is collect, visualize data from Copenhagen International School's building with the Active House Radar as a framework.
This data will be used to showcase the facility in terms being able to create better indoor climate, more daylight and work conditions. Also the data will be used for research and publications.

OUTCOMES
1. To build a live interface for displaying the indoor climate performance at Copenhagen International School.

2. Collect and present the data from the deployment with a view of supporting the building operator.

3. Build a case study with live data to showcase the research and use of active house principles in synergy with Leapcraft & Kuben Management

KEYWORDS:
Data visualization, Usability, Data logging, Indoor Climate, Energy efficiency, Daylight, Heat, Advance analytics

Building performance visualizer

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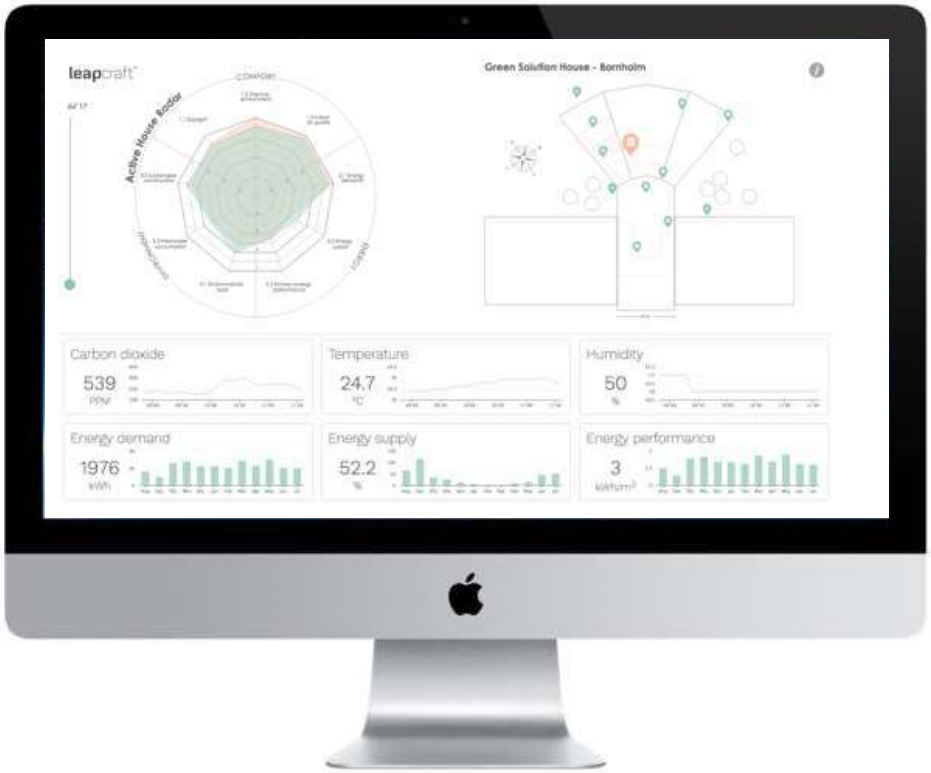

One of the main outcomes of the project will be a live Active House Radar for Copenhagen International School that shows the continuous changes and overall pattern in the data.

Hardware : AmbiNode

AmbiNode is a complementary product that enables more insights for battery powered use cases in tandem with reference applications. The product is standalone and can work as part of our network when the user gives permission.

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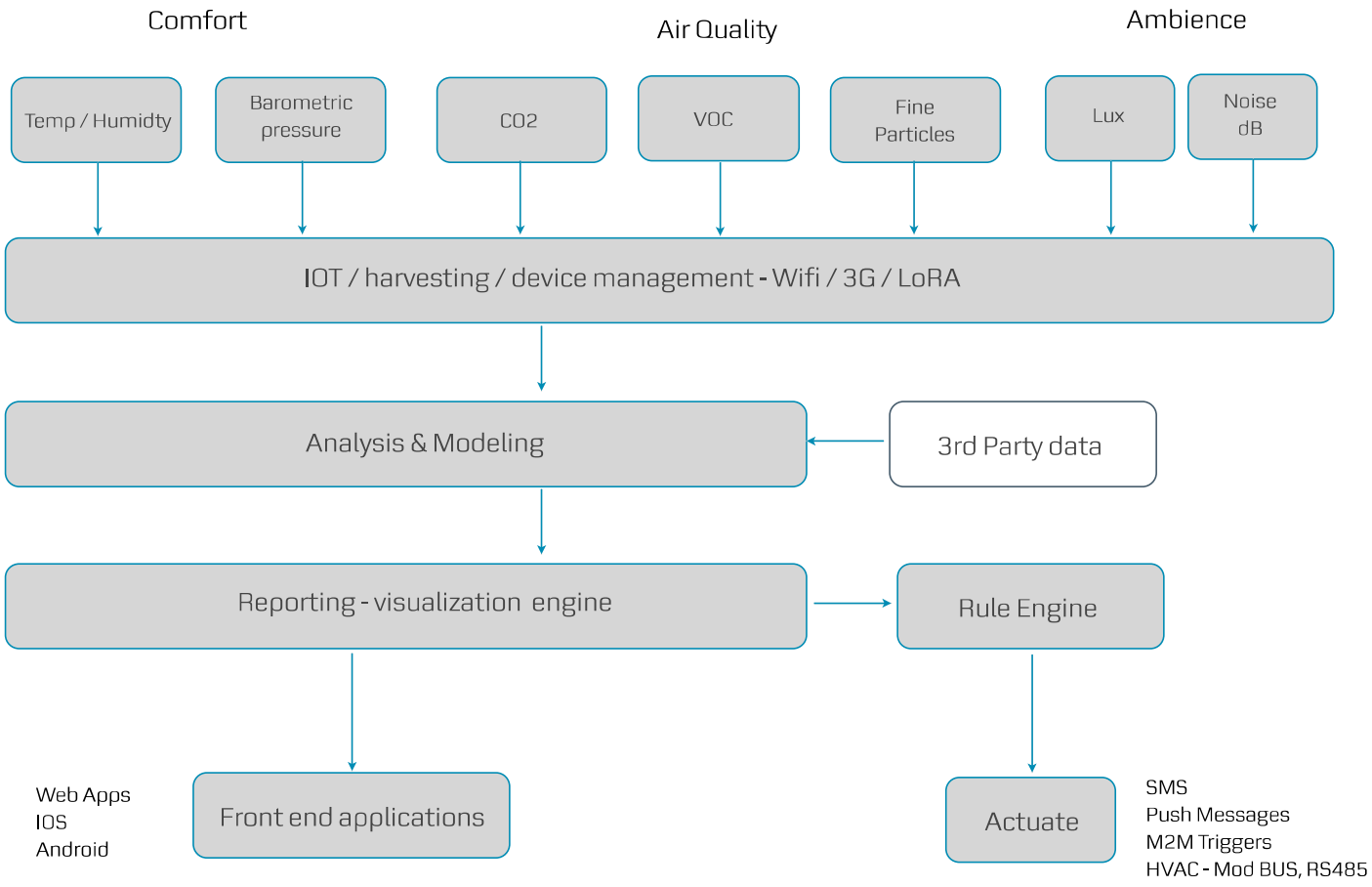
Ambinode architecture



Deliverables

Hardware
5 x Sensors and devices shipped to location. - temp, humidity, co2, particles and noise. Indirect light (Lux)

Dashboard :
Unlimited use: A web based live active house dashboard - that shows the active house radar and a few other parameters over time. This will be custolmised for the Copenhagen International School - from floor plans and details provided by Kuben Management

Mobile App:
Unlimited use : A smart phone app for Android and IoS showing all relevant sensor data and key values in the form of graphs and histograms. Please not the active house radar is not currently available on the smart phone app.

REST-API:
Upto 10,000 requests per month : Leapcraft will provide an API with all data both live and historic for connection to 3rd party systems or external software.

Solar Energy / Photo voltaic data integration
Leapcraft will try to integrate available micro inverter data from the solar photovoltaics from the building. The data is currently not openly available and needs further integration. Leapcraft will connect the data when its available and will indicate work in progress on the dashboard till the data is available from CIS.

Optional Analytics report - not budgeted here
A final report showing long term patterns, relationship to various parameters and modular sky lights etc. Show changes over time / seasonability / correlations between indoor and outdoor parameters. This will be developed via workshops run by Leapcraft with the support of Copenhagen International School's facility team.

Process Overview

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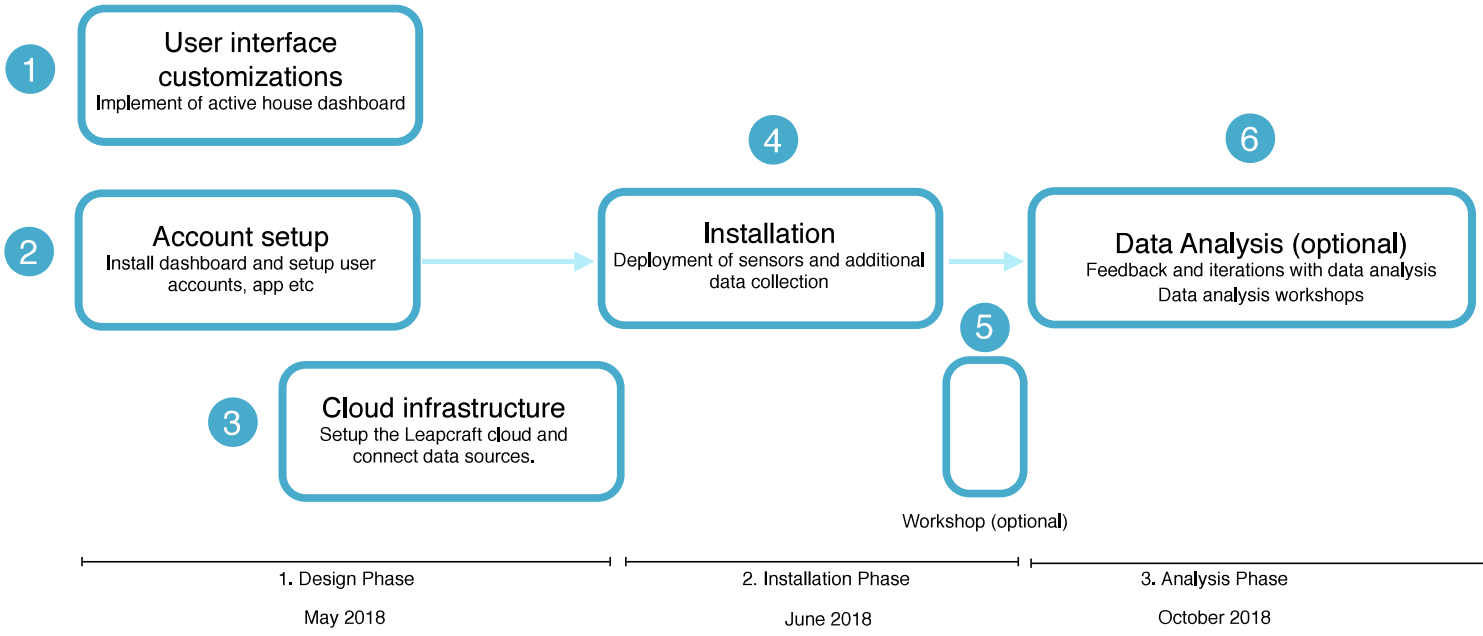

Budget Estimates (for phase 1 & 2)

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5 X Ambinode Sensor (Wifi)	
CO2, Temp, Relative Humidity	
PM2.5, PM10, Noise, Lux	
1 x Custom Dashboard License	
1 x IOS App License	
1 x Android App License	
Installation & Supervision	
TOTAL	100.000 Dkk

50% advance payment at start of project.
50% balance payment at end of project.
Travel and accommodation, electrical installation expenses as per actual.

All prices excl of VAT in Dkk.
Offer valid till 30th May 2018.

Roles & Responsibilities

LEAPCRAFT
User interface customization
Production server for deployment
Back end integration and API provisioning
Factory calibration & testing

KUBEN MANAGEMENT with COPENHAGEN INTERNATIONAL SCHOOL
Sensor installation - in collaboration with Leapcraft (remote support)
Models and calculations - integration to other concepts
Interface with Leapcraft team
Validation of concepts and data
Promotion material and news

Project team (Leapcraft)

Vinay Venkatraman - Project Owner & client relationship
Emily Frimand - UX design and project management
Christian Sonne - Front end development
Rohit Sharma - Data infrastructure
Vignesh Krishnamorthy - Data science and analysis

COMPANY INTRODUCTION

At Leapcraft we built world class IoT solutions at the intersection of good design, big data sets and science.

Leapcraft has an unique cross disciplinary approach with skills in hardware development, software and cloud orchestration and excellent Industrial design skills.

Leapcraft is based out of Copenhagen, Denmark and has been recognized via several awards and mentions from the European Commission and the media.

DESIGN

User Research
UI / UX design
Digital experience

+

DATA

Data Analytics
Data Visualization
Data Infrastructure

+

SCIENCE

Sensor Development
Machine learning
Signal processing

For Acceptance

Vinay Venkatraman, CEO
Leapcraft

30th April 2018, Copenhagen.

For Kuben Managment

Date: _____

Location : _____

Get in touch !

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Zero Emission Methodology for Active House City Areas of the future

13th Conference on Advanced Building Skins

1-2 October 2018, Bern, Switzerland

Implementation of 100% zero energy building standards

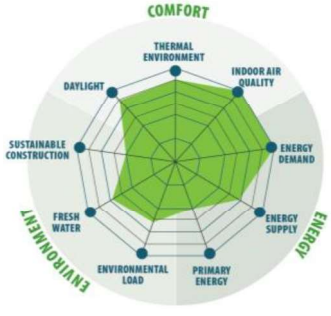
How is it possible to obtain a common standard for energy efficient building, which both aims high for new buildings, while it also can be utilised for existing buildings.
The best background of this discussion is the EU-Building Directive and the connected "Nearly Zero Energy Building" standard.
For new building projects, it is in many cases possible to establish a 100% zero energy building standard, even though it is demanding with respect to optimising the architecture by help of new types of energy producing facades and roofing materials.
And for renovation projects similar solutions will in many cases also be possible, if you are dealing with deep renovation, where the renovation also includes exchange of roofs and facades

The international Active House Standard

If the mentioned policies shall be implemented in practice in the best way, then it will be an obvious choice to combine these with use of the international "Active House" standard. This has a combined focus on "energy, comfort and sustainability", based on 3 criteria for each of these areas, and with possible use both for new building as well as renovation.
Before a building can get the official Active House label, the Active House standard demands, that all parameters are evaluated and verified. See also www.activehouse.info and www.aktivhusdanmark.dk, where the benefits of working with a global oriented standard is illustrated, especially with a very strong focus on indoor air climate, something which is not handled in a clear way in the EU building directive.
It can be suggested to utilize and adapt the Active House Standard, so it also include a focus on user satisfaction and performance documentation in practice, at the same time as different levels of zero emission standards by help of renewable energy is included.
And what would really have a large impact would be development of a methodology concerning how to organize such a standard, not only for one building but for whole city quarters as part of a Smart City and Smart Grid development.

Different levels of zero energy building as a driver for practical implementation of building integrated PV solutions

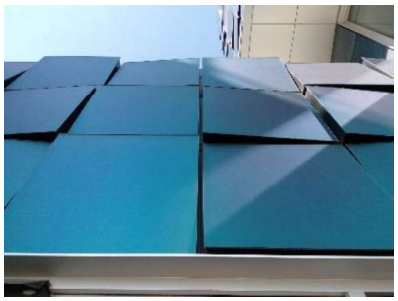
Here it is suggested to use f.ex. prosumer level 1,2,3, and 4, to show how much your building lives up to a zero energy building standard alongside the general energy quality of the building.



Results	
Comfort	
1.1 Daylight:	5.1 %
1.2 Thermal environment:	Better level
1.3 Indoor air quality:	≤ 500 ppm
Energy	
2.1 Energy	30.1 kWh/m²
2.2 Energy supply:	21.7 kWh/m²
2.3 Primary energy:	14.9 kWh/m²
Environmen	
3.1 Environmantal loads:	Good level
3.2 Freshwater:	28 % savings
3.3 Sust. construction:	Good level

Copenhagen International School, CIS

Copenhagen International School, CIS in Nordhavn in Copenhagen has the largest building integrated PV installation in Europe, covering all façades above ground level and supplying 50% of yearly electricity use by solar energy. Cenergia which is now part of Kuben Management has made Active House labelling and combined this with the implementation of an online Active house Radar. See this on: http://labs.leapcraft.dk/cis/.
CIS is a good example of the Prosumer building of the future with BIPV on all facades and actually with a good architecture due to the special PV panels and architectural design. With about 39 % of the total electricity use (inclusive el-apparatus) covered by the PV modules production, CIS is a good example of an almost zero energy building.



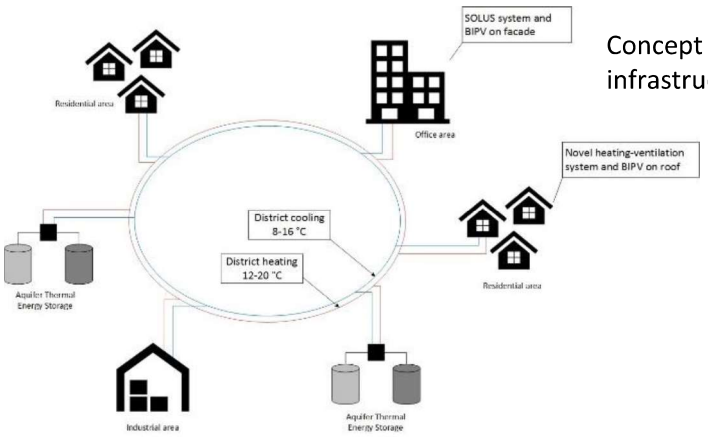
Randomly inclination of the PV panels on the facades of CIS. The PV modules were produced by SolarLab as 60 W green chromatic coated hardened glass panels of 700 X 716 mm, with 16 monocrystalline PV cells (6") and by pass diode. Each 8 panels is coupled to a micro inverter which is easy accessible through the ceiling of the rooms. Architectural design was by C.F.Møller Architects.

ATES groundwater cooling and heating

For the Bisperberg Hospital in Copenhagen was chosen to use Aquifer Thermal Energy Storage or ATES groundwater based cooling as a cheaper alternative than district cooling from HOFOR, the Copenhagen Energy Company.
The yearly energy saving is 75% and more than 90% of stored heat during summer can be recovered. 2 stage heat pumps from Sabroe is used (owned by Johnson Controls).
In winter, district heating is base load and heat pumps delivers the peaks. (Only from November to March).
In Denmark it has been proven that ATES systems can be used even quite near to drinking water pumping stations, but it is a demand that the ground water temperatures are never heated more than 0,5°C in the vicinity of this.
Besides an important effect has been that there has never been any net consumption of water, and there is no noise from the system. This can be compared to normal compressor cooling systems, which have a clear noise problem from the condenser in the roofs in summer.

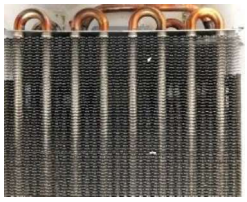
From the ATES system developer Enopsol's point of view, the new and innovative SOLUS heating / cooling system, from Lindab with 19°- 24°C operation temperatures, is really interesting. Since there can be a perspective of avoiding the use of a large part of the heat pump operation, with its quite high electricity use, if the ground water temperatures can be raised somewhat in summer periods.
For a new city development area, Køge Nord south of Copenhagen it has been agreed to implement an advanced low temperature bidirectional district heating solution, which can be ideally combined with the above mentioned technologies, and new types of BIPV facades for a large commercial building development area.

Masterplan of Køge Nord in Denmark, south of Copenhagen. Here a new railway station along the motorway is the base of new city development



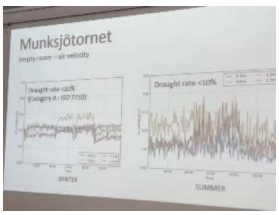
Concept for the energy infrastructure in Køge Nord

Munksjøtårn in Jønkjøbing, Sweden was used for full scale demonstration



Solus heat exchanger

Solus beams in Munksjøtårn



Solus measurements confirms good operation in practice

New BIPV technology from Danish Solar Energy, with light grey panels in the middle was demonstrated by Solarplan in combination with Rock panel facade, showing PV production quite near normal crystalline PV modules.

Contact: Peder Vejsig Pedersen, Tel.: +45 20466755, pepe@kubenman.dk

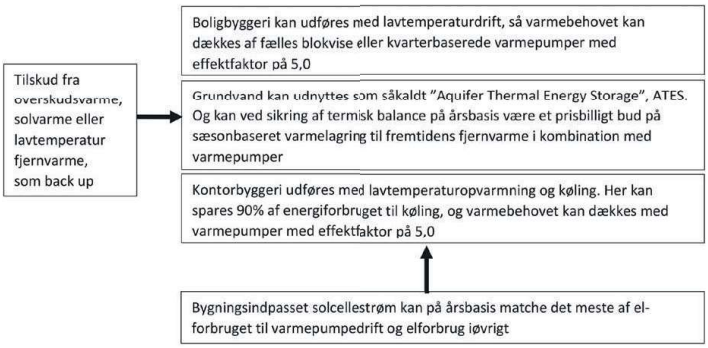
"Prosumers" og 5. Generation fjernvarme

I relation til et større nordisk forsknings- og udviklingsprojekt om"Aktive Tage og Facader", har der været et længerevarende samarbejde mellem Cenergia, der nu er en del af Kuben Management, og så Statens Byggeforsknings Institut , SBi ved Aalborg Universitet. Dette har siden 2017 også omfattet en indsats om udvikling af såkaldt"bidirectional district heating and cooling" som et bud på såkaldt 5. generations fjernvarme som i flere sammenhænge har været nævnt som et vigtigt element i den grønne omstilling.

Idéen er her at arbejde med meget lave drifttemperaturer tæt på omgivelsestemperaturen, og med brug af lokale varmepumper og med hensyn til kølebehov at kombinere med grundvandskøling (ATES), samtidigt med anvendelse af et meget innovativt varme-/køleelement fra firmaet Lindab, der kan anvende drifttemperaturer fra 19-24 C. Idéen med at anvende ATES grundvandsbaseret varmepumpedrift med termisk balance på årsbasis, kan bygge videre på erfaringerne fra en lang række gennemførte projekter af denne type koordineret af det Danske firma Enopsol.

De lave drifttemperaturer udgør en optimal baggrund for lavtemperaturdrift med varmepumper. Af denne grund har SBi/AAU fokuseret på denne teknologi i indtil nu 2 PhD-projekter, hvor der er arbejdet med avanceret simulering med det såkaldte Modellica-værktøj, så der kan skabes grundlag for at udvikle fremtidens fjernvarmeteknologi til såkaldte "Prosumer"- byggerier, hvor der indgår en betydelig egenproduktion af energi f.eks fra bygningsindpassede solenergiløsninger.

Her er det nu også muligt at anvende helt nye teknologiske løsninger for solcelleanlæg med farvede frontglas, så man kan opnå mange forskellige farver. Eksempler på dette er den nye type solcelle-facademodelløsning i glas fra SolarLab som kan fås i alle farver, og som i 2017 er demonstreret med stor succes til Copenhagen International School i Nordhavn i København, som det største såkaldte BIPV-anlæg i Europa. Eller den nye farvede solcelleløsning, der fremvises af firmaet Dansk Solenergi på den såkaldte BIPV Demosite for bygningsindpassede solceller på Teknologisk Institut i Tåstrup, der er etableret i samarbejde med firmaet Solarplan.



Figur 1. Illustration af "Smart Energy"-forsyning med ATES-teknologi, varmepumper og bygningsindpassede solceller.

Se også: www.activehouseBIPV.com, og www.activehouseroofsandfacades.com

Såkaldt BIPV Demosite for bygningsindpassede solceller, der er etableret på Teknologisk Institut i Tåstrup koordineret af firmaet Solarplan.

CENERGIA En del af KUBEN MANAGEMENT

SOLARPLAN BYGNINGSINTEGRERET SOLENERGI