WP1 - Market research

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SCOPE

The intend of this report is to serve as an overview of the market for façade renovation with special focus on Denmark. Separate reports for Norway and Sweden are prepared by project partners in the NORFAC project.

Some general points and background are given in the beginning, before the market analysis with focus on facades and windows. The analysis is based on a model developed at DTU. There is a special focus on public housing as this area covers around 30-40% of all flats in DK, and the decision process for renovation projects of public housing is also described.

The state of the art for façade renovation is described as well as selected stakeholders. As politic has large influence on the economy and incentive for renovation projects various refurbishment programs and EU regulations are included in this report.

Finally, some major competitors, their products and surroundings/user demands for renovation projects are described.

In addition to this report there is a report with some case stories where examples of interaction with and demands from residents to refurbishment and façade solutions can be found.

The implementation of BIM in the NORFAC project is also described in a separate report.

Market description

General points

In the original application it was mentioned that "The market for the façade system is existing buildings from 1950, 1960 and 1970s in Nordic countries and internationally"

Single family houses are believed to less suited for a modular system and will not be in focus.

The focus for the market description will be on flats and institutions e.g. schools, hospitals etc. that covers a large building mass suited for a modular façade system

In the original application it was also mentioned that: "Focus is mass customized sustainable and energy efficient façade solutions, business models and promotion of Nordic cooperation. The façade system will be in three levels: A: A whole new façade system. B: An external and internal insulation system and C. An internal insulated system. However, already at the kickoff meeting it was agreed that solution B should not be included. This was due to the fact that such solution could newer be cost competitive.

Level A can further be divided in A1: complete exchange of façade and A2: New outer façade on existing façade.

Building types

With a rough breakdown the general apartment buildings in the period 1850 - 2000 is described by 5 basic types, see Danish Building practices, Floor construction through 150 years by Jesper Engelmark

With the focus on existing building from 1950, 1960 and 1970s it is only one building type that are in focus;

In general the interior of the building (the shell) is made entirely of concrete manufactured items. Floors and stairs are supported by the inner transverse walls which together with a small longitudinal part that also has a stabilizing effect. The remaining inner walls are of lightweight concrete and / or performed as timber frame constructions with plasterboard liner.

Longitudinal external walls are not load-bearing or stabilizing, and in most cases of light construction. The facades can in this case be totally replaced. However, when the external walls are concrete elements the outer walls can be load bearing. In this case solution A or C should be considered.

Transverse external walls (gables) are stabilizing, and either performed as sandwich construction or as the corresponding interior walls and then clad exterior.

Market description

Background

In Europe, more than 40% of the overall energy consumption and 36% of the overall CO_2 emissions are produced in/by buildings. In the face of Global Climate Change increasingly stringent sanctions on CO2 emissions are passed. At the same time only 1% -1.5% of the European building stock is newly built each year. An important adaptation strategy to comply with future legislation to an economically viable approach is to adapt the building stock to future energy standards.

Ambitious energy standards and passive house energy standards in new buildings can be easily achieved whereas ambitious refurbishment-projects require a bigger effort. They can even lead to conflicts with monument protection authorities and even inhabitants.

In refurbishment projects high energy savings and reductions of greenhouse gases can be achieved by using multifunctional facade systems. One of their main applications is for fast thermal refurbishment of the existing building stock. They often fulfil high thermal requirements, avoid thermal bridges and achieve higher air tightness targets compared to “on site” construction.

The following market analysis, except for the part concerning public housing prepared by MTH, are based on the projection model by Nikolaj Nørregård Rasmussen. The model is part of a master project, Analyse og modellering af renoveringsindsatsens rolle frem mod 2050, from December 2014, prepared at DTU Management Engineering, Institute for Systems, Production and Management.

The model gives the renovation potential until 2050 / 2100 for the various building parts; roof, façade, windows, basement, installations and bath. It is possible to get data from different regions, provinces and municipalities. Data can also be extracted for different building types and the use according to BBR category.

In the analysis made the focus is on the renovation potential until 2050 for Denmark as a whole. The only subdivision is made on

1) Flats

2) Public office and service buildings

3) The total building mass

Specific graphs will be shown for facades and windows, not for the other building parts.

Market description

The lifetimes used in the calculations are based on reference lifetimes given in levetider.dk, and the Institute's publications on lifetimes in a broad sense and from a recognition that the replacement of building components occurs at different rates in relation to the technical lifetime. Reference service life is based on the technical lifetime of the building part. In addition, using an upper and a lower limit of lifetimes that refers to the problem, that some parts of the building will be replaced earlier, while others replaced later than the technical life.

Unit prices for individual renovation measures are based on total - and marginal cost considerations.

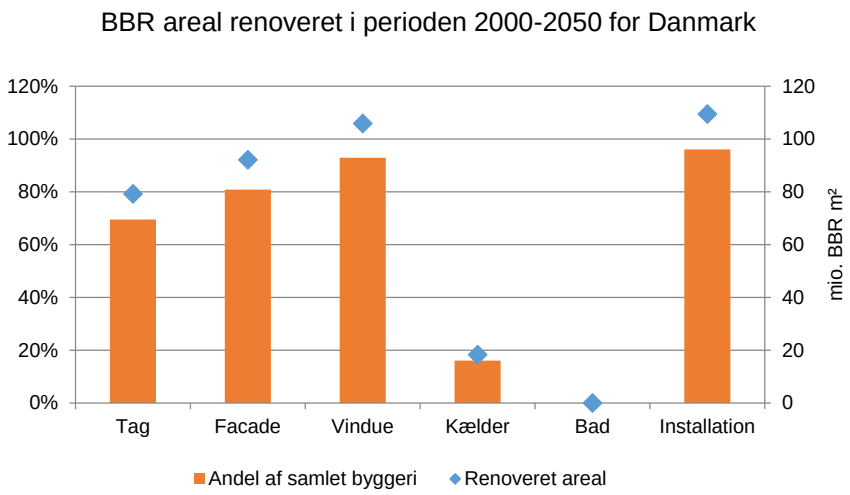
This means, that in the model the calculation is based on both the total cost of a given renovation initiatives - one example is the desire for energy renovation before building component stands for replacement due to end of life - and the marginal cost where only the additional cost of the increased insulation levels are taken into account.

The projection model used absolute prices at a given action, while the marginal cost in the renovation model is based on unit costs for building insulation as a function of the applied insulation thickness. All unit prices are inclusive of labor and excluding VAT. To determine the cost of deploying mechanical ventilation unit prices from V & S price data and calculated based on BBR area are used. Similarly, unit prices for demolition and new construction are determined from the V & S price data. Unit prices for the establishment of windows is partially determined by price data from the manufacturer (Rational), V & S price data and indicative mounting prices from the manufacturer (Kipa). The starting point is a smaller price variation as a function of window energy label (C-A +). This difference represents solely the cost increase for the acquisition of the windows.

In the model there is differentiated between different facade types (light and heavy facade) and different roof structures (attic access and sloping roofs). This is based on the consideration that the costs related to the re-insulation varies markedly between different construction types.

For more info on assumptions on lifetime of different components, demolition rate (10% - 2050), price calculations etc. please see the model and the master project.

Market description – Total



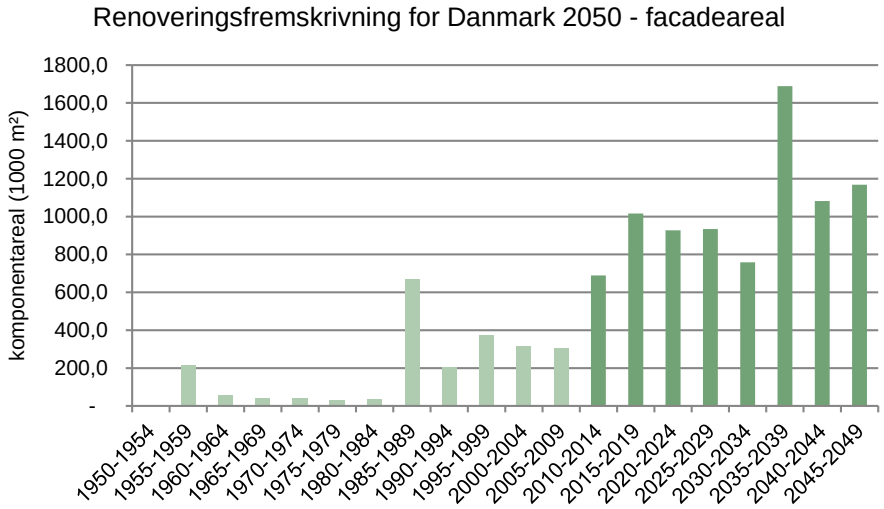
- Renovation potential before 2050, BBR area								
	Roof	Facade	Windows	Basement	Bath	Installations		
Area (mio. m²)	332.10	370.93	413.80	131.99	422.03	427.05		
Percentage	76%	85%	94%	30%	96%	97%		

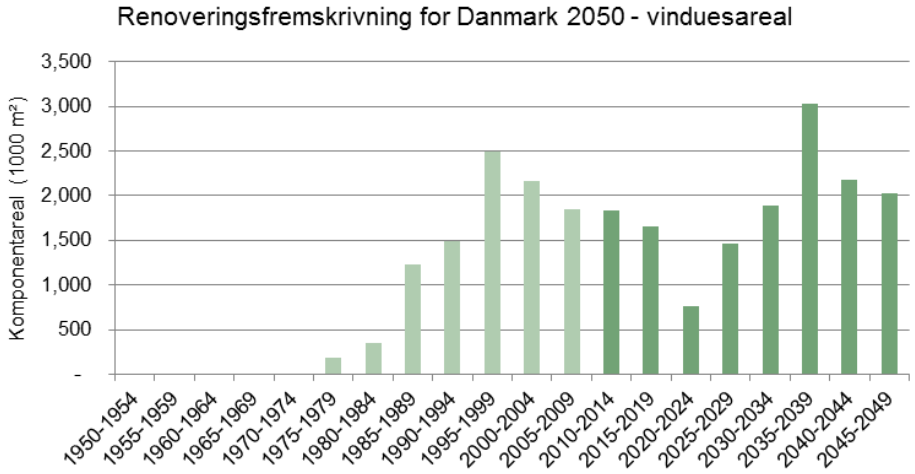
Investments

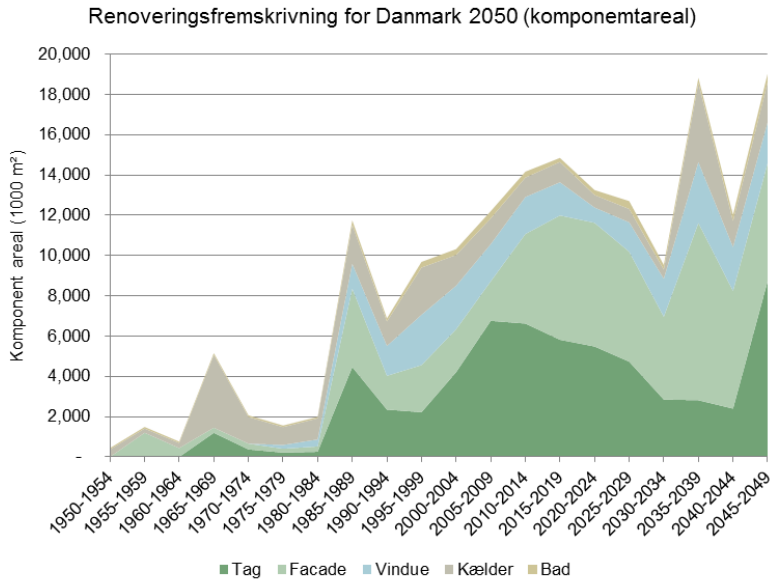
- Planed renovation w/o extra cost for energy improvements (mia. 2014-kr)								
Period	Roof	Facade	Windows	Basement	Bath	Installations	Total	Average/year
2014-2050	211.94	357.76	393.39	36.71	32.97	566.28	1599.05	44.42
2014-2100	469.90	788.91	895.71	75.39	73.25	1230.22	3533.38	41.09

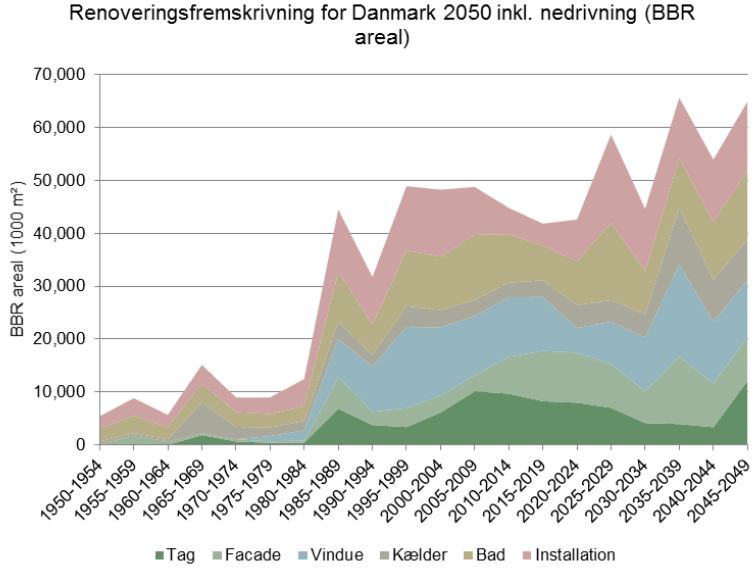
- Planed renovation w extra cost for energy improvements (mia. 2014-kr)								
Period	Roof	Facade	Windows	Basement	Bath	Installations	Total	Average/year
2014-2050	288.63	786.50	393.39	63.07	54.44	566.28	2152.31	59.79
2014-2100	639.94	1734.35	895.71	129.54	120.92	1230.22	4750.69	55.24

Market description – Total

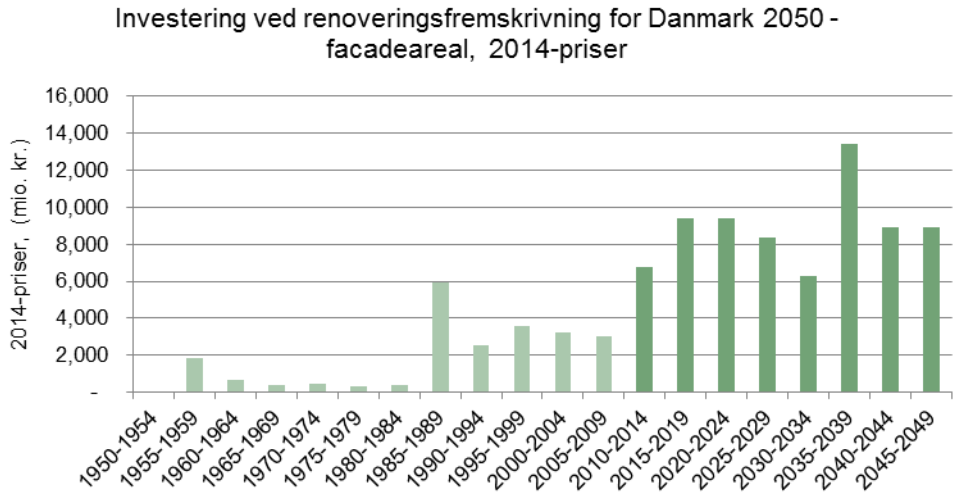


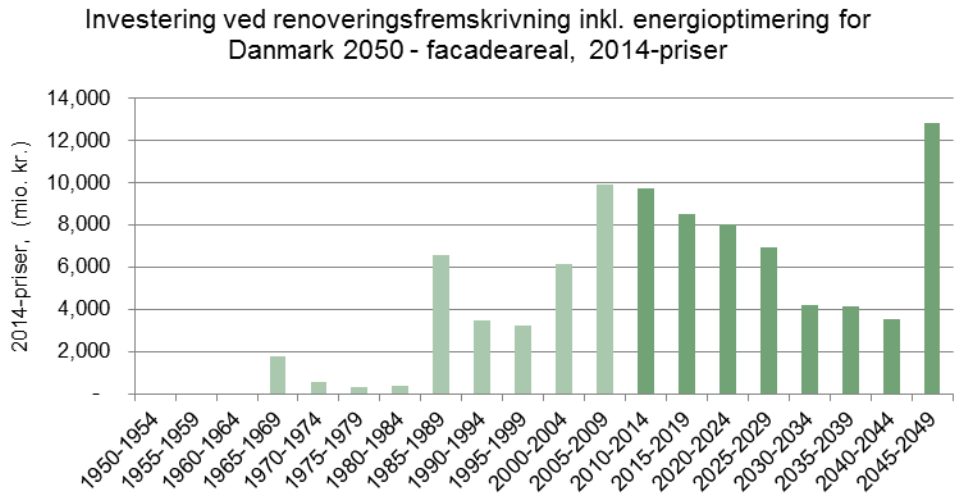


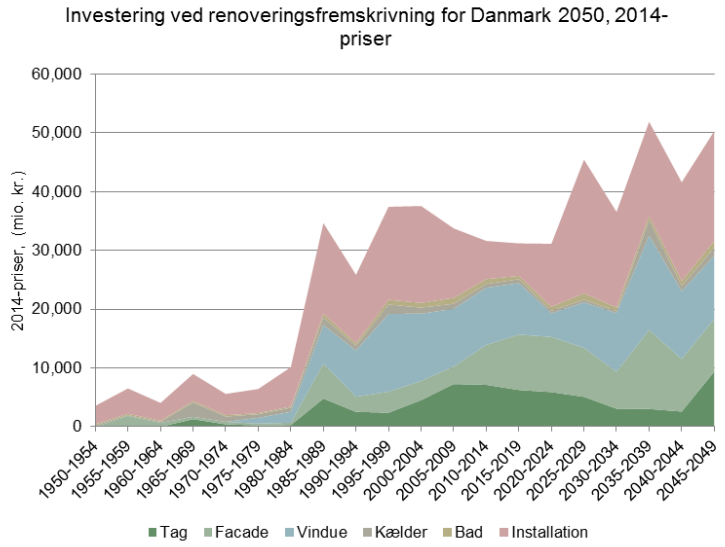


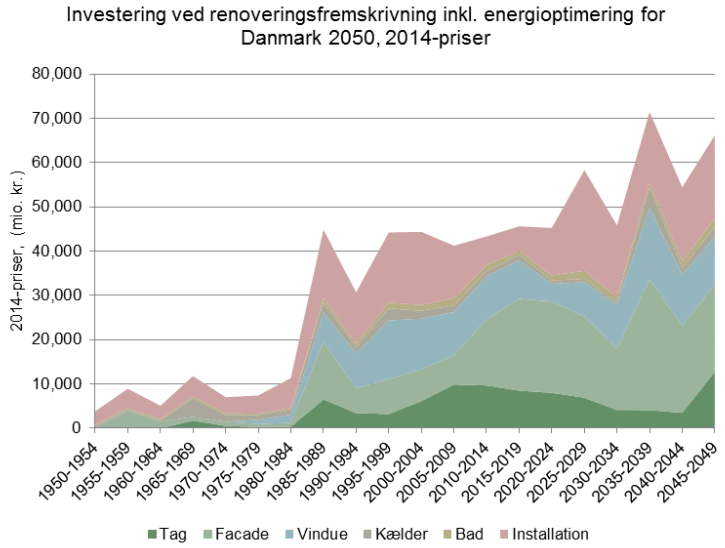


Market description - Total

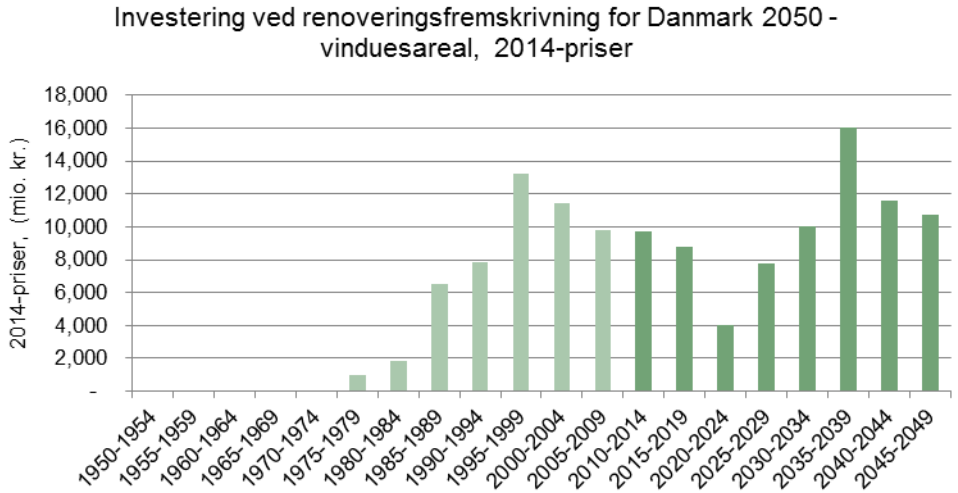


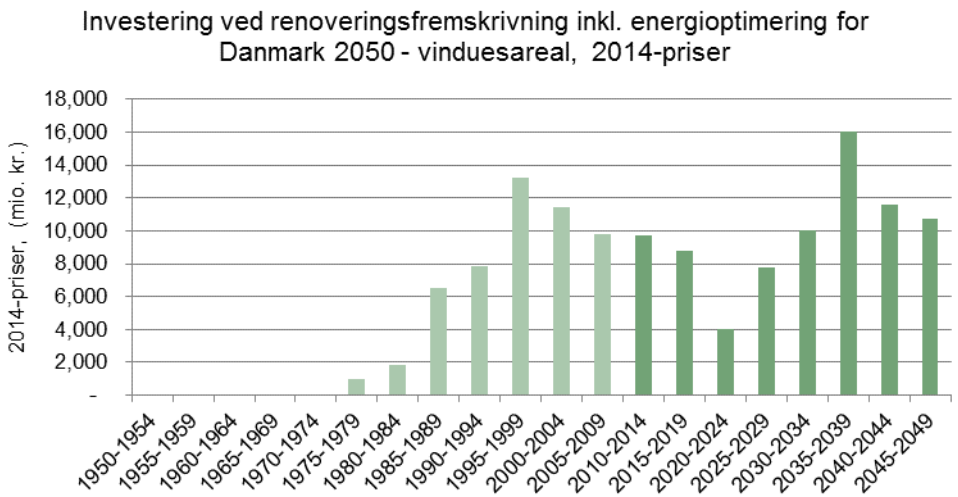




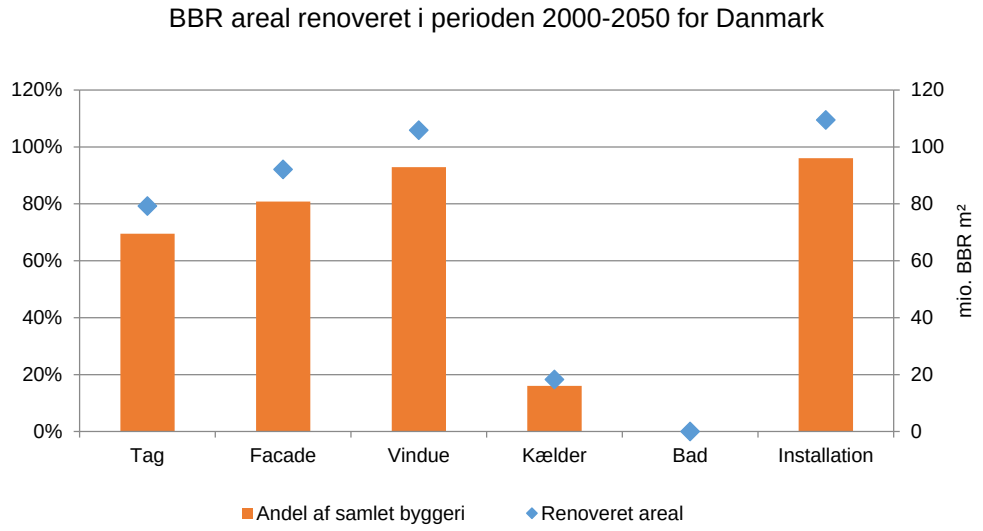


Market description - Total





Market description - Flats



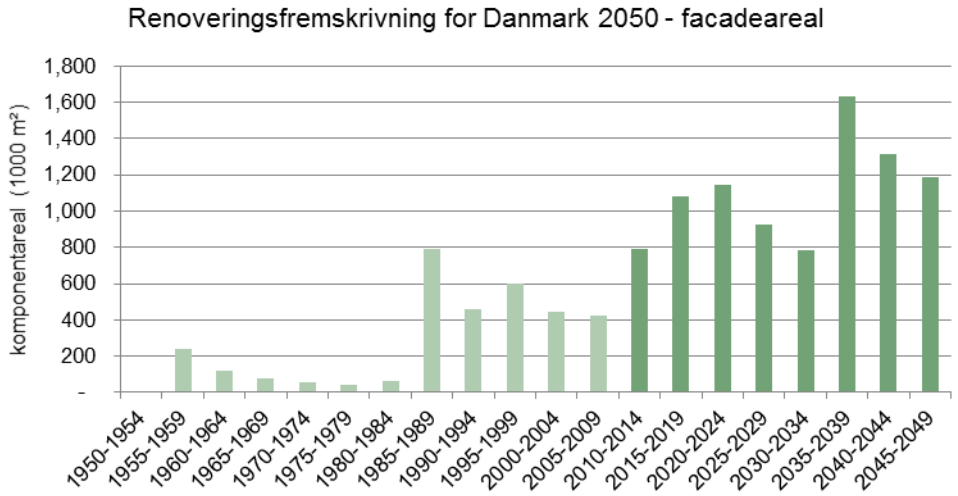
- Renovation potential before 2050, BBR area								
	Roof	Facade	Windows	Basement	Bath	Installations		
Area (mio. m²)	71.69	78.70	87.74	30.09	0.00	90.58		
Percentage	78%	85%	95%	33%	0%	98%		

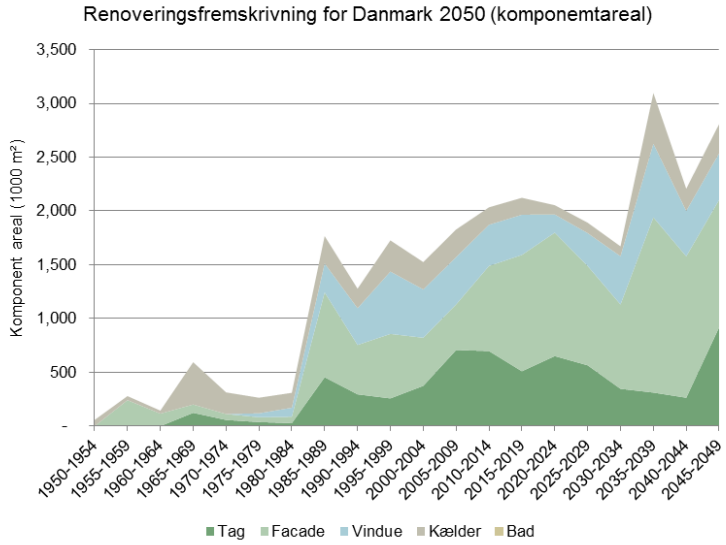
Investments

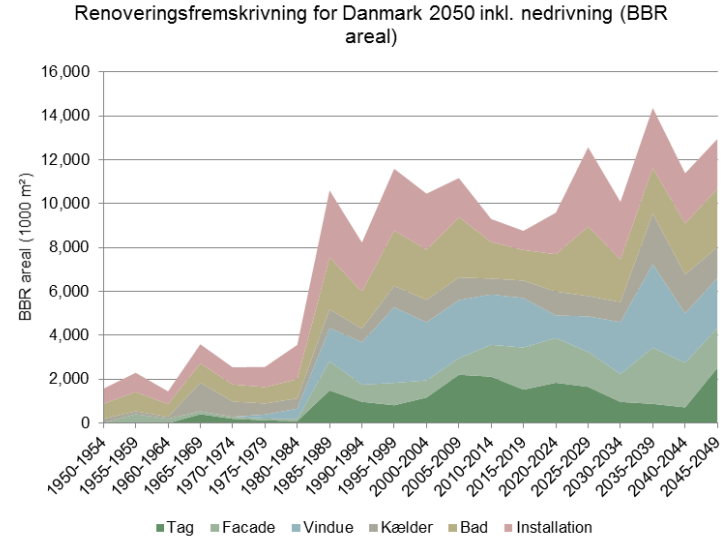
- Planed renovation w/o extra cost for energy improvements (mia. 2014-kr)								
Period	Roof	Facade	Windows	Basement	Bath	Installations	Total	Average/year
2014-2050	22.93	67.65	85.43	5.18	0.00	119.85	301.04	8.36
2014-2100	51.68	149.90	194.68	10.87	0.00	260.60	667.73	7.76

- Planed renovation w extra cost for energy improvements (mia. 2014-kr)								
Period	Roof	Facade	Windows	Basement	Bath	Installations	Total	Average/year
2014-2050	31.23	148.72	85.43	8.90	0.00	119.85	394.13	10.95
2014-2100	70.39	329.53	194.68	18.68	0.00	260.60	873.88	10.16

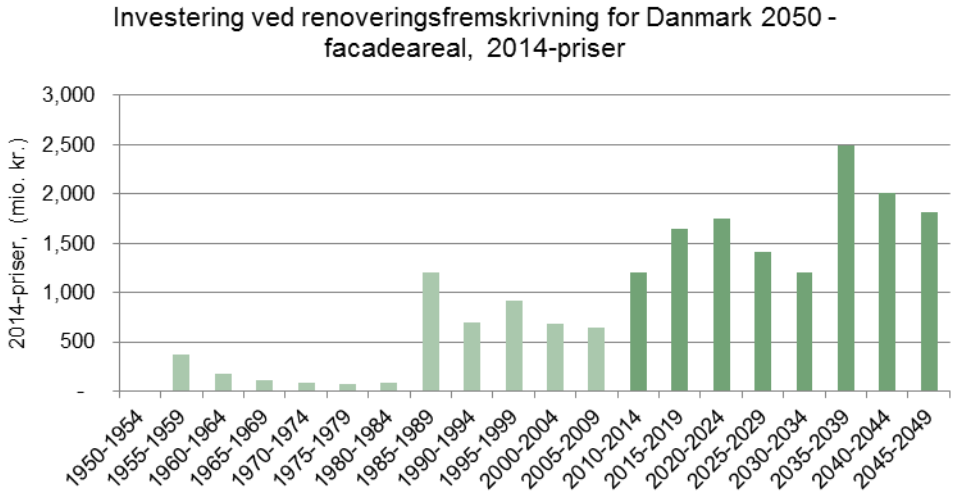
Market description - Flats

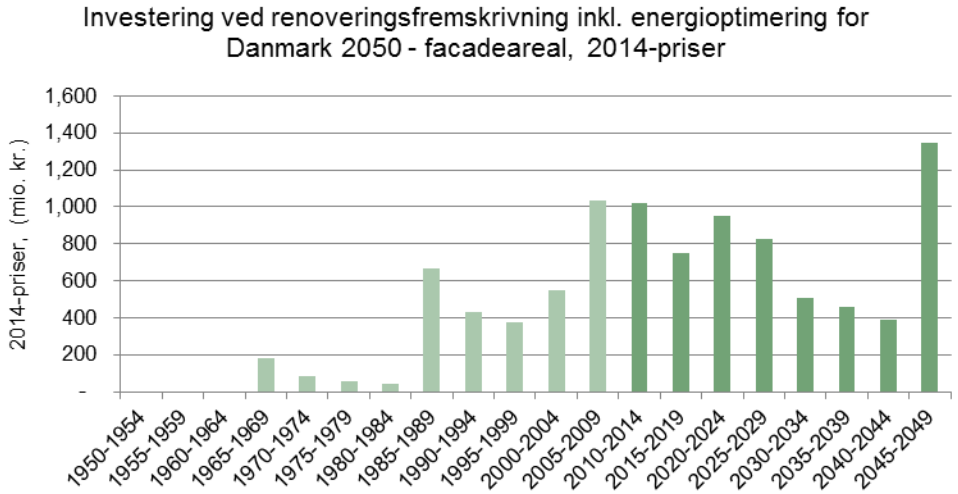


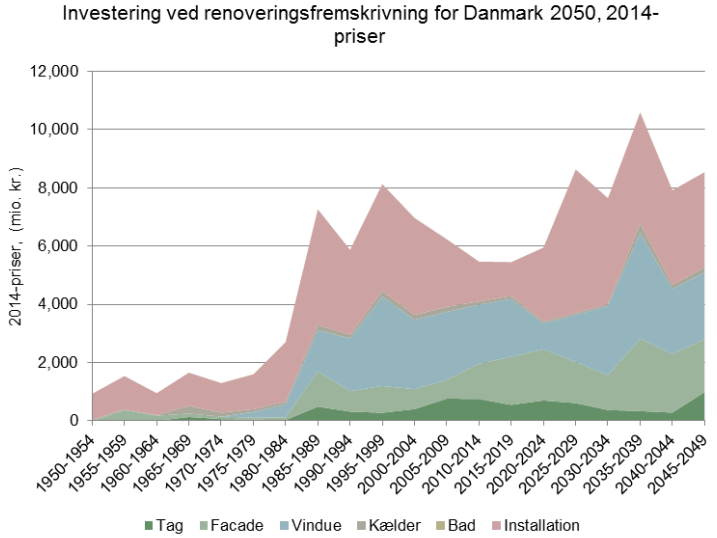


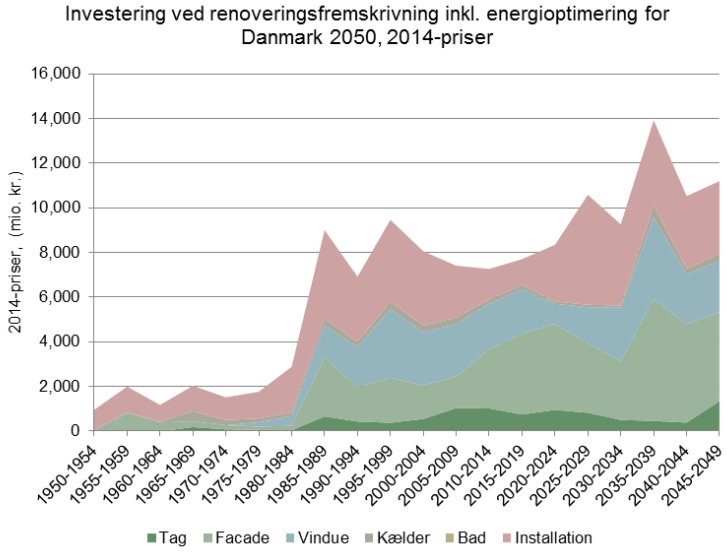


Market description - Flats

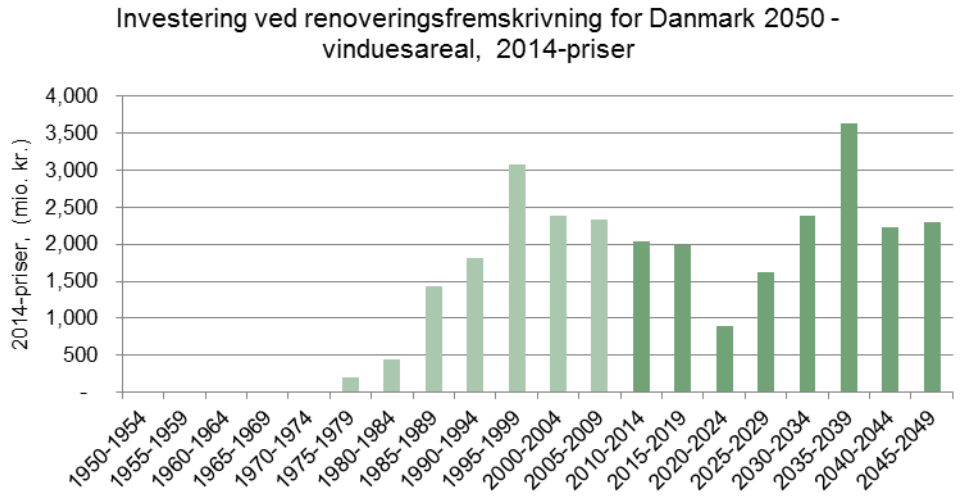


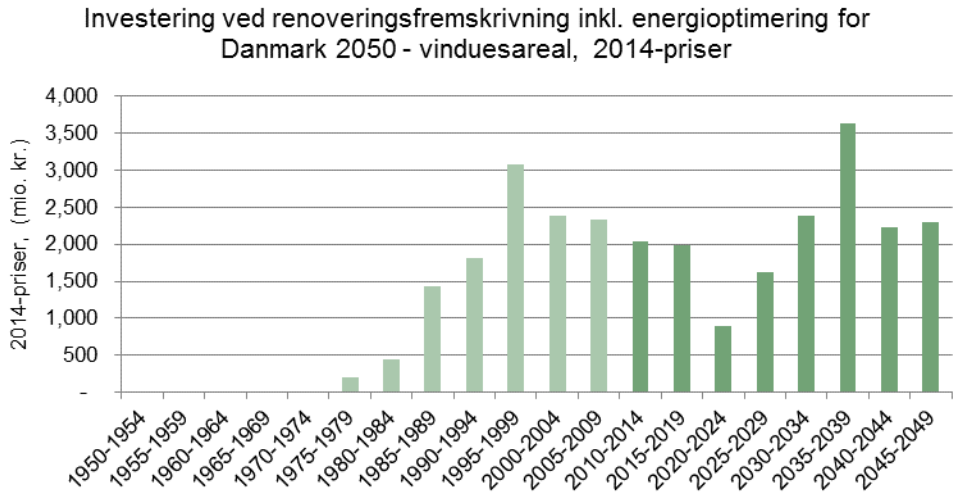




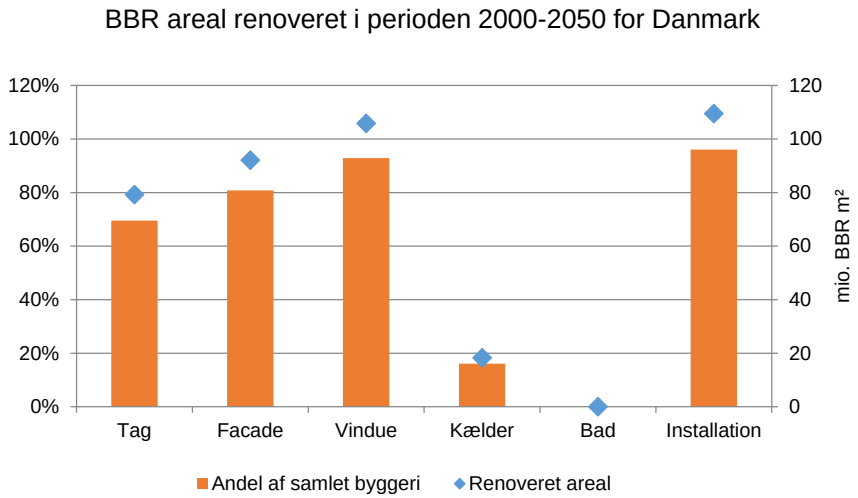


Market description - Flats





Market description – public-, office and service buildings



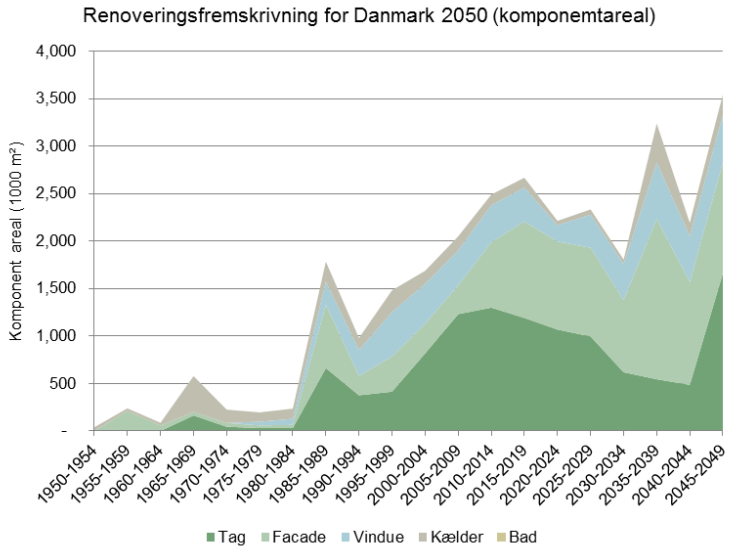
- Renovation potential before 2050, BBR area								
	Roof	Facade	Windows	Basement	Bath	Installations		
Area (mio. m²)	79.24	92.12	105.87	18.31	0.00	109.48		
Percentage	70%	81%	93%	16%	0%	96%		

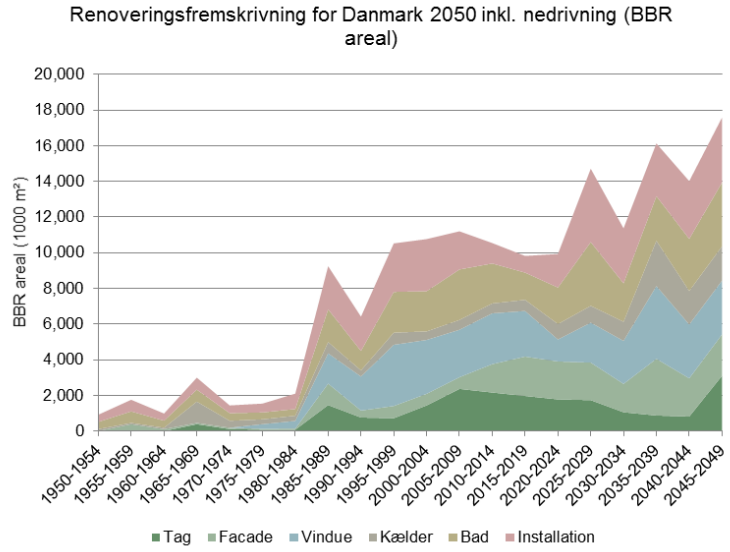
Investments

- Planed renovation w/o extra cost for energy improvements (mia. 2014-kr)								
Period	Roof	Facade	Windows	Basement	Bath	Installations	Total	Average/year
2014-2050	42.27	63.12	85.78	3.78	0.00	145.76	340.70	9.46
2014-2100	96.26	140.23	197.72	7.71	0.00	315.09	757.02	8.80

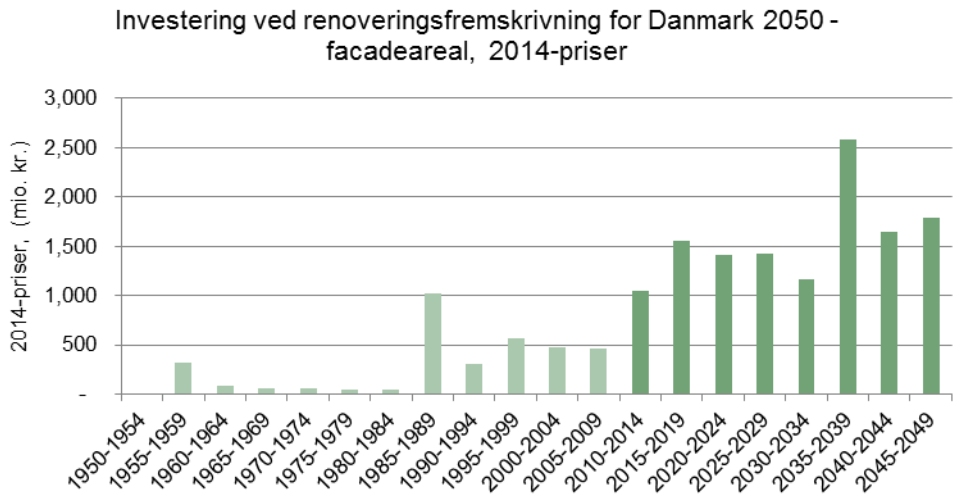
- Planed renovation w extra cost for energy improvements (mia. 2014-kr)								
Period	Roof	Facade	Windows	Basement	Bath	Installations	Total	Average/year
2014-2050	57.57	138.76	85.78	6.49	0.00	145.76	434.35	12.07
2014-2100	131.09	308.27	197.72	13.25	0.00	315.09	965.44	11.23

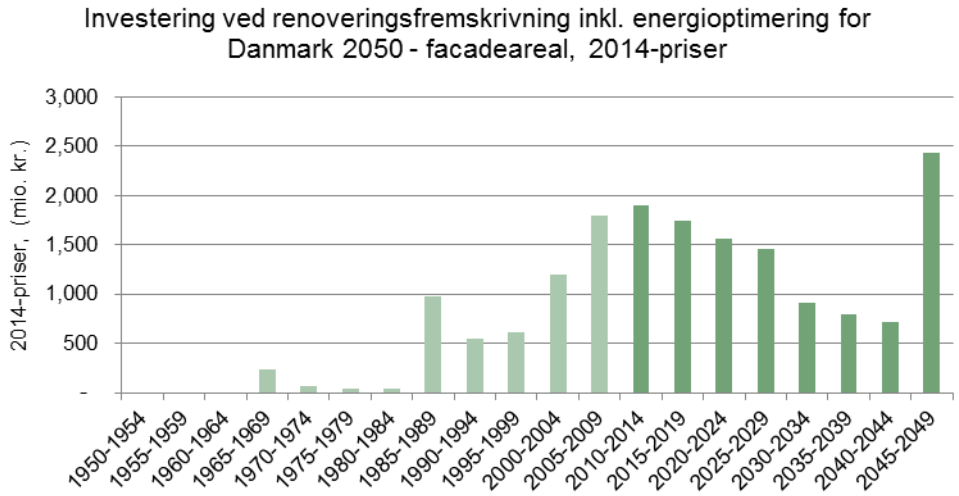
Market description – public...

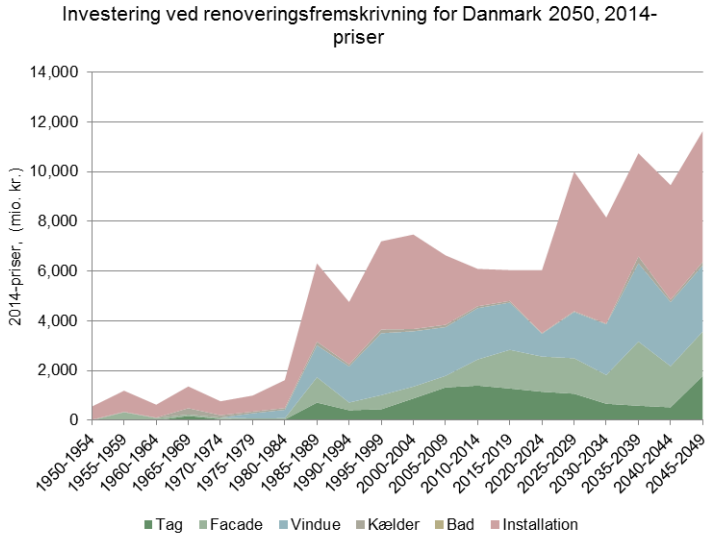


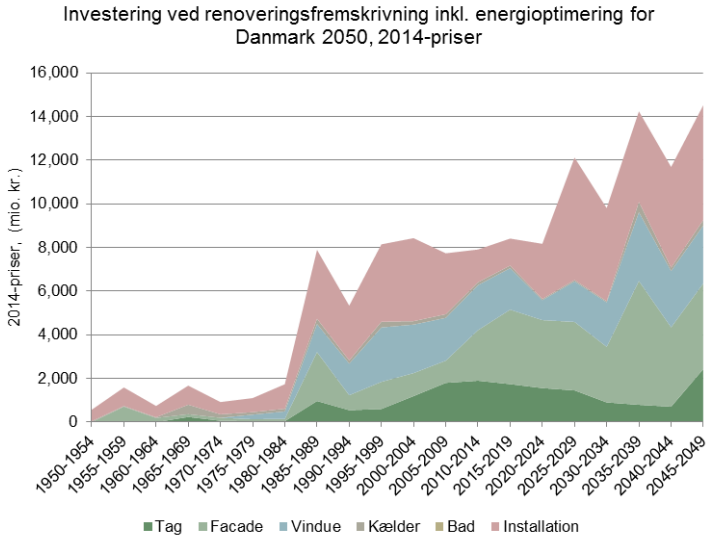


Market description – public...

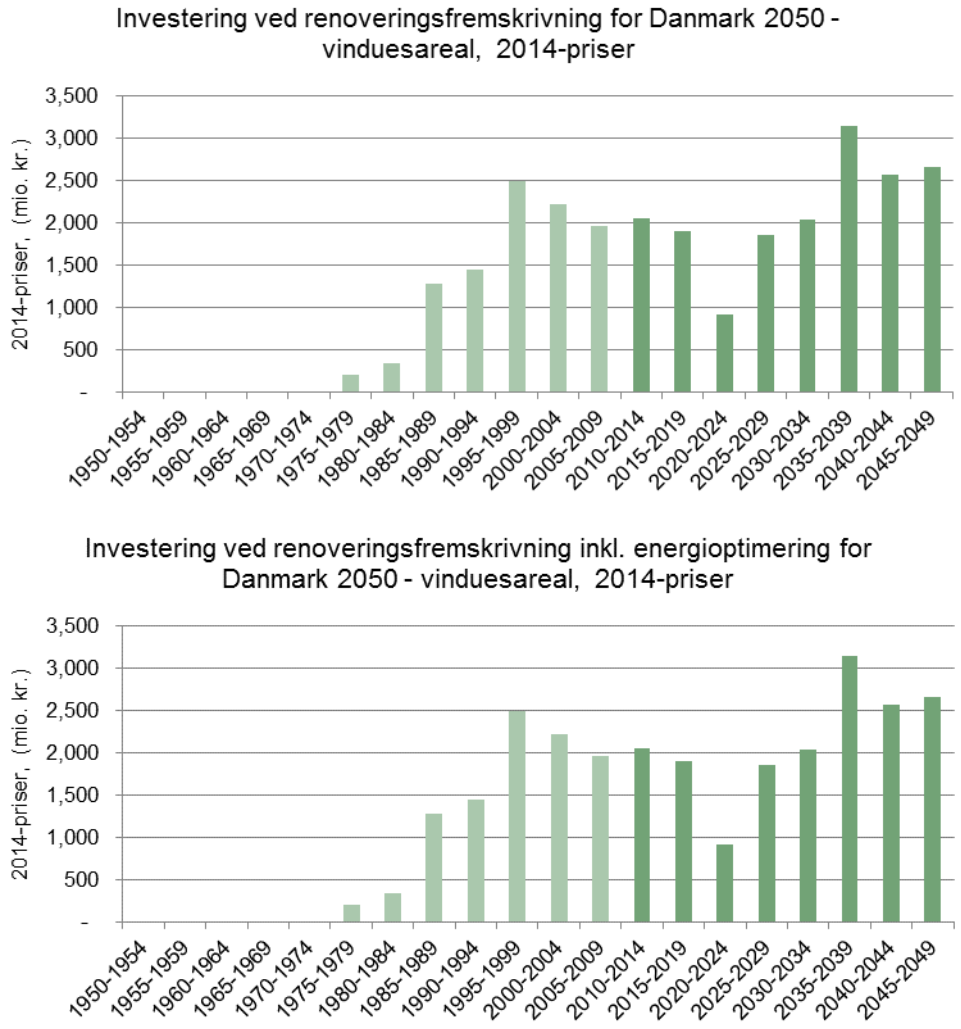








Market description - public-, office and service buildings



Market description - conclusions

Some key figures that can be seen in the previous graphs and tables are summarized below. It can be seen that the renovation potential from flats and public-, office and service buildings only is around one third of the total. Half of the total comes from detached houses.

In the model it is not possible to extract data for buildings build in 1950's, 1960's and 1970's alone. However, it can be found that the façade area for buildings build in this period is 37.7% of the total façade area and for buildings build in 1960's and 1970's the façade area is 30% of the total façade area.

Mia 2014 kr.	Facade	Vindue	
Total	358	393	
Flats	68	85	
Public	63	86	
Total	786	393	
Flats	149	85	With extra cost on energy optimization
Public	139	86	

In general the total renovation potential for facades is around 6-10 mia. Kr./y in the period with a maximum around 13 mia. Kr./y in 2035-2039. For windows it is around 8-12 (16) mia. Kr./y with a low in 2020-2024 at 4 mia. Kr./Y.

For flats alone the renovation potential for facades is around 1.0-2.5 mia. Kr./y with a maximum in 2035-2039 and for windows the potential is also around 1.5-2.5 mia.Kr./y with a low in 2020-2024 at 1 mia. Kr./y.

For public-, office and service buildings the renovation potential for facades is around 1.0-2.5 mia. Kr./y and 1.0-3.0 mia. Kr./y for windows and as for flats there is also a low for windows in the period 2020-2024.

Having in mind that the façade area for the buildings build in 1950's – 1970's is 37.7% of the total façade area one third of the above figures can be attributed to the buildings that are in focus as our direct market.

The overall conclusion is then that there is market for renovation of facades and windows for building from 1950's – 1970's around 1.5 – 3.5 mia. Kr./year.

Market description – public housing

Public housing:

The public housing area covers around 30-40% of all flats in Denmark

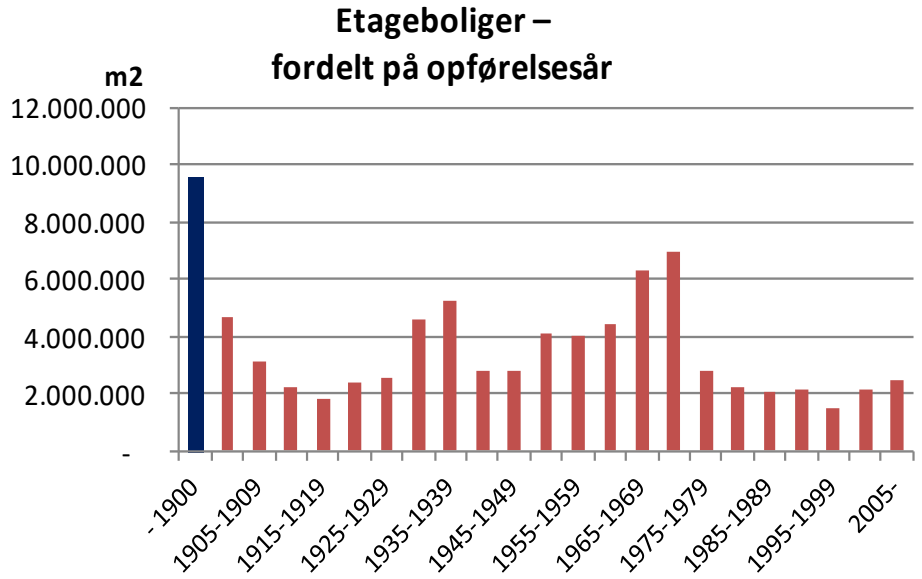
Half of the 560,000 public housing is multi-storey buildings built before the 1974th

They must each be renovated for half a million in the 2025th

Half of this is façade renovation

Overall needs are estimated at 9 billion. kr. annually

The homes are built in large series.



Need to ensure attractive public housing, reduce energy consumption and get more renovation for the money

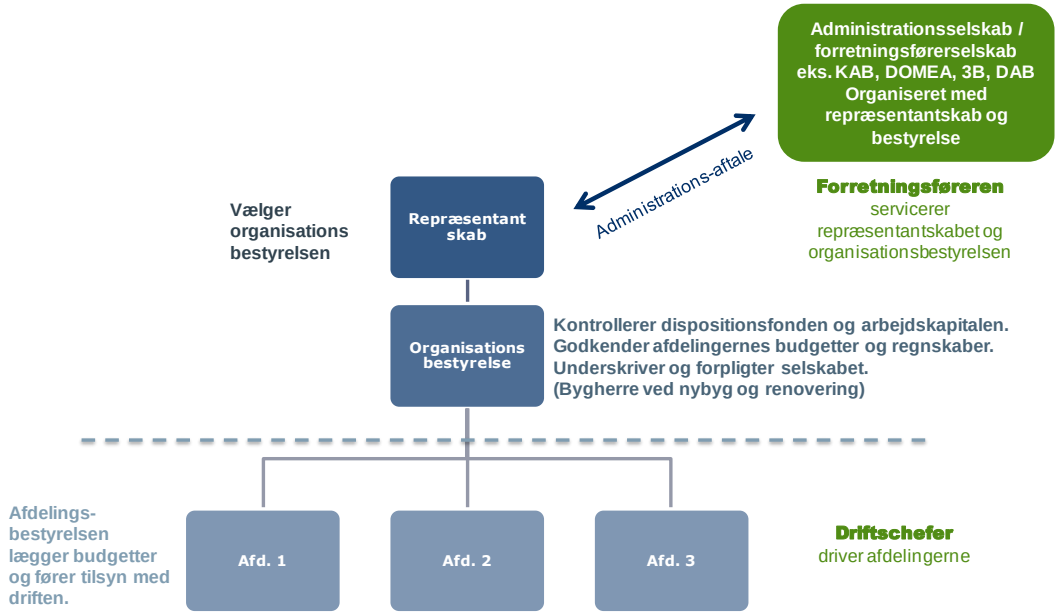
Market description – Decision processes

Public housing - financing and purchasing process

- Self-financed - savings in funds. Renovation Needs 9 billion. annually until 2025
- Landsbyggefonden control half of the savings
- Parliament decides the National Building Fund support framework
- Boligselskabet prepare master plan (3-10 years)
- Landsbyggefonden promises support - trigger financing from housing association. Renovation started.

The parliament decides the activities, the cases are a long time coming and Landsbyggefonden is a bottleneck

Organiszation of the Housing companies:

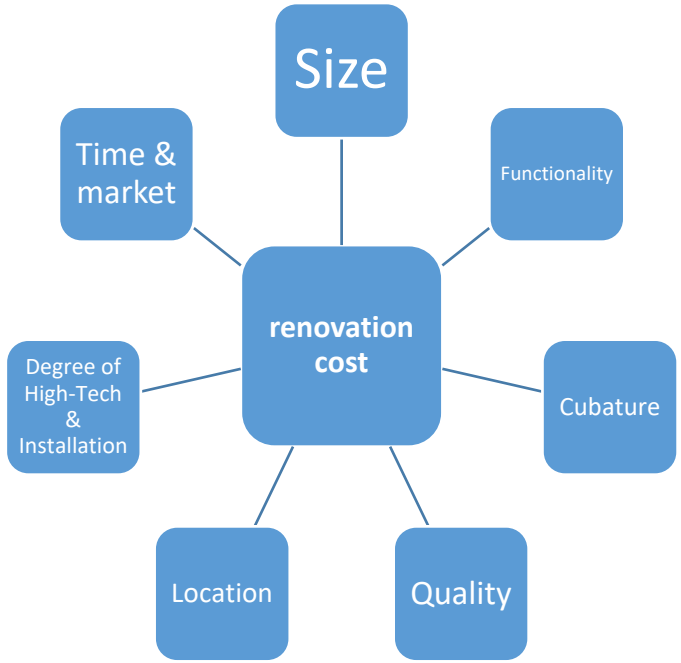


The managers in the housing companies are the key to the housing companies
The decision processes are democratic

Market description - Total economy

Energy saving measures and overall economy - Models for Total Economic calculation

What factors can be optimized in a cost optimization? The following describes how an efficient design approach to energy renovation also can be used in energy efficiency improvements by using facade areas more efficiently – e.g. by avoiding shade and thermal bridges. There is not necessarily a linear coherence between the investment in energy saving and cost saving potential.



Overview of factors that influence the renovation cost.

Market description - Total economy

Calculation methods

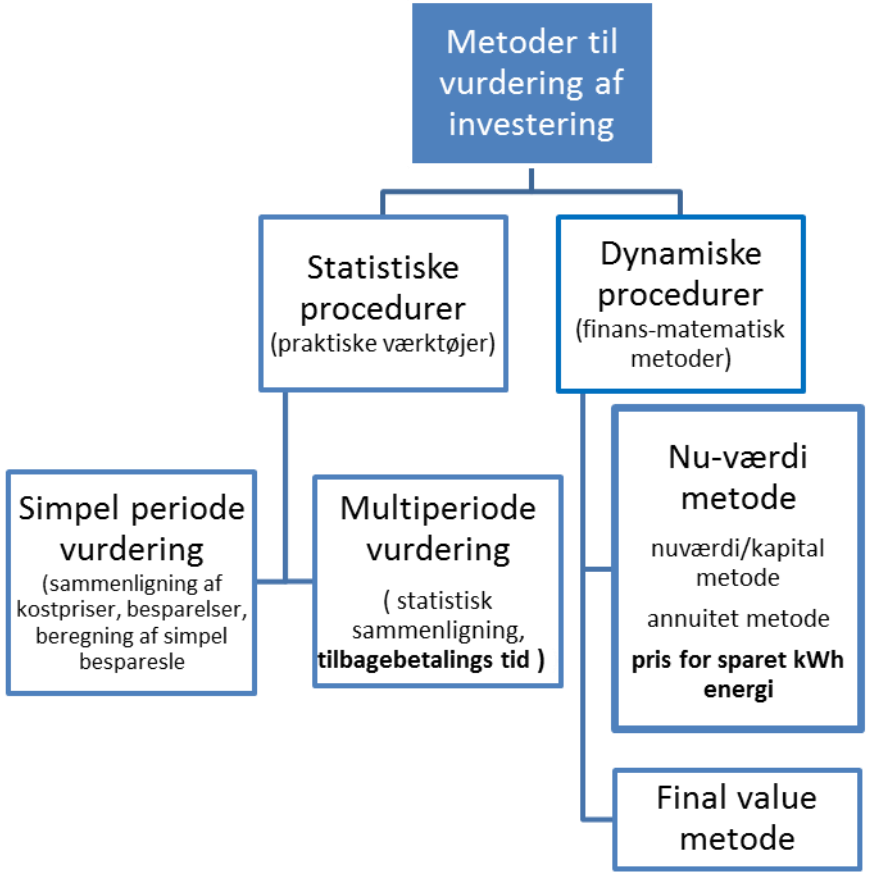
Total Economic calculation methods can be divided into 2 model considerations, one that uses statistical procedures, and a projection of an evolution based on set parameters. The former is suitable for short-term investments but is not applicable to the provision of long-term investments.

After registration and analysis, various saving measures for the building can be assessed individually together with the client and others in relation to the supply-related assumptions and other assumptions such as socio-infrastructural requirements for openness or ecological sustainability requirements or choice of material.

In addition, selected design measures, so the total will achieve a reasonable correlation between the operating and maintenance costs, investment and logistics of an energy renovation.

Finally, there may be a desire to obtain benefits in terms of improved indoor air quality, sustainable aspects and better function.

The economics can using a Present-value calculation method, calculated at an annual cost over the selected time frame for energy renovation - annuity method. This means taking into account the energy price increases, an acceptable return on investment and the result is comparable to the building / -ernes ongoing operating expenses.



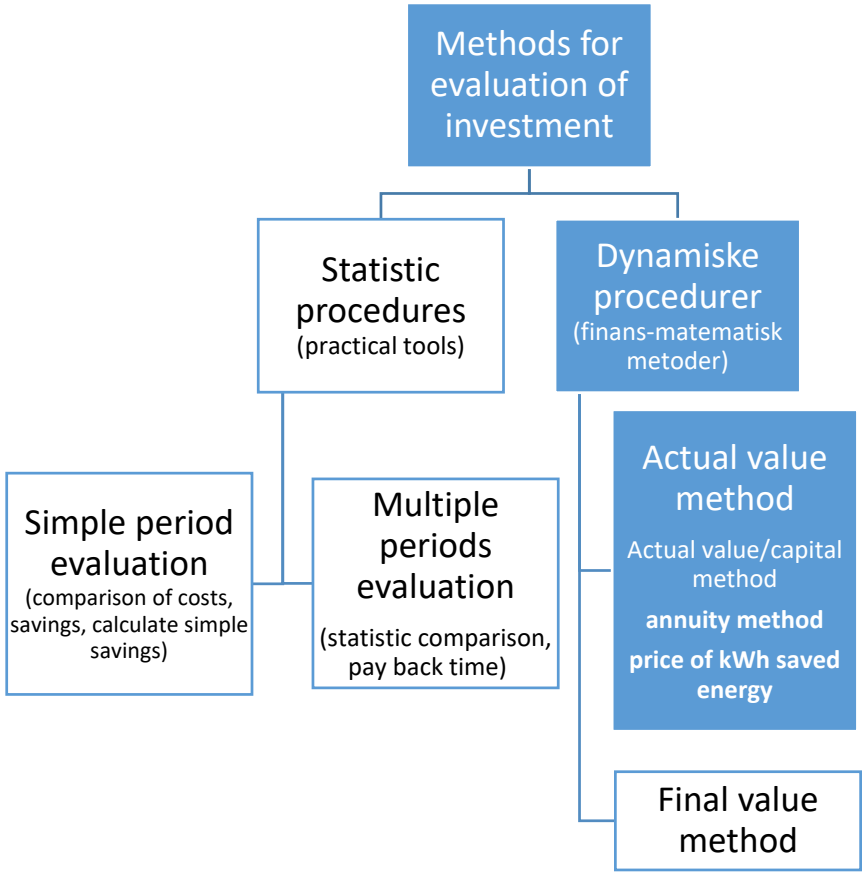
The annuity method projects the energy savings from carefully assessed energy and environmental levy increases on the basis of statistical data from the Danish Energy Agency and the Treasury, financing conditions and general increase in prices (inflation).

Market description - Total economy

Cost of conserved energy - CCE method

In order to assess the actual cost of the energy saving additional investment a calculation of "cost of kWh saved energy" as compared with the price of a purchased kWh is prepared. The calculation method offsets the investment that anyway prospectively should be made to the building envelope and include the residual value obtained by investing in the envelope with life beyond the funding period. Conventional simple calculation can not include this value increases than offset the maintenance investment going forward yet to be made.

Therefore, assessed the overall economy and the total payment time best with a reference scenario as a minimum include operating costs for maintenance and investment in building maintenance of components of life is shorter than the period of funding. It is typical maintenance of roof surfaces and replacement windows are included as investment in the existing scenario. Calculated an ongoing operating expense with standard% rates of the proposed investment in the building envelope and difference in intended operational maintenance expense are shown separately in the reference scenario.



CCE method, calculation of cost on saved energy.

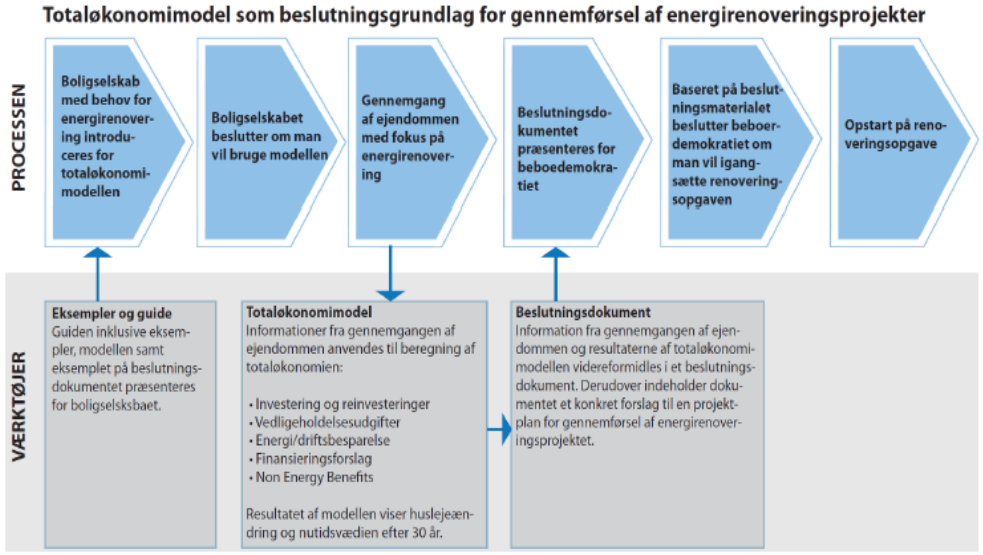
Market description - Total economy

Renovation of governmental buildings, public housing, etc..

Housing and Urban Affairs has published a guide for Total economic calculations in state construction. It is noted that there is a demand for overall financial calculations and assessments when a construction leads to a construction project. At the same time the emphasis is on "method freedom". The guide describes a exel based spreadsheet that includes construction costs broken down into the following main points:

- Establishment of construction index calculation period (life) land (land area and gross area) - assumptions.
- Calculation of construction costs including the cost of advice etc..
- Calculation of maintenance costs including the cost of ongoing maintenance and alignment.
- Calculation of the annual joint operating expenses including expenses to supply (heating, water, lighting, refuse collection and drains, etc.) as well as the cost of cleaning (exterior and interior street cleaning and cleaning).
- Estimated annual costs of management, including taxes and taxes.

City and housing ministry has put a calculation model on the website http://mbbl.dk/model-totaloekonomi-ved-energirenoveringer-i-almene-boliger, and a guide. Calculation Tool is intended as part of a decision-making process for the implementation of renovation projects.Building types



Total Economy as a tool for decision making in subsidized housing - example of the process from City & Housing Ministry.

(http://www.bygst.dk/media/22268/Totaloekonomiske-beregninger.pdf?AspxAutoDetectCookieSupport=1)

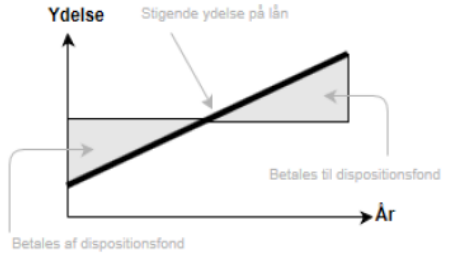
Market description - Total economy

An operating savings over 30 years leads due to the rising energy prices at increasing annual savings. The investment for achieving savings would during a typical investment would be shared out over the investment period. There arises in this way an increasing surplus in the latter part of the period and a smaller annual deficit in the first part of the period. To cover the deficit in the first part of the period, funds that are not burdened with investment costs can be used. It could be savings - typically set aside in a reserve fund for major maintenance actions. Operating savings in the latter part of the period realized through operational savings can then be inserted into the reserve fund. It establishes basic two scenarios - a baseline and a renovated scenario. The model calculates the total economic differences between the two scenarios.

Whether additional investment of operating savings pays depends on how the operational savings are composed. Operating savings which result in a better thermal indoor climate can also lead to a higher NEB (Non Energy Benefit) in the form of higher satisfaction and valuation of the property. The composition of operating savings - such as investments in higher energy efficiency of the energy and distribution system - can be influenced by subsequent or simultaneous investment of higher energy efficiency in the building envelope.

The interdependent operating investments are covered only in a separate energy frame calculation as the Total Economic calculation here is NOT connected directly to the energy efforts, it is only possible during the process to see each of the initiatives impact on the overall economy - if energy frame calculation and cost is built parralelt. Similarly, it is difficult to assess each of the initiatives total economic value - since individual actions may have additional effects that are not valued if, for example comparison is made between replacement of windows energy class C and A respectively.

It is interesting that the housing Boligkontoret in a debriefing about the use of the tool has conducted a survey among 72 potential tenants of whether an improved climate would affect their valuation of the property. 75% responded positively to it.



Example of the link between investment costs and operating savings. (http://mbbl.dk/sites/mbbl.dk/files/dokumenter/publikationer/rapport_-_totaloekonomivaerktoejet_i_praksis.pdf)

Market description - Total economy

Price for saved energy

The insulation depends on the thickness. Stated popular - the last cm isolate smaller than the first one. The thermal heat resistance becomes less per. unit length of the thicker material. The thermal conductivity of the material remains the same - so it's not a change of material property.

Less insulation capacity per. unit length in highly insulated structures to some extent offset by increasing energy - and the tax rates - but how much or when it pays to insulate?

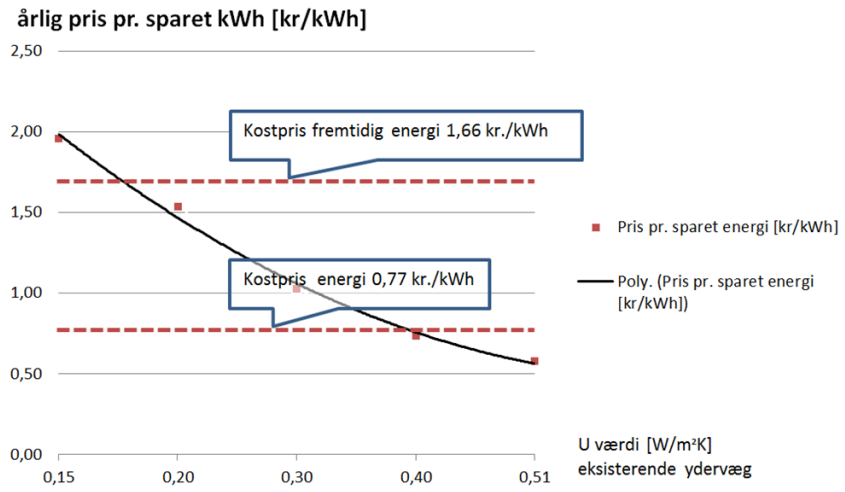
By calculating the cost price of energy - price per. kWh saved - this can be readily compared to what else paid for energy in current prices and expected future average energy price.

In an analysis of an existing exterior wall of brick cavity wall construction with different U values calculated "price per kWh saved" by renovation to a U-value of 0.12 W / m2K. The cost of energy is shown ex. VAT respectively of a kWh gas heat in 2013 prices and a future medium energy price of 1.71 kr / kWh by an expected energy and tax increase on an annual 5% with an inflation rate of 2-3%.

The calculation shows that the renovation of existing external walls with U-values down to 0.40 immediately is a bigger annual profit by saving energy than by adding "bought" energy since the cost of saved energy is less than the energy cost.

The calculation shows that the existing external walls with a U value down to 0.17 in the U value can be obtained a lower energy cost by saving energy. At an outer wall with a U value of 0.17 W / m2K after isolated to 0.12 W / m2K achieved the same price for the saved energy in kr / kWh as of estimated average cost of energy without VAT. When VAT is taken into calculation can insulations for U = 0.12 of external walls down to 0.15 W / m2K worthwhile.

The calculation includes the cost of the insulation. The cost of renovating the facade surface is considered in this analysis as a "anyway actions".



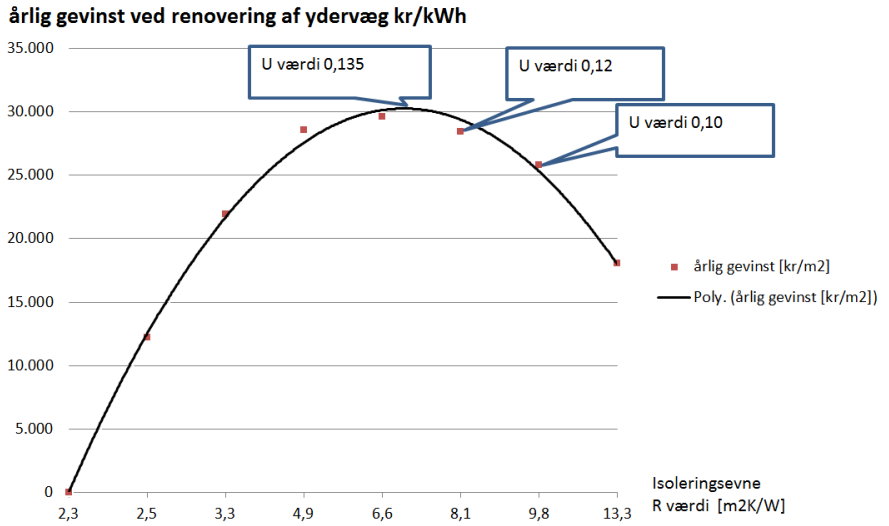
Annual cost per kWh saved energy by renovating the exterior walls down to the U-value of U = 0.12 W / m2K. The graph shows the economy by various existing external walls with different U values or insulating properties. The cost of the energy saved compared with the price of energy now and in the future.

Market description - Total economy

Economically optimum energy renovation

Based on correlations between high insulation, existing U values and energy cost annual benefits for the renovation of a cavity wall exterior wall with a U value of 0.51 W / m2K to compare the economy by choosing a higher insulation capacity and greater savings with a cheaper investment and lower U value are calculated .

In the analysis here a concrete case located in climate zone 3 (Denmark) annual gains of different insulation abilities. The curve describes an economic optimum with a U value for the renovated wall of D = 0.135 W / m2K. When renovating the proposed U value of 0.12 W / m2K achieved a slightly smaller annual gains. However, note that the additional energy or tax increases to a shift of the curve optimum to right indicating a choice of a slightly better U value between U = 0.135 and 0.10 W / m2K.



The calculation shows that the existing external walls with a U value down to 0.17 in annual profit for facade thermal rehabilitation. The graph shows the economy at different degrees of insulation capacity by renovating an existing brick cavity wall with a U value of 0.51 W / m2K.

Market description - Total economy

Economic optimum of isolation and operation saving renovation measures

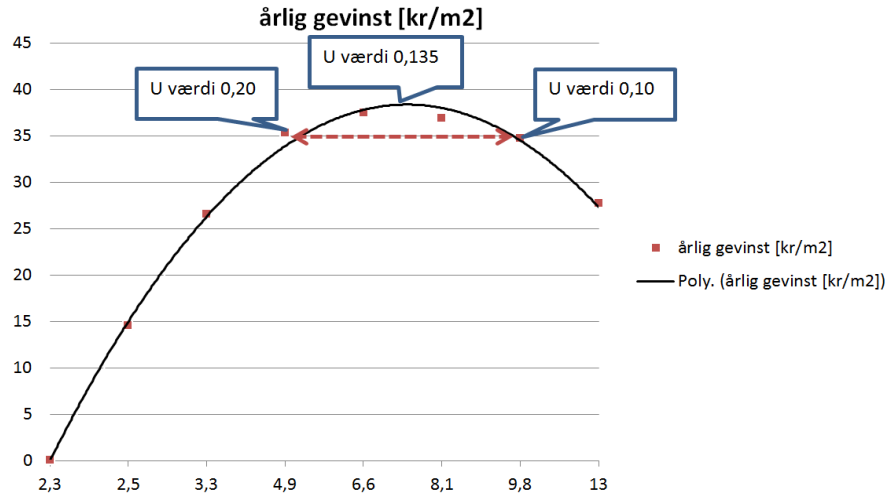
The economy of renovating a façade with external insulation for different energy classes is analyzed. Economy renovation of the facade cladding is an "anyway actions" and will be omitted. Only the additional investments that contribute to operational savings are included.

When calculating an average conservatively estimated lifetime of insulation included 40 years. A life expectancy of 40 years is the foundation for the investment depreciation. Parameters for investment costs of an NPV calculation which the amortization of the investment and energy savings are projected to a present value is:

- Investment capital real interest rate 3.5%
- Price increase in general - infaltion 3.0%
- Energy and tax increases yearly 5%

The calculation examines the annual profit – i.e. the annual energy savings incl. price increase of energy - less investment cost for the useful life period. The analysis is based on two scenarios between building heat loss by 2 different U values and through cost saving measures or energy efficiency levels.

By listing the insulation capacity R-value in m2K / m2 as x value and annual profit as the y value in diagram form, the economic optimum be at the apex of the bend. The apex of the example corresponds to an outer insulated cavity wall construction having an overall U-value of 0.135 W / m2K. The red squares are the concrete calculation results.



Annual profit per m2 facade insulated. The graph shows the economy at different degrees of insulation capacity by renovating an existing brick cavity wall with a U value of 0.51 W / m2K

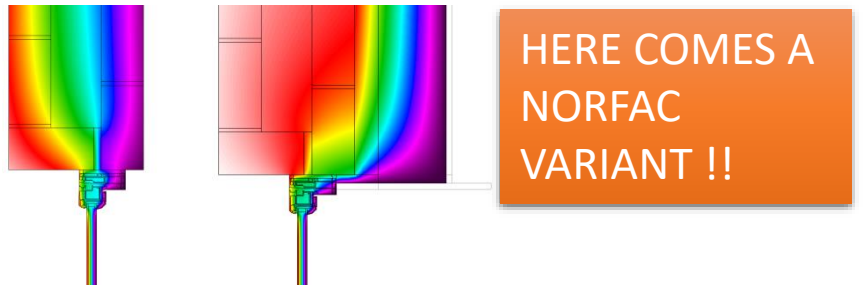
Market description - Total economy

It is seen that with a higher insulation capacity corresponding to a U-value of 0.10 a slight fall in annual profit, from 37 to 35 kr per year. m2 façade can be achieved. By selecting the highest insulating capacity within the displayed spread between U value of 0.20 W / m2K and 0.10 W / m2K, optimum annual gains is achieved and the action made more robust to unexpected further increases in energy.

The cost of after isolating a cavity wall exterior wall is here hedged for a time when the renovation of the facade happen "anyway" – i.e. where the life expectancy of the outer parts of the building element is expired. Average life of the building envelope is 40 years - weather exposed building about 50 years, not weather exposed parts typically longer.

The time of renovation can typically chosen when it is required anyway by total renovation of mold in housing - renovation of the facade and / or exchange it / maintenance of essential components integrated in the building element such as windows or light organic-based elements or environmentally hazardous building be dismantled and removed. However, the replacement of components such as windows and doors happen simultaneously so installation / assembly of windows is done in the new heat-insulated layer and recessed line losses thereby minimized.

Line loss at the installed equipment in or in connection with load-bearing portions of an outer wall may have large line losses. Typically, a line loss Placed near the existing window hole without cold bridge switching off 2-3 times larger than a window frame mounted in the insulating layer. airtightness and thermal bridges in a renovation element is also important parameters for overall to reach the finish with the desired reduced heat transmission loss.



Section in the outer wall structure with brick's cavity wall and frame mounting with thermal bridges indicated.

Market description–Special refurbishment programs

CEICAD program (Common Energy Investment program in the Capital Region of Denmark) is an EU-funded initiative that aims to promote energy efficiency in public buildings.

The program consists of two parts:

• energy-efficiency investments in municipal and regional buildings, for example hospitals, schools, institutions and administrative buildings. This can, for example deal with more insulation, upgrading ventilation or heating systems, replacement of windows and doors and other renovations, resulting in a lowered energy consumption.

• Supply of buildings with renewable energy. Here are a primary focus on the production of electricity by setting up solar panels and heat by deploying solar heating systems.

It is a very varied building mass covered by the project. It offers many different types of energy investments performed. A hospital, for example have other demands on indoor climate than a kindergarten or an administrative building. Therefore, investments in the CEICAD project include a wide range of solutions for both renovation and renewable energy.

Partners in the project

The Capital Region is a partner in the project along with 10 municipalities. The 10 municipalities are: Albertslund, Fredensborg Municipality, Frederikssund Municipality, the Municipality of Gentofte, Gladsaxe, Hørsholm, Ishoej Municipality of Copenhagen, Lyngby-Taarbæk and Rudersdal.

The region's effort is aimed primarily at two hospitals, Bornholm Hospital and Glostrup Hospital.

You can read more about the organization and the partners at the homepage of Region Hovedstaden

Schedule and Budget

The program runs in a 3-year period from 1 December 2013 to 30 November 2016. The total budget for all partners is approximately 460 million. kr. The partners are involved in the project with different investment objectives and are responsible for the financing. The financing typically are as loans that are repaid by the saved energy costs.

For the technical preparation of CEICAD program the Capital Region has received assistance from the EU Commission. The assistance comes from the ELENA system, which provides support to local and regional authorities to prepare investments in energy conservation and renewable energy. ELENA stands for European Local Energy Assistance.

Market description–Special refurbishment programs

Organisation and partners in CEICAD

CEICAD project has an internal organization, ensuring that the project is proceeding as planned and that the required knowledge is secured through project groups and AD HOC groups.

The organization in CEICAD is as shown.

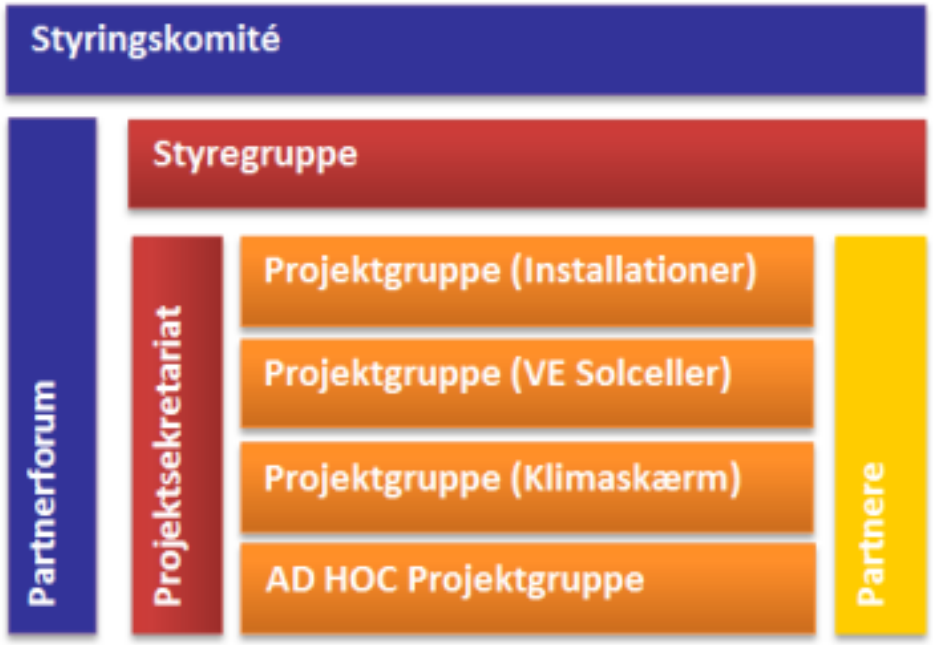
The steering committee has the following. Tasks: Organizing, using ELENA funds within the established framework, approval of monthly reports, setting the interim report and final report to the Steering Committee as well as evaluating the major and fundamental questions.

Partner Forum is an advisory body with one representative from each municipality and region. Partner Forum advises the steering committee of the larger and more fundamental questions. Additionally, discuss and coordinate the professional issues across project teams.

The project secretariat assists project teams Partner Forum, Steering Committee and the Steering Committee, provider and contracts consultancy, provides common communication (press releases, website, etc.), provide meetings, conferences and workshops, handles finance and accounting, reporting to the EIB and provides project management. We recruited a project manager for these tasks. In addition, there hired two consultants who partly provides technical assistance to municipalities and the region and assists the project manager's tasks.

The project groups made up of local and regional building and energy workers. The three groups will supervise and coordinate the work in their fields, in collaboration with the Project Secretariat.

Partners are the 11 municipalities and the Capital Region as represented by Bornholm Hospital and Glostrup Hospital.



Market description–Special refurbishment programs

ELENA (European Local Energy Assistance) is a European facility that helps local authorities to prepare the areas of energy renovation and renewable energy.

The support is given as part of the IEE II program (Intelligent Energy Europe).

ELENA supports a wide range of programs across Europe. In the list below you can see the types of projects eligible under the program:

- Energy renovation of public or private buildings, including street lightning
- Implementation of renewable energy in existing urban environments.
- Dissemination of district heating / cooling
- Optimization of private and public transport in urban areas, for example. dissemination of hybrid buses, electric cars or optimized logistics for freight transport in cities.
- Local infrastructure, for example. smart grids and IT and communication networks that can promote energy conservation.

Common to all projects is that they must result in energy savings or production in the form of renewable energy.

In most cases it is necessary to gather many smaller projects to a larger program, which receives support from ELENA. The same is true of CEICAD, which brings together hundreds of projects in building renovation and renewable energy. A program covered by ELENA must have a total investment of some 30 million. EUR.

Market description–Special refurbishment programs

REEEZ program (Renewable Energy and Energy Efficiency in Zealand) aims to increase energy efficiency and use of renewable energy in public buildings in the region.

The program consists of two parts:

- energy-efficiency investments in municipal and regional buildings, such as hospitals, schools, institutions and administrative buildings.
- Supply of buildings with renewable energy.

Insulation and solar cells

The concrete projects in Region Zealand all about insulation of walls, decks and roofs, replacement windows and doors, optimization of technical installations and replacement of inefficient installations.

In addition, there will be projects with renewable energy in public buildings - especially in the form of solar cells. There will also initiated projects for improvement of cooling systems and equipment in hospitals.

Cooperation with municipalities

Region Zealand collaborate with 12 municipalities on the program. The 12 municipalities are: Faxing, Greve, Falster, Holbaek, Køge, Herlev, Odsherred, Ringsted, Roskilde, Slagelse, Solrod and Oakville.

Schedule and Budget

The program runs from 1 March 2012 to 28 February 2015. The total budget is 465 million. kr. Most of the budget will be financed by loans that will be paid back through saved energy costs.

For the technical preparation of REEEZ program has Zealand received EU Kommunsionen. The assistance comes from the ELENA system, which provides support to local and regional authorities to prepare investments in energy conservation and renewable energy. ELENA stands for European Local Energy Assistance.

Market description–Special refurbishment programs

REEEZ program

Objectives and activities

The total investment program of 465 million kroner consist of investments in renewable energy and improving energy efficiency in the region and municipal buildings

The objectives of REEEZ is through energy investments of 465 million, to achieve the following

- Energy efficiency - Annual total saving 43,500 MWh
- Renewable Energy - Annual energy production 5,200 MWh
- CO2 reductions - Annual reduction of 15,500 tonnes of CO2

The investment program consists of large investments in improving energy efficiency in the region and municipal buildings (ie hospitals, schools, institutions, etc.) And an increased use of renewable energy at these sites.

In addition to providing technical assistance will REEEZ program help explore the possibilities for synergies as joint procurement and joint purchasing and assembling projects in greater supply. The technical assistance will thereby providing valuable experience in procurement across municipal borders and allows the municipalities and the region to work systematically and shared with major energy projects.

Larger projects and areas of focus include:

RES electricity production

The region and the municipalities wishing to set up solar panels on public buildings. REEEZ program enables them to establish the technical, architectural and economic criteria for selecting buildings to solar power plants. Besides helping REEEZ to assess effects on energy production and to develop requirements specifications and tender paradigm for the use of the participating parties. Through REEEZ program will invest at least 78 million in solar cells, which will result in an annual power generation of 3,200 MWh and annual CO2 reduction of approximately 1,500 tons.

VE heat production

The municipalities and the region will include use of technical assistance from REEEZ program to investigate possibilities for the establishment of other renewable sources, such as geothermal and solar heating. REEEZ program will enable municipalities to establish criteria for the selection of buildings and techniques.

There will be invested approximately 12 million. kr. in renewable heat generation, which will result in an annual energy production of around 2,000 MWh and an annual reduction of almost 700 tonnes of CO2.

Market description–Special refurbishment programs

REEEZ program continued

The insulation of the building envelope

With technical assistance from REEEZ the municipalities and regions will review and make quality assurance of energy labels, perform technical studies of buildings and on that basis develop effective insulation and window projects. This makes the walls, roofs, floors and pipes more insulated, and windows and doors replaced. In addition, technical assistance will be used to identify potential opportunities for joint procurement of client deliverables.

The total investment in the energy efficiency of building envelopes is 214 million, which will result in annual energy savings of approximately 23,000 MWh and annual CO2 reduction of 6,000 tons.

Adjustment and replacement of inefficient installations

Through REEEZ will lighting, ventilation and heating control systems be adjusted or replaced. Technical assistance is needed to identify possible opportunities to bring together supply and to explore new solutions to market.

The total investment for the installations will be approximately 142 million, which will result in annual energy savings of 19,500 MWh and an annual reduction of approximately 6,700 tonnes of CO2.

Hospital Equipment

The region is responsible for public hospital facilities in all municipalities in the region, a total of 23 hospitals and health centers. REEEZ allows hospitals in the region to focus on the development of large supply that combines several areas for energy efficiency. This can include combinations of solar cells and possibly solar heating and energy efficiency in the associated buildings. The results of these projects are included in the focus areas listed above.

REEEZ will also make it possible for the region to focus on hospital equipment. This may include cooling and utilization of excess energy from energy-intensive hospital equipment or otherwise reduce the energy consumption of existing equipment (replacement of medical equipment will not be part of the project).

The total investment to reduce energy consumption in existing hospital equipment is approximately 19 million This results in an annual energy savings of over 1,000 MWh and annual CO2 reduction of 600 tons.

Market description–Special refurbishment programs

REEEZ organization

REEEZ organization is structured as shown. The daily work with the planning and execution of projects in energy efficiency and renewable energy will take place in the support function and the three project groups.

The project groups made up of local and regional building and energy workers. The three groups will supervise and coordinate the work in their fields, in collaboration with The support function.

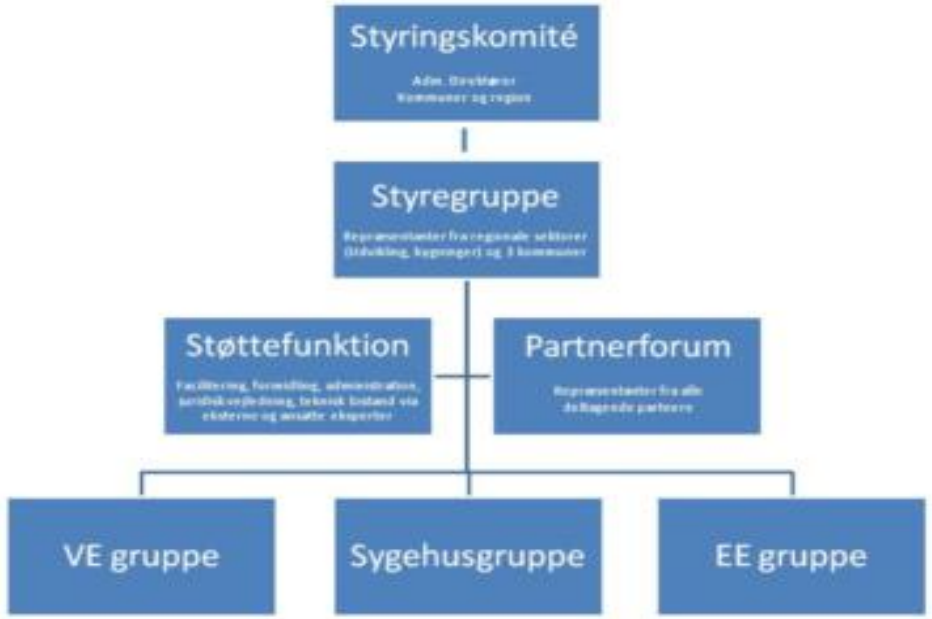
The support function assists project teams Partner Forum, Steering Committee and the Steering Committee, provider and contracts consultancy, provides common communication (press releases, website, etc.), provide for meetings, conferences and workshops, handles finance and accounting, reporting to the EIB and provides project management. There is employed a program manager for these tasks.

In addition, there is hired two program officers, which partly provides technical assistance to municipalities and the region and assists the Programme Manager with his duties.

Partner Forum is an advisory body with one representative from each municipality and region. Partner Forum advises the steering committee of the larger and more fundamental questions. In addition, it discusses and coordinates the academic issues across project teams.

The steering committee (Jan Vestergaard (Chairman) and Kurt Reitz from Region Zealand, Morten Hall Green from Næstved, Lauge Brandt from Roskilde and Christian Refstrup from Guldborgsund) has the following tasks: Organizing, using ELENA funds within the established framework, setting the preliminary and final report to the Steering Committee as well as evaluating the major and fundamental questions.

The Steering Committee (city manager and the region's CEO. Director) approves the interim report and final report. In addition, the steering committee is involved in matters of principle.



State of the art

Multifuncional façade systems

Prefabrications of Façade Systems were used for large scale buildings, for example large multi family buildings in the 1970´s or prefabricated plate buildings in Eastern Europe. Today, larger buildings are sometimes already constructed with a frame structure which is closed by prefabricated façade panels, in modular dimensions. The disadvantage of these panels is their focus on only some of the building physics functionalities (e.g. lighting, sometimes shading, thermal insulation, acoustics, fire protection, and moisture handling).

Multifunctional Façade Systems are designed to be used in modular construction methods with the highest possible level of prefabrication. The main application is for new development of large-scale residential and office buildings and for a fast thermal refurbishment of the existing building stock (especially buildings from the 1950´s-1970´s).

They fulfil high thermal requirements and make use of the advantages of prefabrication, such as avoiding thermal bridges and reducing on site construction time. High air tightness targets are achieved easily compared to "on site" construction. Windows, ducting, cabling etc. can also be integrated and thereby prevent thermal bridges or air leaks. Furthermore, large-scale innovative renewable energy sources can be integrated (e.g. solar thermal, photovoltaics, Hybrid-technologies etc). Another focus lies in considering different technical solutions and integration of new "smart-materials".

The challenge is to have flexibility in manufacturing the facade elements, in order to adapt them to the types of facades and needs. Cost optimization and return on investment time frames of the redevelopment costs will be future challenges for multifunctional facade systems, including inter- and transdisciplinary planning from the project start, as well as accompanying socio-economic studies.

The topic on multifunctional façade systems is divided into five categories, to give a general overview of the numerous systems that are available on the market. Main differences lie in integration of materials, renewable energy or solar energy concepts. One or two systems are described for each category and further information is given at the end of each category.

State of the art- System categories

Wood façade systems

These Multifunctional façade Systems focus on renewable building materials (NAWARO, e.g.: wood construction) and dismantling and recycling compatible construction systems.

TES EnergyFacade

TES EnergyFacade is a prefabricated building system of large scale timber frame elements that introduces the benefits of modern timber construction to the modernisation process of the existing building stock.

- a precise prefabrication technique off site
- a fast mounting process on site reducing the disturbance of the inhabitants through noise and dirt
- integration of other building elements, such as windows, balconies, solar active components or plumbing and electricity
- the ecological performance of timber and other biogenic building materials

www.tesenergyfacade.com/index.php

Pilotproject Norway Risor Technical College (Project Team TES Energy façade and Arikektstudio AS, Fabricator Trebyggeriet AS)

enVELOP façade system

In the framework of the competence center "alpS –Center for climate change adaptation technologies" five industrial partners (Weissenseer Holz-System Bau GmbH, GAP solution GmbH, Deutsch Metallwerke GmbH, ATB Becker, Isocell GmbH) and two research institutes (Technical University Graz, University for Natural Resources and Life Sciences Vienna) have developed this façade system for thermal renovation of residential buildings from the 1950s to the 1970s achieving passive house or near passive house energy standard.

The system includes prefabricated wood elements with ecological insulation materials and innovative energy components (integration of renewable energy and GAP 4 solution panels). A modular system with integrated ventilation components offers flexibility for different requirements. o Through standardized prefabrication high quality and thermal improvement of the building shell (façade, building and roof extension) can be achieved. Simultaneously reducing on site construction time and disturbance for the inhabitants. o Integral overall planning packages: inter-and transdisciplinary planning from the project start.

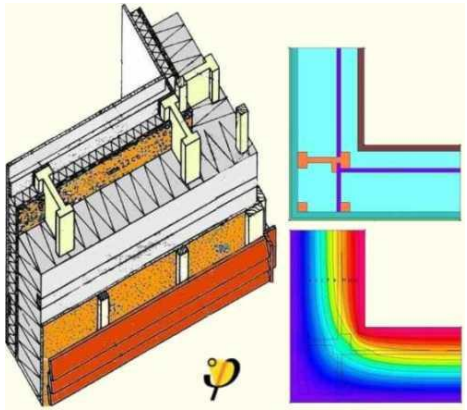
www.alps-comet.com/

State of the art – System categories

PHI-Wood façade systems Naumann & Stahr

Architects Naumann & Stahr developed a wood facade system for new buildings and renovation certified by the *Passive House Institute* in Darmstadt, Germany. The basic design of the building system is a wood frame structure. Every 1.283 m an I-wood beam is located with OSB (Oriented Strand Board) panels in between to the inside of the inner belt. The outer casing is made of thermo-wall plaster tiles that are nailed to the beams. Neither the outer nor the inner shell have load bearing functions allowing alternatives like ventilated timber formwork, wood cement board with paint or a mixture of various facade systems.

The wall panels are manufactured basement high and an overall building height of five floors is possible. (www.naumannstahr.info/)



Basic concept of the Wood Façade System

Solar-active façade systems

In this category solar radiation is used and stored in passive energy concepts.

GAP solution façade system

A stable honeycomb structure made of natural materials is the innovative component in this façade system. The rays of the winter sun penetrate deep into the honeycomb and increase their temperature. This autonomous zone reduces heat loss to almost zero and reduces thermal bridges. During summer much of the radiation is reflected due to the comb structure itself. Depending on the orientation the improvement of the U-value of the exterior wall is up to 90% or more. (www.gap-solution.at/)

Similar systems using different materials are:

Lucido Solar: www.lucido-solar.com/ger_der.htm

Thermocollect: www.thermocollect.at/

Construction layers: existing wall – insulation – wood frame element - GAP Solar Paneel

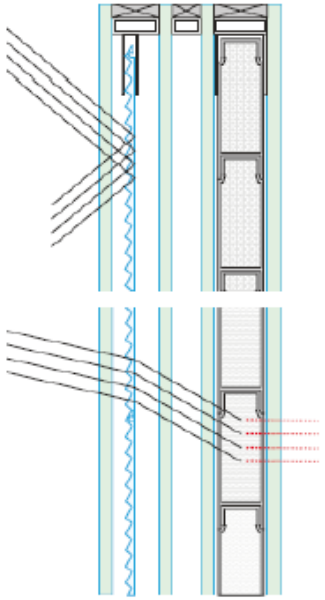
State of the art – System categories

GlassXcrystal Phase Change Materials (PCM)

A layer of salt crystals stores the heat irradiated by the sun, and releases this as required to the interior space. A prismatic glass that is also incorporated allows the solar radiation to pass through only when the angle of radiation is low (i.e. in winter), and in summer protects the space from overheating. In this manner a building element is created that utilizes and stores the power of the sun and at the same time provides protection from it.

(www.glassx.ch/index.php?id=332)

concept: above summer, below winter



Energy façade systems

Optimised building equipment (heating, cooling and ventilation) and/or renewable energy are integrated in these façade panels, which are mainly used for new development and office buildings.

i-modul façade

The i-module Façade is a cladding system with integrated building services for heating, cooling, ventilation and heat recovery as well as lighting and sound insulation within unitised cladding panels which measure a mere 20 cm in depth.

State of the art – System categories

Photovoltaic (PV) integration

PV-integration avoids additional sealing of natural green areas. An improvement of the eco-efficiency and value increase of modern sustainable buildings is achieved.

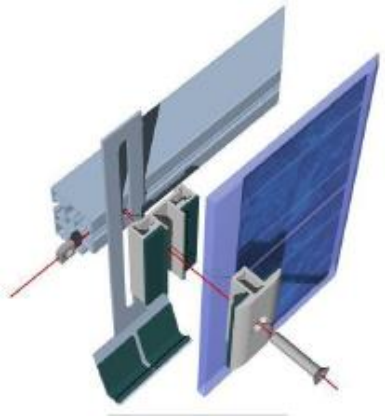
For the integration of PV in facades, new fixing systems were developed (for example in the framework of the EU-funded project: "PV-Enlargement"). They comply with load bearing requirements and at the same time fulfil high aesthetic design expectations.

(www.pvenlargement.com/)

Further Multifunctional Façade System with PV Integration is:

Schüco Window and Façade module ProSol TF:

www.schueco.com/



Hybrid façade systems

In hybrid façade system new „smart-material", such as nano-, aerogel and vacuum insulated panels, are integrated. Most of these materials are still very young technologies and further development and research is necessary. Most promising development can be found for Vacuum Insulated Panels.

Integration of Vacuum Insulated Panel (VIP)

Insulating effect of VIP is 5 - 10 times better compared to conventional insulation systems. VIP is still a very young technology and less suitable for processing at construction site, as they can easily be damaged. Accordingly this material is suitable for prefabricated building elements or sandwich elements. Individual demonstration projects have been realized, however, further experience is necessary focusing on the following aspects: thermal bridges, moisture problems, fire resistance, risk of damage by building users, durability of the vacuum (currently 30 years), maintenance or replacement of single panels. (www.hangleiter.de/)

Precast Concrete with VIP, demonstration project in Ravensburg, Germany (Design: weinbrenner. single. Architekten Werkgemeinschaft Nürtingen/ Façade elements: Albert Hangleitner GmbH)

State of the art – System categories

Green façade systems

The large potential of building facades in the cities on the one hand and the need to find solutions for overheating, water balance, fine dust, biodiversity etc. is a main driver to develop new products for vertical greening systems. For architects and builders many different forms of vertical greening products are available. Combining these products for vertical greening with standard refurbishment is possible and different sizes are available. Current challenges are the high costs (material, mounting systems, and irrigation), high maintenance and the necessary fertilization.

Advantages of green façade systems are:

- Improvement of the microclimate (reducing temperature, increasing air humidity)
- Prevention of overheating
- Noise reduction
- CO2-storage
- Biodiversity
- Dust filtration

Below some available products in Europe are listed:

Flexipanel / Sempergreen:

www.sempergreenvertical.com/?gclid=CIjlxNbJh6UCFcEj3wodMxeDfw

Techmetall / Green wall: www.gruenwand.at

90degreen: www.90degreen.com/

Elata – Helix Systeme: www.helix-pflanzensysteme.de/de/content/system-elata-117/

Vegetalis / Greenwall: www.greenwall.fr/

Optigrün Facade System: www.optigruen.de/Presse/MesseBauMuenchen2011.html

LEFT: Flexipanel / Sempergreen; MIDDLE: Techmetall / Green wall system; RIGHT: 90degreen

State of the art – System categories

Refurbishment façade system

Existing big-volume buildings are renovated with a prefabricated façade system from outside including cladding, windows, insulation, decentralized ventilation, solar shading, wiring and energy producing elements like PV.

Function	• An external load-bearing structure is fitted with fixing brackets from ceiling to ceiling over a specified distance onto the grid of the building structure. In this way non-load-bearing spandrel areas can be bridged.
How does it work?	• The new façade is mounted outside including all functional elements required. Inside the old windows are removed afterwards. The method puts the client in a position to keep the building in operation throughout the renovation work
Applicability	• In all parts of Europe • Great potential concerning energy efficiency (up to 0,24 m insulation thickness) and architectural design (colours, dimensions,…) • Short construction work because of prefabricated components
Potential environmental benefits	• At the end of the building's use, everything could be separated and materials recycled • Energy demand is lowered to a minimum • Users' benefits because renovation works are short – less disturbance
Potential influence on cost	• Price is difficultly comparable to other systems, where single measures are set up onto the wall • Certified system and warranty incl. product quality with predictable costs
Expertise required	• For the production special expertise concerning the prefabricated elements is necessary • Experience in cladding and operating the building services system is needed.
Availability	• All over Europe, at least Austria, Germany

State of the art – System categories

Brand names	• "Schüco Façade System ERC 50
Existing use of solution	• DGB building, Düsseldorf, Germany • Gymnasium am Römerkastell, Bad Kreuznach, Germany • Heilbronn University, Heilbronn, Germany • Südharz Hospital, Nordhausen, Germany
User satisfaction	• No information until now
Procurement considerations	• System and all components are available on the market. New decentral ventilation solutions for school buildings within the same system will soon be available.

State of the art – System categories

Pre-fabricated active and passive façade modules

Pre-fabricated active and passive facade modules with technical building service systems and solar panels for retrofitting of large buildings.

Function	• Renovation of buildings with pre-fabricated façade modules combining insulation and technical building services (HVAC) in one standardized façade element.
How does it work?	• Renovation of buildings with pre-fabricated façade modules combining insulation and technical building services (HVAC) in one standardized façade element.
Applicability	• Mainly for large housing blocks, but also applicable for other building types (office and school buildings, etc.) • In all parts of Europe
Potential environmental benefits	• Wooden light weight construction enables ambitious energetic renovation targets (passive and plus energy standard). Against conventional thermal insulation composite systems (e.g. polystyrene) this system shows better ecological performance values (embodied energy, GWP, recyclability).
Potential influence on cost	• Large-scale production of pre-fabricated façade modules offers high cost saving potentials for renovation projects. Integration of HVAC-systems and active solar panels as well as renovation work to be done without • evacuation of tenants has also impacts on the decrease of costs.
Expertise required	• In general no specialist skills for construction are required. Renovation work can be done by normal timber construction firms, whereby special attention for the integration of different crafts (technical building services and timber construction) is required.
Availability	• Available in Austria

State of the art – System categories

Brand names	• Kulmer Holz-Leimbau GesmbH , Hart 65, A-8212, Pischelsdorf, Austria
Existing use of solution	• Housing project Johann-Böhm-Straße, A-8605 Kapfenberg, Austria • Housing project Dieselweg, A-8041 Graz, Austria
User satisfaction	• No information
Procurement considerations	• Technologically prescriptive specifications required, integration of technical • specifications from different crafts (technical building services and timber • construction)

State of the art – System categories

Reflective insulation

Reflective insulation consists of aluminum foil and polyethylene plastic.

Reflective insulation works by reflecting heat radiation directly to the aluminum surface in contrast to the traditional insulation as mineral wool and glass wool which act by delaying the heat flow through trapped air pockets in the material. 10 mm reflective insulation thus provides the same insulation as 200 mm traditional insulation. With less thickness the weight of insulation material will be considerable reduced.

The materials contains no organic components and will not rot or absorb water. This means that there can be no mold or other allergens. The material is therefore very allergy friendly. The film is non-combustible and the intermediate layer are made of flame retardant polyethylene. It can be used like other materials, rock wool or glass wool, in BD and BS Engineering. Reflective insulation is also a 100% dense vapor bulb and radon barrier.

The aluminum foil reflects electromagnetic radiation and windowless room will be shielded for mobile and wireless networks.

The material remains intact throughout its lifetime

The material can be recycled and reused without damaging waste.

www.aluthermo.dk

www.adflexion.dk

State of the art – www.passiv.de database

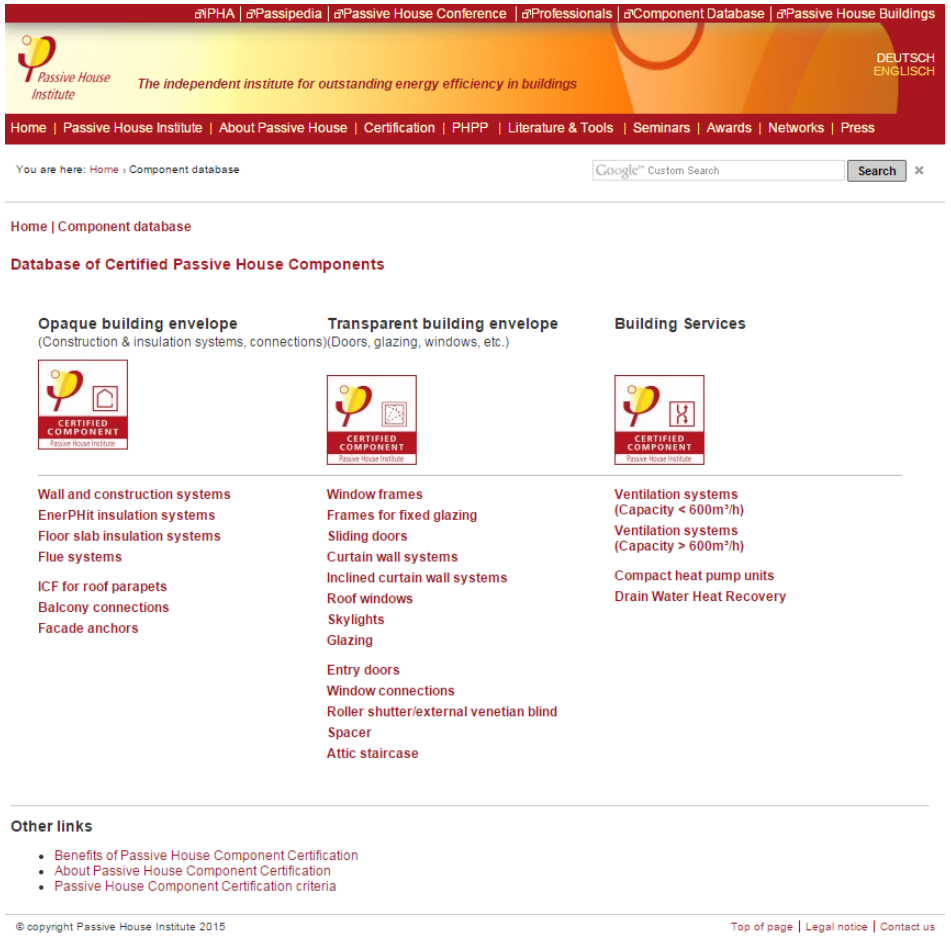
www.passiv.de

The German homepage from the Passive House Institute is worth having a look at for inspiration.

The Passive House Institute (PHI) is an independent research institute with a continuously growing interdisciplinary team of employees. PHI has played an especially crucial role in the development of the Passive House concept. The first pilot project Kranichstein Passive House, Darmstadt, Germany, 1990) was Europe's first inhabited multi-family house to achieve a documented heating energy consumption of below 12 kWh/(m²a), a consumption level confirmed through years of detailed monitoring.

Since then, the Passive House Institute has assumed a leading position with regard to research on and development of construction concepts, building components, planning tools and quality assurance for especially energy efficient buildings. PHI has been responsible for the building physics related consultancy and technical guidance on a number of firsts including the first Passive House office building, the first Passive House factory, the first Passive House schools and gymnasiums, the first Passive House indoor pool halls and the first Passive House retrofits. The Institute is currently providing such expertise for numerous new, innovative projects

The Passive House Institute is constantly developing and improving upon algorithms and software tools for dynamic building simulations, the determination of energy balances and the planning of Passive House buildings (for example, through the Passive House Planning Package). The Institute acts as an independent testing and certification centre for buildings and building components such as wall and construction systems, windows, doors, connections, ventilation systems and compact systems.



State of the art – www.passiv.de database

www.passiv.de

The Passive House Institute makes its knowledge available to everyone. Its research, its certification and training programmes, as well as the distribution of its planning tools such as the Passive House Planning Package (PHPP) and designPH can thus not be claimed as a monopoly by any single local entity. The Passive House Institute does not enter into exclusive contracts. It is happy to co-operate with suitable partners at any time, provided all necessary conditions and requirements are met. You are welcome to contact the Passive House Institute directly with any questions regarding partnerships, the certification of professionals, buildings, or building components, as well as all relevant consultancy services.

The figure on the page before shows the overview of the component database. From this it can be seen that the database contains all kind of building elements divided in opaque and transparent parts and in service components e.g. ventilation systems. The picture at the right shows a part of the various products / suppliers within the category of wall and construction systems.

On the following slide there is an example of products /suppliers within the category of window frames. For each product there is a certificate with various details on the specific product. An example is shown on the next slide.

Home | Component database | Wall and construction systems

Search in db category: go

Advanced Search

Product name	Cert.	Manufacturer	Head office	Type of construction	Description
		all	all	all	
A-Hus PASSIVE HOUSE SYSTEM	DE EN	A-hus AB	Sweden	lightweight construction	Holzriegelkonstruktion mit hinterlüfteter Fassade
PAMAflex Passivhaus-Detailset	DE EN	Alpha-Beton GmbH	Belgium	Massivbau in Fertigbauweise	Hochisolierte maßgefertigte Betonfertigteile für Wand und Dach
Beattie Passiv Holzbausystem	DE EN	Beattie Passive Build System Limited	UNITED KINGDOM	lightweight construction	Holzständerbauweise mit Wärmedämmverbundsystem
PassivHaus WDV-System	DE EN	Brillux GmbH & Co. KG	Germany	solid construction	Wärmedämverbundsystem auf Mauerwerk
DANWOOD PASSIVHAUS-BAUSYSTEM	DE EN	Budimex Danwood Sp. z o.o. Niederlassung Berlin	Germany	lightweight construction	Holzständerbauweise mit Wärmedämmverbundsystem
Capatect-WDVS für Passivhaus-Bauweise	DE EN	Caparol	Germany	solid construction	Wärmedämverbundsystem auf Mauerwerk
Cygnum Passive 350	DE EN	Cygnum Timber Frame Ltd.	Ireland	Holzleichtbau	Holzleichtbau mit Stegträgern auf Fundamentierung
ALLIGATOR Passivhaus WDVS	DE EN	DAW SE. Gb: ALLIGATOR FARBWERKE	Germany	solid construction	Wärmedämverbundsystem auf Mauerwerk
alsecco Passivhaussystem	DE EN	DAW SE. Geschäftsbereich alsecco	Germany	solid construction	Wärmedämverbundsystem auf Mauerwerk
Egernsund Tegl - Passivhus System +C		Egernsund Tegl amba	Denmark	solid construction	Massives Mauerwerk mit Sichtmauerwerksschale
FINGERHAUS PASSIVHAUS-BAUSYSTEM	DE EN	FingerHaus GmbH	Germany	lightweight construction	Holzständerbauweise mit Wärmedämmverbundsystem
GISOPLAN-THERM 375/225	DE EN	GISOTON Wandsysteme Baustoffwerke Gebhart und Söhne GmbH & Co. KG	Germany	solid construction	Schalungselement aus Blähton
Unipor W07 CORISO	DE EN	Hörl & Hartmann Ziegeltechnik GmbH & Co. KG	Germany	solid construction	Monolithischer Wandaufbau mit hochwärmegedämmtem Ziegelstein
HOTBLOK Bausystem für Passivhäuser	DE EN	HOTBLOK S.A.	Poland	solid construction	Wärmedämmende Ziegel aus Blähton
Isorast-Schalungssystem	DE EN	isorast GmbH	Germany	solid construction	Betonschalungselement
WDV-System mit Kooltherm K5 022	DE EN	Kingspan Insulation B.V.	Netherlands	solid construction	Wärmedämmverbundsystem (aus Phenolharzschaum) auf Mauerwerk
Kingspan TEK Bausystem	DE EN	Kingspan Insulation Ltd	United Kingdom	lightweight construction	Selbstragendes gedämmtes Paneel mit WDVS

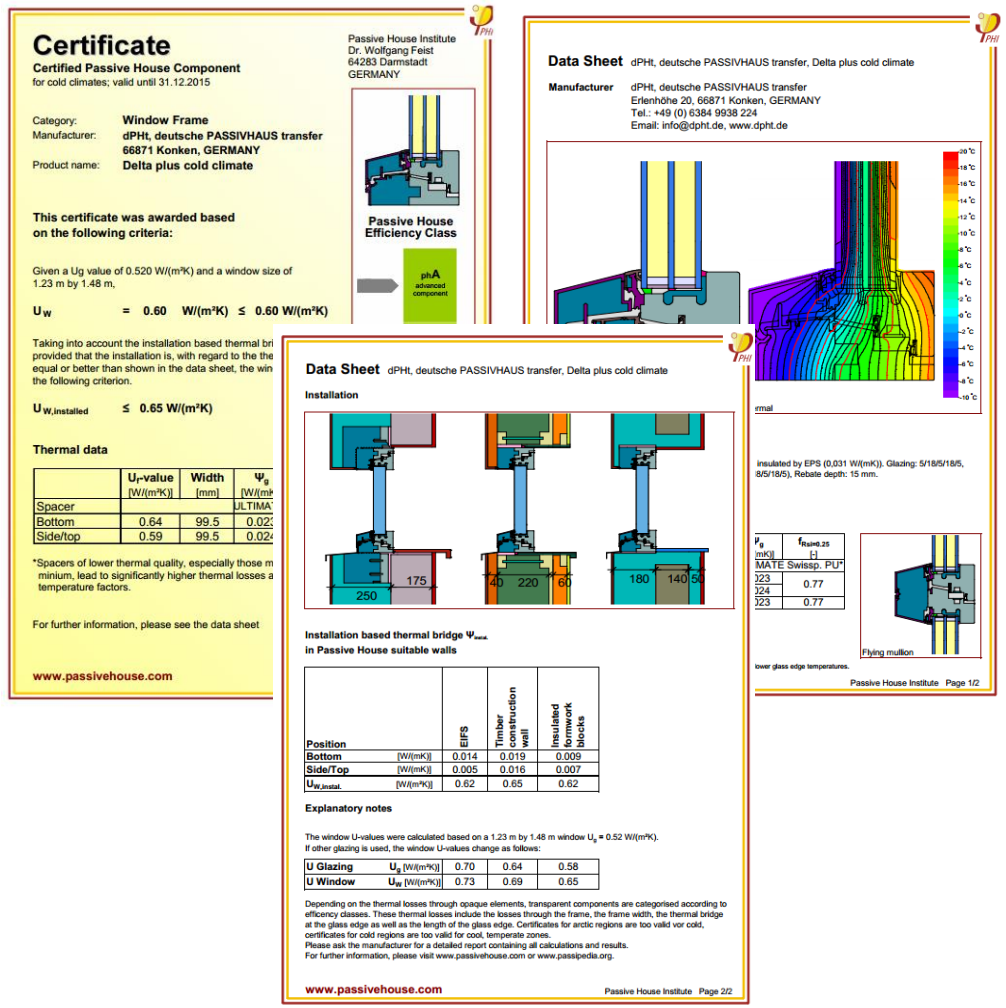
State of the art – www.passiv.de database

Home | Component database | Window frames

Search in db category: go

Advanced Search (i.e. filter by country)

Product name	Cert.	Manufacturer	Material	Efficiency class	U_w	Additional info
		all	all	all		all
ACO Therm® 3.0 PHT	DE EN	ACO Severin Ahlmann GmbH & Co. KG	PVC	phB	0.80	
Climatic PH-F	DE EN	Adams-Fensterbau GmbH. RITTER Fenster & Türen	PVC	phB	0.80	
Alcoa RT 82 HI+	DE EN	Alcoa Architectuursystemen	aluminium	phB	0.80	
S91	DE EN	Alumil S.A.	aluminium	phC	0.79	
energeto 8000 I passiv	DE EN	aluplast GmbH	PVC	phB	0.80	
energeto 8000 view	DE EN	aluplast GmbH	PVC-Alu	phB	0.79	
MB-104 Passive Aero	DE EN	Aluprof S.A.	aluminium	phB	0.76	
MB-104 Passive SI	DE EN	Aluprof S.A.	aluminium	phC	0.80	
Gemini Passiv	DE EN	Aluron Sp. z o.o.	timber-aluminium	phB	0.79	
TA35 SE VB	DE EN	batimet GmbH	timber-aluminium	phB	0.73	coupled window
TA35 SE	DE EN	batimet GmbH	timber-aluminium	phB	0.78	
BI-Passif		BIEBER portes et fenêtres	timber-aluminium	phC	0.80	
BRUCKNER HOLZ-ALU-PASSIV	DE EN	Bruckner Fenster und Türen GmbH	timber-aluminium	phB	0.80	
ALUVOGT Design Uw-08	DE EN	BUG - Alutechnik GmbH	timber-aluminium	phB	0.79	



Certificate

Certified Passive House Component
for cold climates; valid until 31.12.2015

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
GERMANY

Category: **Window Frame**
Manufacturer: **dPHt, deutsche PASSIVHAUS transfer 66871 Konken, GERMANY**
Product name: **Delta plus cold climate**

Passive House Efficiency Class

This certificate was awarded based on the following criteria:

Given a Ug value of 0.520 W/(m²K) and a window size of 1.23 m by 1.48 m,

U_W = 0.60 W/(m²K) ≤ 0.60 W/(m²K)

Taking into account the installation based thermal bri
provided that the installation is, with regard to the the
equal or better than shown in the data sheet, the win
the following criterion.

$U_{W,installed}$ ≤ 0.65 W/(m²K)

Thermal data

	U_f-value [W/(m²K)]	Width [mm]	Ψ_g [W/(m
Spacer			ULTIMA
Bottom	0.64	99.5	0.02
Side/top	0.59	99.5	0.02

*Spacers of lower thermal quality, especially those m
minium, lead to significantly higher thermal losses a
temperature factors.

For further information, please see the data sheet

www.passivehouse.com

Data Sheet dPHt, deutsche PASSIVHAUS transfer, Delta plus cold climate

Manufacturer dPHt, deutsche PASSIVHAUS transfer
Erlenhöhe 20, 66871 Konken, GERMANY
Tel.: +49 (0) 6384 9938 224
Email: info@dpht.de, www.dpht.de

rmal

insulated by EPS (0,031 W/(mK)). Glazing: 5/18/5/18/5, 8/5/18/5), Rebate depth: 15 mm.

Ψ_g [W/(mK)]	$f_{Rsi=0.25}$ [-]
MATE Swissp. PU*	
023	0.77
024	
023	0.77

Flying mullion

lower glass edge temperatures.

Passive House Institute Page 1/2

Data Sheet dPHt, deutsche PASSIVHAUS transfer, Delta plus cold climate

Installation

250 175 40 220 60 180 140 5

Installation based thermal bridge $\Psi_{inst.}$ in Passive House suitable walls

Position		EIFS	Timber construction wall	Insulated formwork blocks
Bottom	[W/(mK)]	0.014	0.019	0.009
Side/Top	[W/(mK)]	0.005	0.016	0.007
$U_{W,instal.}$	[W/(m²K)]	0.62	0.65	0.62

Explanatory notes

The window U-values were calculated based on a 1.23 m by 1.48 m window U_g = 0.52 W/(m²K).
If other glazing is used, the window U-values change as follows:

U Glazing	U_g [W/(m²K)]	0.70	0.64	0.58
U Window	U_W [W/(m²K)]	0.73	0.69	0.65

Depending on the thermal losses through opaque elements, transparent components are categorised according to efficency classes. These thermal losses include the losses through the frame, the frame width, the thermal bridge at the glass edge as well as the length of the glass edge. Certificates for arctic regions are too valid vor cold, certificates for cold regions are too valid for cool, temperate zones.
Please ask the manufacturer for a detailed report containing all calculations and results.
For further information, please visit www.passivehouse.com or www.passipedia.org.

www.passivehouse.com

Passive House Institute Page 2/2

Stakeholders

Landsbyggefonden

Housing associations e.g. KAB, DOMEA, 3B, DAB

Regions e.g. Hovedstadsregionen, Region Sjælland

EU

National

Stakeholders

Landsbyggefonden:

By the housing settlement of 18 January 1966, it was agreed that the earlier social housing should pay contributions to "landsbyggefonden", a national building fund for social housing, and that the fund would be used for loans for new social housing.

The national building fund is a private foundation established by law. The Fund aims to promote the general building's self-financing.

The fund is managed by a board of nine members. Chairman of the Board and four other members of this are elected by the housing associations. 2 members of the board are elected by the Tenants national organization in Denmark. One member is elected by kommunernes landsforening and one member is elected by the Copenhagen and Frederiksberg jointly. All elections are made for 4 years.

The fund has an independent administration, headed by an Executive Board consisting of the President and Secretary. The Fund is organized in three centers.

The administrative center is in charge for asset management, collection of mandatory contributions and new contributions to the land reserve fund, drawing litigation, handling of loan and guarantee matters of special operating and renovation, etc., portal / rent registry, asset management, bookkeeping, accounting and human resource management.

Centre for Special Operating conducting the prosecution in relation to renovation etc., capital, rent assistance, etc., Social efforts and provide secretarial assistance to the Board of Directors.

The Centre for Analysis conducting the guarantee of department funds, accounting reporting on the computer, the accounting database, general management dialogue, benchmarking, thematic studies and analyzes, as well as the accounting review and provides guidance on accounting issues, etc.

Stakeholders

Housing organization – example KAB:

Description of the role in construction and advisory as described on the KAB homepage

At KAB, we have a tradition of taking the lead in the development of housing. This applies both in architecture, interior decoration, accommodation facilities, ecology and environment, engineering and economics.

KAB's build function protects the client's interests in construction management, construction project business management or project management. This applies to all kinds of new construction, remodeling and building renovation.

Construction Business Manager

KAB work as construction manager for local government, social housing organizations across the country (companies and associations) and private institutions. We can act as construction manager on all sides of a building, but we also provide advice on a wide range of sub-areas of a large number of sub-areas within the building.

The individual tasks are controlled and managed by KAB's build function experienced project managers and economists - supported by the building's special departments in law, economics, energy management and operation.

KAB develops construction

At KAB we have for many years had close contact with the Housing and Urban Ministry and building other parties in order to continue to develop the building architecturally, technically and economically - for the benefit of society and the individual developer.

Stakeholders

Housing organization – example KAB:

KAB is a general management organization that is owned by a number of housing associations in the metropolitan area. KAB manages approximately 50,000 properties

KAB collaborates with social housing associations and municipalities to build, rent and manage residential and residential areas.

KAB's core areas

- to rent housing and other leases
- administering housing
- working with local estate offices
- developing residential areas in dialogue with residents and municipalities
- solving tasks as building manager in Denmark - both for new construction and renovations
- to solve problems in the energy operating in a residential area
- developing and coordinating social housing initiatives

KAB's senior management is a Board, where the social housing organizations and companies are members. Representatives elects KAB's board of senior management. The Board appoints and dismisses the Executive Board. The Board consists of 153 people

The Board of Directors consists of 19 people

Resident Representative Creator (4 of Representatives)

There is a resident of Representatives of each of the four management areas in KAB. Residents of Representatives shall be composed of all elected members of the department boards and organization directors and Board members in the housing organizations managed by the Client.

Self housing organizations

KAB has cooperation agreements with about 60 housing organizations and companies. All housing organizations and companies are independent and have their own boards and committees of representatives. They use KAB as manager and as a partner.

Stakeholders

EU, Government and Regions in Denmark

In general the various political organizations on EU, national or regional basis have large influence at the "climate" for refurbishment activities. This is shown by the examples mentioned e.g. the CEICAD, ELENA and REEZ programs.

The latest strategy for energy renovation of buildings in Denmark from May 2014 can be found on this link:

http://www.ens.dk/sites/ens.dk/files/byggeri/Strategi-for-energirenovering-af-bygninger/strategi-for-energirenovering-af-bygninger-web-050514.pdf

The report tells in details about the various initiatives to promote energy renovation of buildings that exist in Denmark and list the various initiatives for the different building parts – building envelope, windows, installations etc.

EU regulations

In the EU there is a target of a 80-95% reduction in CO2 emissions by 2050 (1990 level) and targets for 2020 and 2030, respectively 20 and 40% reduction. With 40% of the total EU energy consumption from buildings, it is clear that there must be significant reductions in this area.

EU Buildings Directive 2010/21/EU, Energy Performance of Buildings Directive, deals with energy performance of buildings and is a continuation of Directive 2002/91/EU. The Directive is implemented in Danish legislation in 2005 "Act to Promote Energy Savings in Buildings". This has led to changes in the energy labeling scheme and implementation of low energy classes in the building code defined as near-0-energy houses and requirements for energy improvements to building for renovation. The requirements of the Directive are complied with by the introduction of low-energy class 2020, that is expected to be made compulsory by 2020 and for public buildings from 2018.

The Energy Efficiency Directive 2012/27/EU, EED, were agreed during the Danish Presidency in 2012. This directive requires public bodies role model and requires that 3% of public buildings, both owned and rented, are energy renovated annually, so minimum requirements in the building regulations are complied with.

As part of the energy agreement in 2012, there was presented a strategy for energy renovation of buildings. The strategy aims to promote energy renovations, energy efficiency and conversion to renewable energy in the home at a cost effective manner.

The strategy presents a number of initiatives. A group of these initiatives are targeted multifamily, commercial buildings and public buildings.

These initiatives are focused on minimizing the risk renovations of energy in the form of guaranteed benefits for energy savings in residential buildings and office buildings or guarantees for energy savings through landsbyggefonden when housing associations are energy renovating.

Competitors

Rockwool

Saint Gobain – Weber, Isover, Gyproc

Schüco

Sto

In the description of competitors only North European suppliers of complete façade solutions are included. This means that competitors/ suppliers on individual components like windows, solar active components, HVAC systems etc. are not treated here.

Competitors

Saint-Gobain

Despite being one of the largest companies in the world and specialized in the building industry the product range for façade system is quite simple / limited when searching on the Saint-Gobain homepage.

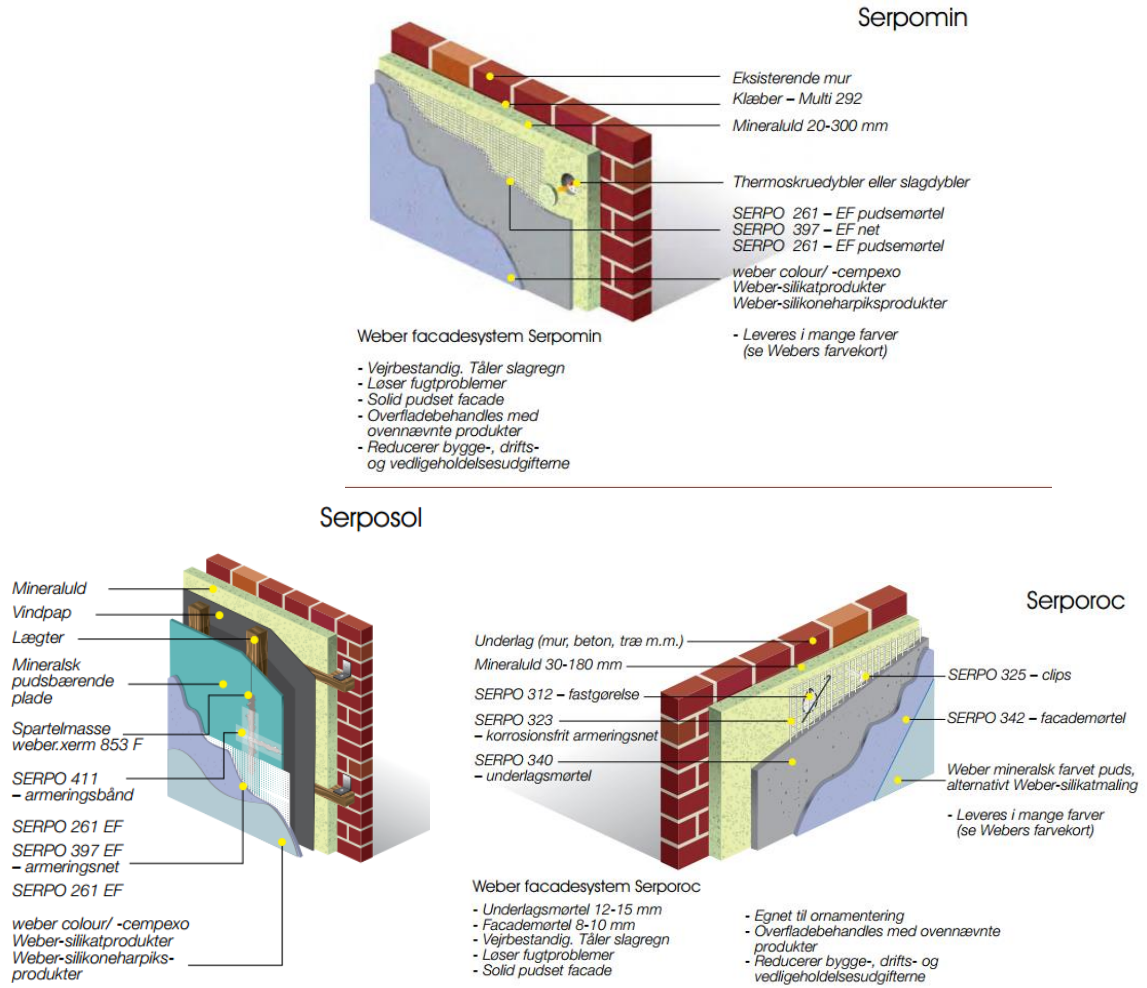
<u>Weber:</u>

There are three systems all based on a layer of mineral wool (ISOVER) and a plastered surface (Weber);

Serporoc, Serpomin, Serposol

A special brand name, Weber.therm.plus.ultra façade system gives a U-value at 0,021 W/mK for the insulation plate, weber.therm RS 022 Facade. The plate thickness ranges from 20 – 200 mm.

Saint Gobain also delivers glass for facades, insulation tapes, plastic foams etc.



Competitors

Saint-Gobain

Gyproc

With Gyproc THERMOnomic it is possible to

It is possible to build supporting structures for up to 2 floors with Gyproc THERMOnomic, or the system can be used as walling in buildings with many floors.

Gyproc THERMOnomic exterior wall system, makes it possible to build Flexible, Sustainable and Energy Efficient letbyggeri that meet future demands.

Gyproc THERMOnomic Exterior walls is a system made of steel profiles and plasterboard and accessories for building light skeletal rear walls.

Gyproc THERMOnomic system has been developed in order to minimize heat loss through the external wall, in that the profiles are provided with punched spare rows, which minimizes heat loss. A variety of structural assemblies with extra features like. Transverse-mounted profiles allow room for extra insulation thickness. The thickness of the construction vary from about 180 mm to about 400 mm, and thus can achieve U-values that meet both today as future energy requirements.

The system facilitate many different facades. On the rear wall outside the installation of a wind-proof plate, for example. Glasroc H Storm GHS 9 composite plate or Gyproc GU, impregnated plasterboard. On the inside is mounted, for example. Normal Gyproc plasterboard. Where there is high fire requirements for the overall construction can be fitted clothing of Gyproc PROTECT F fire plasterboard. These are available in impregnated versions as weatherproofing plate or as versions for cladding on the inner side wall. The cavity is typically filled with insulating material consisting of mineral wool. The façade can be ventilated.

References: Pharma Science project in Copenhagen, Skive Rådhus – façade with solar panels, Skodsborg Sundhedscenter, Thors Bakke in Randers. At the Pharma Science project the prefab steel cassettes are made from Gyproc profiles and assembled by the a local carpenter.

Competitors

Rockwool

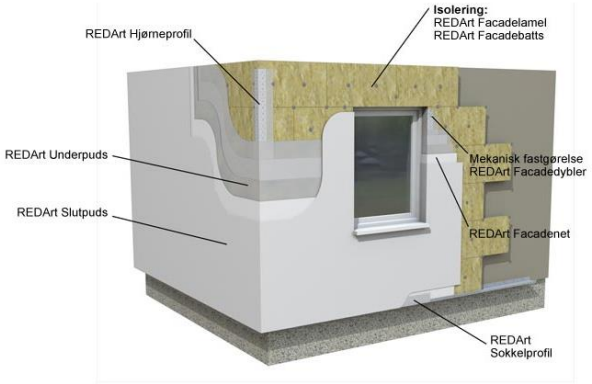
Delivering complete solutions not only insolation

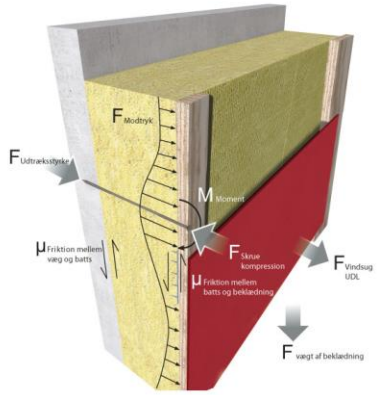
Taken over BASF wall systems and Polish FAST façade system

Systems based on mineral insulation and a plastered surface.

REDArt is the common name for ROCKWOOL Group plastered facade systems. REDArt is a simple and energy-efficient system that meets all requirements for future façade solutions. REDArt is a complete facade system containing all of the components to a façade plaster solution. REDArt can be used for both new construction and façade renovation projects.

REDArt can be used for most types of new build and refurbishment projects up to 30 m. High

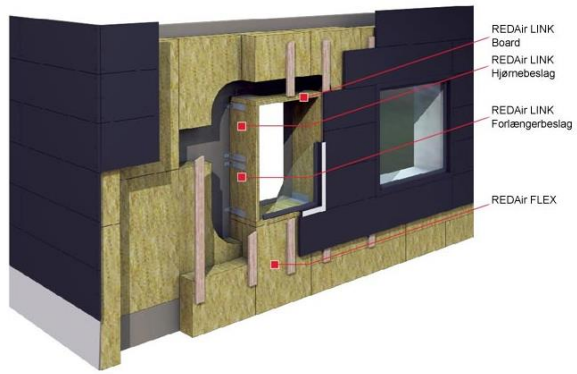




The basic idea behind REDAir FLEX ventilated facade solution is simple: It should be possible to work freely with forming, clothing and insulation thickness, while getting a fireproof solution. The system's few components results in a rational and efficient construction process.

REDAir FLEX is "self-supporting" and are not to be anchored to the roof structure and is also not dependent on the transfer of forces to the foundation. This is because the façade cladding weight recorded in a combination of wool's strength and friction against the back wall as well as special screw mounting on the rear wall.

REDAir LINK is an innovative and thought-mounting box to select the position of windows, typically associated with an exterior facade insulation. REDAir LINK is a new, simple and energy-efficient system that meets all requirements for future thermal bridge free facade solutions.



Competitors

Rockwool

Ydervæg isoleret med REDArt Facadebatts - 80 mm

Type af bagvæg	Eksisterende U-værdi(W/m²K)	Ny U-værdi (W/m²K)	Besparelse (kWh/m²)
100 mm Beton (2% stål)	3,36	0,41	205,78
100 mm Letbeton (645 kg/m³)	1,23	0,34	62,10
120 Letklinker (600 kg/m³)	1,24	0,34	63,09
348 mm Massiv Mursten (standard sten 1800 kg/m³)	1,20	0,33	60,67
32 mm massiv træ (450 kg/m³) på 95 mm isoleret træskelet	0,37	0,21	11,62
18 mm OSB (650 kg/m³) på 95 mm isoleret træskelet	0,39	0,21	12,55

Ydervæg isoleret med REDArt Facadebatts - 250 mm

Type af bagvæg	Eksisterende U-værdi(W/m²K)	Ny U-værdi (W/m²K)	Besparelse (kWh/m²)
100 mm Beton (2% stål)	3,36	0,14	224,25
100 mm Letbeton (645 kg/m³)	1,23	0,13	76,31
120 Letklinker (600 kg/m³)	1,24	0,13	77,37
348 mm Massiv Mursten (standard sten 1800 kg/m³)	1,20	0,13	74,79
32 mm massiv træ (450 kg/m³) på 95 mm isoleret træskelet	0,37	0,11	18,63
18 mm OSB (650 kg/m³) på 95 mm isoleret træskelet	0,39	0,11	19,86

Competitors

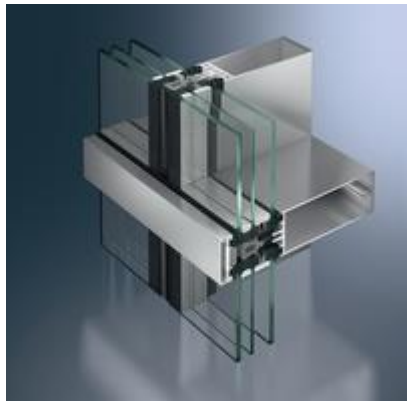
Schüco has a very wide range of products and façade solutions. It is almost impossible to get a quick overview of the various solutions.

The product range includes:

- Facades
- Security systems
- Building automation
- Sun protection systems
- Various aluminum surfaces

For facades alone the product range includes:

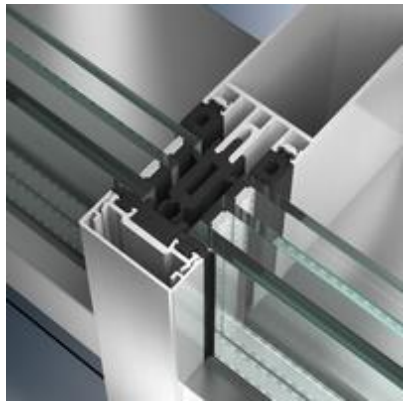
- Façade systems
- Element facades
- Modernizing facades
- Steel facades
- E2-facades
- Parametric facades



The façade system are further subdivided in various systems:

- FW50+.Si
- FW60+.Si
- FW50+SG.Si
- FW60+

What seems to be common for almost all solutions is the mounting system. The mounting system is then used for various solutions. The facades is in general either glass or steel and can include various surfaces in aluminum or an integrated photovoltaic solution.



Competitors

SCHÜCO

Schüco passive house façade

Passive house certification means that the Schüco FW 50+.SI and FW 60+.SI systems can now be used to build aluminum façades to the passive house standard. Only Schüco can provide systems of this type.

Schüco FW 50+.SI and FW 60+.SI

The newly developed SI (Super Insulation) versions of the FW 50+ and FW 60+ aluminum mullion/transom constructions impress with their trend-setting system details. The new type of isolator design uses innovative materials to reduce energy losses to a minimum. Inward-facing reflective surfaces on the pressure plates also contribute to the outstanding U_f value of up to 0.78 W/(m^2K), including screw factor. The system achieves this value for the passive house-certified version with a glazing thickness of 48 mm.

As part of certification by the PHI, the system met the passive house comfort criterion of $U_{cw} \leq 0.80$ W/(m^2K) and was certified as fulfilling the passive house standard with outstanding thermal insulation. This value was calculated and certified by the PHI in accordance with the latest criteria for certifying façade systems, using triple insulating glazing (U_g = 0.70 W/(m^2K)) with a façade module of 1.20 m x 2.50 m. In addition to the effects of the pressure plate fixings, the impact of the glazing supports has also been taken into account for the first time.

"The certification has been achieved in the main thanks to an excellent value for the screw factor," explains Professor Wolfgang Feist from the Passive House Institute in Darmstadt. "In addition, it uses a high-quality spacer and the losses at the glass edge are markedly reduced by means of the glass fiber-reinforced plastic pressure plate. The low thermal conductivity of the pressure plate is also a reason for the minimal impact of the screw factor. Stainless steel has been used for the glazing supports; its thermal conductivity is considerably lower than that of aluminum. The glazing rebate area is filled with very well insulated polypropylene foam."

Building-integrated photovoltaics

To further improve the ecological balance of a building, a system solution is available for FW 50+.SI that allows secure and economical fabrication of building-integrated photovoltaics. The product range also includes various articles, such as mullions and transoms with cable ducts, cable guides and sleeves to ensure simple, secure and economical cabling for PV modules.

As well as Schüco photovoltaics, thermal solutions can also be integrated into the façade. This in turn brings sustainable environmental relief.

Competitors

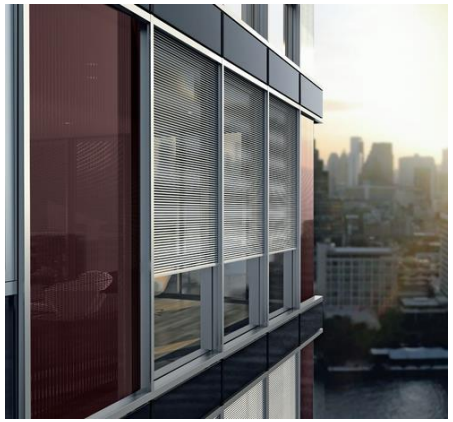
Schüco E² façade is the ideal combination of transparency and efficiency that combines elegant design with intelligent facade engineering.

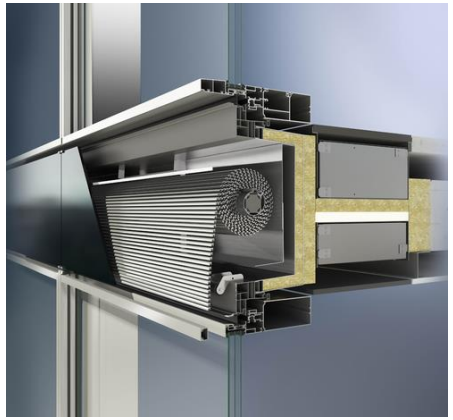
Schüco E²-facade is an energy efficient complete system with a completely new combination of facades and civil engineering that saves and extracting energy at the same time. With its four functional modules (decentralized ventilation technique facade integrated Photovoltaic, façade integrated solar protection and integration of opening elements) can be implemented individual solution packages.

With the modular concept of Schüco fan IFV can perform various ventilation concepts. Depending on the requirements, the input air is heated or cooled individually room by room, with or without heat recovery from the exhaust air. The individually adjustable civil engineering for maximum comfort. The integration of Schüco fan IFV in floor deck enables additionally that the facade and the interior space can be designed freely. It also reduces the building's investment and operating costs, because the channel network for ventilation of the building lapse. This allows floor heights and engineering areas is reduced, and you can both save heating and cooling energy.

With facade integrated Photovoltaic and the associated energy extraction influenced the building's energy balance positive. Photovoltaic modules in floor height, the shape and structure can be designed flexibly, can be opaque (e.g. In the façade spandrel area) and transparent (e.g. In the non-insulated facades visible range). This makes the building envelope into an energy producer that has the same functional characteristics as an ordinary glass section.

The exterior, flat, highly efficient solar shading that is integrated in the façade, Schüco CTB (Concealed Toughened Blind), with anodized micro Aluminum fins ensure efficient shade while maximum transparency for the sake of visibility. In the summer, when a height of the sun of 50 ° less than 2% of the solar energy into the room. This prevents effectively that the premises are heated. Energy costs for cooling energy is reduced significantly. Schüco solar shading CTB also handles heavy wind loads and can in practice be used independently of the wind. Opening elements as top-down windows or windows with parallel opening, opening outwards, seamlessly integrated into the facades. There can be executed large frame weights and solutions in large formats.





Competitors

TES EnergyFacade

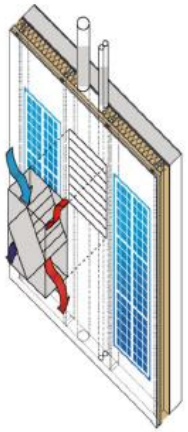
TES EnergyFacade is an international research project, which aims at developing a method for the energetic modernization of the building envelope, based on wood framed prefabricated facade elements.

TES EnergyFacade is targeted at the refurbishment of the existing building stock built from 1950's to 1980's. The project aims at creating prototype solutions as well as a basis for a construction system that could be utilized European-wide.

TES EnergyFacade introduces prefabrication methods to modernization projects.

TES EnergyFacade is a timber building system with a high quality ecological performance.

www.tesenergyfacade.com/index.php



Partners

Germany: Technische Universität München, Hochschule Rosenheim, B&O Wohnungswirtschaft, Gumpp & Maier GmbH, Ambros GmbH, Funding: BMBF

Finland: Aalto University, Finnish Real Estate Federation (Suomen Kiinteistöliitto ry), Finnish Wood Research Oy, Metsä Wood, Puuinfo Oy, PAK RAK Oy, Funding: TEKES

Norway: SINTEF, NTNU Norwegian University of Science and Technology, Funding: The Research Council of Norway

Duration 2010-2013

Pilotproject Norway Risor Technical College (Project Team TES Energy façade and Arikektstudio AS, Fabricator Trebyggeriet AS)

Competitors

Danish Manufactures of prefab wood elements

The below companies al produce prefab wood elements for facades

- BM Byggeindustri A/S
- Enemærke & Petersen A/S
- Facta Building SIA
- RBM Elementer ApS
- Scandi Byg
- Taasinge Elementer

The following is snapshots from the respective company homepages (in Danish).

Taasinge Elementer

Taasinge facadeelementer anvendes både til nybyggeri og renovering og i stigende grad til energirenoveringsopgaver, f.eks. udenpå eksisterende betonsandwichfacader med dårlig isolering og kuldebroer, eller når de gamle udtjente facadepartier skal udskiftes til nye tidsvarende isoleringsstandarder. Facadeelementerne kan udføres som "lavenergifacader" med U-værdier ned til 0,08 W/m2K.

Taasinge Facadeelementer "skræddersys" til den aktuelle byggesag, så kontakt Taasinge, hvis der ønskes nærmere information om de mange muligheder. F.eks. kan vinduer og døre med fordel præmonteres fra fabrik.

ELEMENTOPBYGNING

Taasinge facadeelementer er opbygget af bærende træribber, isoleret og beklædt både indvendig og udvendig. Efter montagen kompletteres på byggepladsen med en udvendig "regnskærm"/ facadebeklædning og evt. supplerende indvendig beklædning.

Facadebeklædning - "regnskærm"

Taasinge facadeelementer afsluttes normalt på byggepladsen med en udvendig, ventileret regnskærm efter 2-trins tætningsprincippet. Den lodrette ventilationsspalte skal normalt være min. 0,3% af facadearealet.

Regnskærmen kan være af:

- profilerede metalplader
  - plane plader (eternit ol.)
  - metalkassetter
  - træbeklædning
  - glas el.lignende.

Beklædningen monteres typisk på trykimprægneret forskalling, der evt. kan færdigmonteres fra fabrik, tilpasset det aktuelle projekt. Træbeklædning kan i visse tilfælde præmonteres fra fabrik. Etagehøje faceelementer type F-2 kan endvidere anvendes som bagmur for en halvstens skalmur.

Vindtæt afdækning

Til beskyttelse og tætning af konstruktionen monteres en vindtæt, vandafvisende og diffusionsåben afdækning på elementernes udvendige side. Den består normalt af en 8 mm fibercementplade, men andre diffusionsåbne pladematerialer kan anvendes (f.eks. imprægneret gipsplade) og banevarer, afhængig af brandtekniske overfladekrav og modstandsdygtighed i forhold til facadebeklædningen.

Competitors

BM Byggeindustri

Kerneområder

- Præfabrikeret modul/boks byggeri som:
- Totalentrepriser
- Hovedentrepriser
- Storentrepriser
- Modulentrepriser
- Tømrer/snedker entrepriser
- Hovedentrepriser
- Totalentrepriser
- Træ/stålelement leverancer
- Præfabrikerede badekabiner

BM Byggeindustri's præfabrikerede moduler er baseret på træelementer fra egen elementproduktion i Hobro. En elementproduktion med 25 års erfaring fra bl.a. bolig, institutions og industriprojekter.

Modulerne samles og apteres i egne produktionshaller i Hobro. Der indbygges bl.a. egne præfabrikerede badekabiner i modulerne. Badekabinerne udføres med betonbund og opkanter samt løsninger og samlinger iht. SBI 200.

Modulerne udføres typisk i størrelser som LxBxH - 10,0x4,0x3,5 m., men tilpasses altid de enkelte projekter f.eks. Århus Universitetshospital på 16 meter i længden, så kontakt BM Byggeindustri for nærmere information.

Aptering af modulerne udføres af BM Byggeindustri samt nøje udvalgte underentreprenører og leverandører, således at kvaliteten og færdighedsgraden på udførelsen af moduler fra fabrik er maksimal optimeret ift. projektet (færdighedsgrad mellem 80-90%).

Derved er toilet/baderum, køkkener, trægulve, malerarbejder, installationer og vinduer/døre færdigapteret fra fabrikken i Hobro. Modulerne transporteres derefter til byggepladsen hvor de monteres, fastgøres, tilsluttes og færdigapteres til nøglefærdig byggeri.

Enemærke & Petersen

Case: Brøndby Strand

Ikke kun de nye facader har sat en ny standard for de almennyttige boliger i Brøndby Strand - vi har også sat en ny standard for, hvor hurtigt og smertefrit boligrenovering kan gennemføres.

Umiddelbart ligner fornyelsen og renoveringen af Brøndby Strand-området et klassisk renoveringsprojekt i kerneområdet inden for renovering af tage og facader - men udførelsen er nytænkende og epokegørende.

Efter et omhyggeligt planlægningsarbejde, tæt dialog og samarbejde med rådgivere og opbygning af en 1:1 model, blev dette projekt gennemført med en høj grad af industrialisering, således at facadeelementer inkl. indvendigt malerarbejde blev færdigproduceret på vores byggefabrik istedet for den traditionelle opbygning på stedet.

Det har givet en masse fordele:

- Optimering af byggeprocessen og tidsplan

- Kortere produktionstid i de enkelte boliger (max. 10 dage)
  - Ingen "åbne" boliger om natten
  - Færre gener for beboerne
  - Bedre arbejdsforhold for vore håndværkere og færre tunge løft
  - Facadeelementet er kvalitetssikret inden opsætning

Montering af et helt facadeelement ”fylder meget”; når lastbiler ankommer med elementet, telt over boligblokken med indbygget traverskran - og et større opbud af mennesker, der skal sikre, at alt går rigtigt for sig - til gengæld er det hele meget hurtigere overstået!

Competitors

Scandi Byg

Industrielt fremstillet modulbyggeri generelt

- Ved at benytte industrielt fremstillet byggeri – i Scandi Bygs tilfælde modulbyggeri – spares der energiressourcer i hele byggeprocessen.
- Hele værdikæden - fra de rå byggematerialer modtages og bearbejdes i vores produktionshaller til de færdige rumstore moduler monteres på byggepladsen - er optimeret og processerne gennemtænkte og velplanlagte, ligesom medarbejderne kender deres roller i opgaveløsningen indgående.
- Da vores leverandører er gjort grundigt bekendt med vores leverancekæde, ankommer materialerne også just-in-time og indkøbes i øvrigt i stadigt større omfang på fixmål, hvorved spildet minimeres yderligere.
- Ved brug af industrielt fremstillet modulbyggeri efter Scandi Bygs koncept forbruges der naturligvis energiressourcer på transport af de færdige moduler og til kranløft på byggeriets endelige adresse. Men energiforbruget ved disse velgennemtænkte manøvrer mere end opvejes af de store mængder energi, som vi forudgående i produktionsfasen sparer miljøet og klimaet for ved at producere i et effektivt forløb i vores velindrettede og veludstyrede produktionshaller.

Træ som bærende konstruktion

- Hos Scandi Byg har vi valgt at benytte træ som den bærende konstruktion, det vil sige i gulve, tagkonstruktioner og vægge. Modsat størstedelen af alle øvrige materialer i samme funktion, herunder beton, stål m.v., har træ den særlige egenskab, at det binder CO_2.
- Benytter man træ i byggeriet, lagrer man derfor CO_2 i meget store mængder. Træbyggeri bliver således CO_2-neutralt i hele byggeriets levetid og livscyklus, modsat f.eks. stål og beton

Scandi Byg har på nuværende tidspunkt erfaring med opførelse af byggerier efter BR10 standardkrav og Lavenergiklasse 2015/2020. Vi har i vores organisation desuden lagt vægt på at råde over medarbejdere, som har den nødvendige uddannelse til at projektere og opføre byggeri efter passivhus-standarden. Udvalgte medarbejdere er f.eks. uddannet som 'certificerede passivhus'-designere.

Fleksibel arkitektur

- Som beskrevet under punktet 'Industrielt fremstillet byggeri', er byggeprocessen hos Scandi Byg optimeret og foregår efter standardiserede retningslinjer. Det betyder imidlertid ikke, at slutproduktet er standardiseret.
- Ét vigtigt element i Scandi Bygs strategiplan er tværtimod fortsat at være yderst fleksibel, hvad angår det ønskede byggeri.
- Som kunde hos Scandi Byg vil du derfor ikke opleve, at vores standardiserede processer får indflydelse på det slutprodukt, som du ønsker.
- **Certificeringer**
- Blandt de forskellige globale certificeringsordninger har Scandi Byg valgt at være medlem af Green Building Council Denmark og arbejder målrettet på at kunne tilbyde vores kunder en DGNB-certificering efter danske standarder.
- Ønsker du som kunde dit byggeri certificeret efter en særlig standard, som BREEAM, LEED eller lignende, bestræber vi os på enten selv at kunne rådgive eller foranledige og koordinere kvalificeret ekstern rådgivning. Vi opfører f.eks. en børneinstitution i Oslo med BREEAM-certificering til aflevering i 2014.

Competitors

RBM elementer

Ranum Byggemontering A/S blev startet i 1973. I starten var arbejdsopgaverne traditionelt tømrerarbejde, men hurtigt begyndte en mindre produktion af elementer til sommerhuse og industrihaller.

Firmaet er blevet udvidet af flere omgange, og i 2013 fik virksomheden nye ejere og skiftede i den forbindelse navn til RBM Elementer ApS.

I dag er arbejdsopgaverne primært levering og montage af elementer i hele Danmark, såvel som i udland. Montagen foregår i tæt samarbejde med montagevirksomheder, som har gavn af de mange års erfaring, som RBM Elementer ApS har med levering og montage af træelementer.

Med egen tegnestue og ingeniører er RBM Elementer ApS i stand til at løfte ethvert projekt indenfor træelementer.

RBM Elementer ApS er i dag hjemmehørende i Farsø, hvor faciliteterne er til rådighed for en moderne og effektiv produktion af elementer i alle afskygninger.

Med CNC-styret opskæring af råtræ opnås tolerancer, som lever op til gældende lovgivning. Ved hjælp af specialopbyggede produktionslinier sikres en hurtig og nøjagtig samling af elementer. Al lager og produktion foregår indendørs under kontrollerede forhold, således der sikres en uafhængighed af vind og vejr, og den høje kvalitet, som er firmaets kendetegn, bibeholdes.

Certificering

RBM Elementer ApS er i en certificeringsproces, hvor elementerne produceres i henhold til prEN 14732, som er de krav, som træelementproducenter skal overholde for at producere træelementer. RBM Elementer ApS er i den sammenhæng underlagt Dancert, som kontrollerer kvalitetssikringen, hvilket er kundernes garanti for, at virksomheden altid lever op til de krav, der stilles til træelementer.

Facta Building

Facta Building SIA producerer fleksibe elementsystemer af træbaserede materiealer til industri og boligbyggeri. De præfabrikerede elementløsninger tilpasses individuelt til den aktuelle byggesag, hvor Facta Building SIA stiller sin tegnestue, ekspetise og erfaring til rådighed i et tæt samarbejde med byggeriets parter. Facta Building SIA er en ordreproducerende virksomhed som fremstiller byggesæt så som facader, tagelementer og skillerum. Elementerne er kombineret som byggesæt.

I 2001 opstartede Facta Building SIA i Letland under dansk ledelse. Virksomhedens grundlæggere har rod i dansk ingeniør og håndværksvirksomhed. Virksomhedens idegrundlag er baseret på at forproducere elementer under kontrollerede forhold. Herved opnås en effektivitets og en kvalitetsgevinst som kommer bygherren til gode.

Facta Building SIA følger standarden som foreskrevet i prEN 14732.

Facta Building SIA leverer og opfører industribygninger, parcelhuse, sommerhuse og pavilloner til en række forskellige lande, men især skandinavien.

Facta Building SIA har egen tegnestue og har derfor den mulighed at tilbyde at designe eller tilpasse konstruktionen efter bygherrens ønske. Vi er en mindre, men bestemt flok der med sin fleksibilitet og omkostningsbevidsthed yder maksimal værdi til sine kunder.

Facta Building SIA uddannelse, tegnestue, erfaring og logistik kombineret med placering i relativt lavtlønsområde, sætter Facta Building SIA i stand til at levere kvalitetsbyggeri til konkurrencedygtige priser.

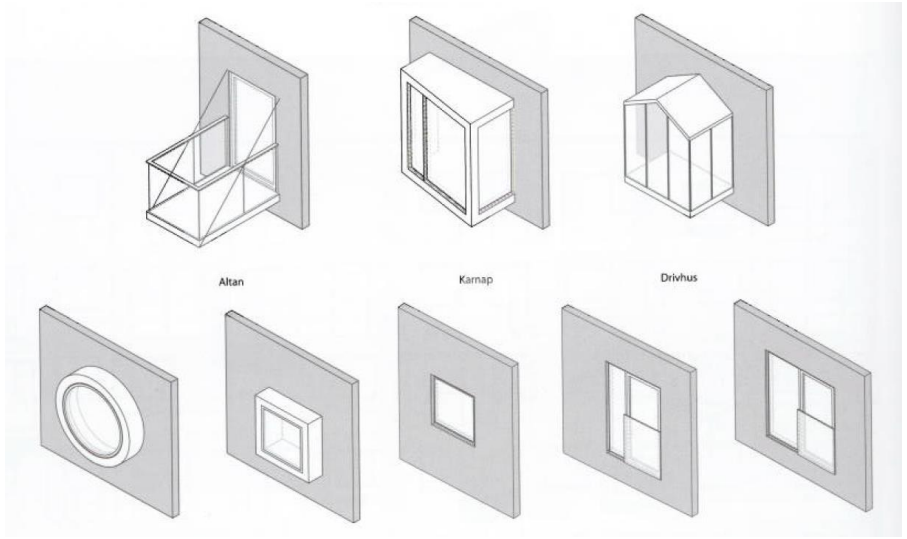
Surroundings/users – demands to the solution

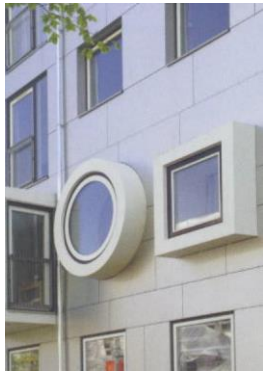
This part of the report is based on 3 cases – two from Denmark, Egedalsvænge and Kildeparken, and one from Sweden, Brogården.

The various cases from MT Højgaard (Egedalsvænge and more), Passivhuscentrum (Brogården) and Himmerlands Boligforening (Kildeparken) can be found as separate reports / files.

In these cases a more in depth description of interaction with and demands from residents to refurbishment and façade solutions can be found, in addition to the description of other parts than the façade of the renovation projects.

Surroundings/users – demands to the solution





Egedalsvænge (MTHøjgaard)

Project with renovation of 18 building blocks in Kokkedal built in 1970's. More than 1000 façade elements.

"The buildings must be changed so that they appear more personal and varied rather than large and uniform."

As part of the project a digital and physical façade mock-up was constructed to determine the design, attachment, detailing and finish as well as test assembly method.

It is noted that the right communication strategy with the residents from the beginning of the project is important. The residents have had a high degree of influence on the project.

The residents could chose among various options for the facades e.g. cantilevered balconies, bay windows and greenhouses. "These options also give variation in the different areas of the settlement." The residents also had influence on materials and the arrangement of their own apartments.

Involvement of the residents was a direct decisive parameter in the selection of consultant for the project.

In the Project there has been extensive use of industrialized building parts. The new facade is prefabricated with windows installed and pre-painted. Optional Elements for facades such as cantilevered balconies, bay windows and greenhouses are also prefabricated.

Surroundings/users – demands to the solution

Brogården, Alingsås

Project with renovation of 16 building blocks, 300 appartments in Allingsås, built in 1970's.

The is not only a façade renovation project but a complete renovation project with rearrangement of apartment layouts and to passive house standard.

The old brick wall was removed and a new façade built on site 44 cm of insulation in steel cassettes – a more less traditional solution.

The new facades more or less resembles the old uniform impression but the renovation resulted in a larger variation in layouts of apartments and a larger number of bigger apartments.

The material on Brogården does not give much information on the facades, more on other parts of the project and of course on the energy used in the building before and after renovation.

Surroundings/users – demands to the solution

Brogården, Alingsås, Study Visit

April 2015 the NORFAC group visited Brogården and discussed the findings/experiences from this site visit in the following workshop. The various positive and negative findings are summarized here.

Positive:

Holistic approach: The whole renovation project was given a holistic approach taking many aspects into consideration e.g. indoor climate, surroundings, CO2 footprint, cradle2cradle, sustainability, ownership …

Ownership: During the complete process the customers (residents) were involved and the housing association listened to the demands and delivered according to customer demands.

Added value: When renovating the façade extra m^2 was added to the apartments by moving the balconies outward and also readjusting the apartments sizes giving a larger variation in apartment sizes and more larger apartments.

Prefab / industrial: Using industrial, preassembled façade modules gave shortened the construction period. During the project there was a good learning process and a the period for changing a façade was reduced from 6 weeks to 3 days.

Integrated energy and ventilation solutions: In the project integrated intelligent energy and ventilation solutions have been used.

Learnings:

- Must include the CO2 accounts
- The criteria for the construction to be determined early and continuously reviewed
- Include sustainability and reusability
- Processes must be optimized for planning, production, mounting and future demolition/reusability

Surroundings/users – demands to the solution

Brogården, Alingsås, Study Visit

Negative:

Cell plastic: The use of cell plastic for insulation as this is a fossil material. Brogården believe or there might be a trend in Sweden that organic (natural) material is not good. Such a trend or if they tell others that natural material is not good is also seen as one of the major threats to learn from the visit.

Sustainable enough?: With the choice of using cell plastic it is questionable how sustainable (environmental respect) the project is.

Integrated / multifunctional construction: In the project there is no integrated active elements e.g. solar panels or any multifunctional construction.

Durability of 60 years? The pay back time is 60 years and it was questioned whether it will last for 60 years. Seems a very long time.

Residents moving out: During the renovation had to move out. Some see this as a negative point (see also discussion of site visit to Himmerland)

Threats: Other major threats learned from the projects was the high price optimization focused at and that the construction time was lowered to 1 week / block

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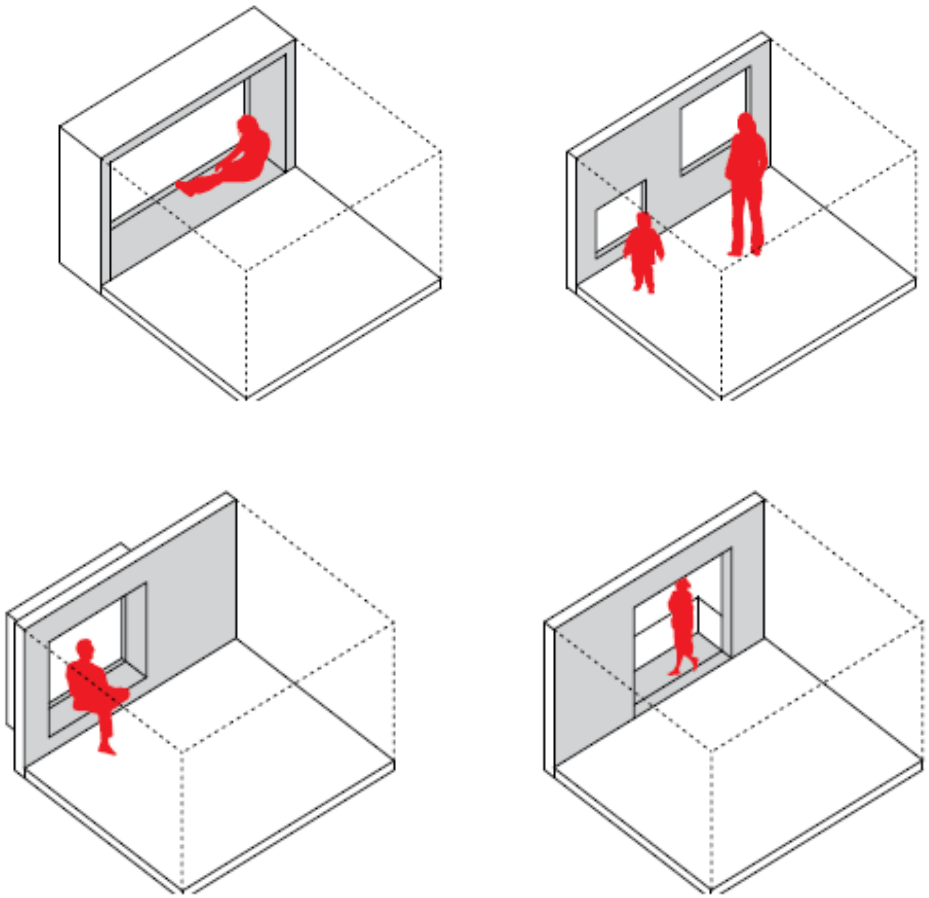
Surroundings/users – demands to the solution



Kildeparken , Aalborg

Project with renovation of 74 building blocks, with 950 homes in Aalborg built in late 1960's early 1970's. More than 3500 façade elements, 368 balconies. The façade area is app. 50.000m^2. the budget for the complete renovation project is 1.500 mio DKK. The project includes not only facades but also rearrangement of the interior and also changes to the living space around the housing blocks.

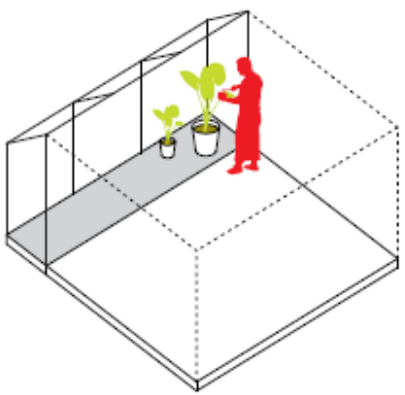
"Will ensure the future sustainability and energy efficiency of the housing blocks and an increased differentiation of the housing supply."

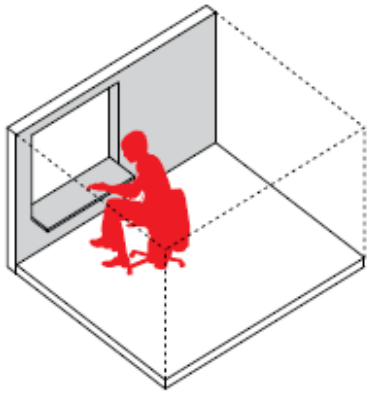
"Uniformity and monotony is one of the major challenges for Kildeparken".

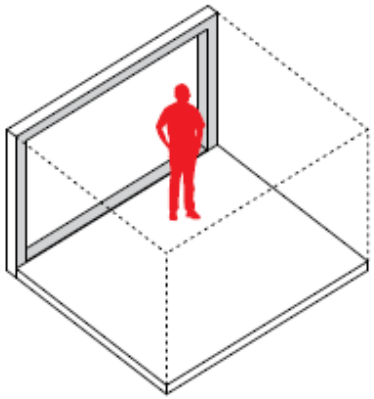
"With the exception of small differences in the apartments' layouts, the apartments are characterized by identical staircases, identical gardens, identical facade elements and similar parking and arrival situation."

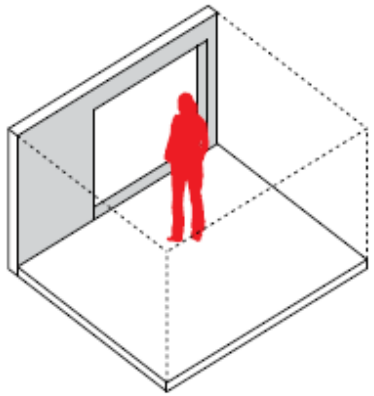
"In the future Kildeparken there should be a variety of different housing quality as a basis for a more varied mix of residents. The master plan envisages the creation of a basis for smaller communities and a greater pride, unity and improved neighborhood in the very close living environment."

Surroundings/users – demands to the solution









Kildeparken , Aalborg

The second stage of the project, "Ravnkildevej" begins in 2015. The project has operated with various solutions; Only the front plate of the sandwich elements in the facades are changed, the front plate is changed with larger windows, new holes for windows in existing facades, the complete sandwich element is replaced.

The materials for the facades could be concrete elements with bricks, concrete panels, slate, wood, metal, ceramic plates or fiber concrete.

As with the Egedalsvænge project this project also operates with various possibilities for the facades; bay window, child window, sit niche, French windows, greenhouses, desk niche, frame, large window

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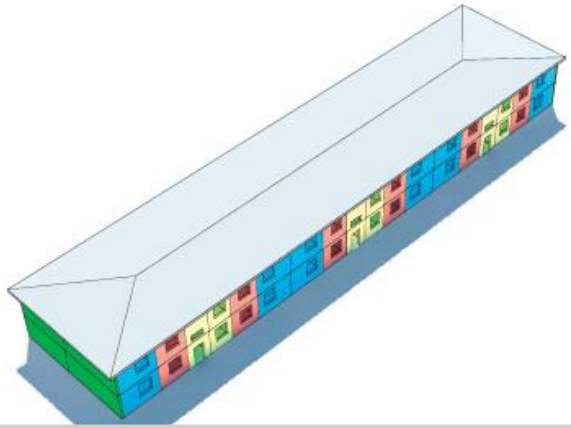

Surroundings/users – demands to the solution

Kildeparken , Aalborg

"From one type of facade for many different"

"Facade elements on floor blocks are filled with thermal bridges and tear, and a larger facade renovation is needed. A major renovation gives the possibility to create various renovation solutions to the respective houses and thus contributing to greater variety and rich experience of the area as a whole as well as for the individual home."

"Floor homes are 13 meters deep and has very small window openings on the north side of buildings, resulting in a bad light and thus also the risk of a poor indoor environment and high energy consumption for artificial lighting."

Variation in materials

"One of the keys to creating a more diverse and attractive town is to create varied and diverse experiences in materials and architecture. It can be done in particular by rethinking the use of materials, expression and experience as an integral part of the technical renovation."

"Material composition may now be best described as "different shades of gray," where the only significant material change is between courtyard houses and blocks of settlements. The master plan envisages that the facades renovated in a wide range of different materials and architectural expression that will help create a large variation in the environment in Kildeparken"

Contact between home and outdoor area

"The initial feasibility study for the master plan suggests that it may advantageously be worth switching all facade elements rather than just the front panel. This also provides great flexibility in facade renovation and design of openings from the deep apartments for the beautiful green outdoor areas. The openings can be designed as windows, balconies, French balconies, bay windows, seating niches and more, and can be placed in children's height, lateral or high on the elements and thus create a variety of light incidence and looking for opportunities from the homes."

"At the same time new facade openings to farm land and green areas is an important element in improving perceived safety in Kildeparken when one of the conclusions of the preliminary study has been that creating more "eyes" in the public domain."

Surroundings/users – demands to the solution

Kildeparken , Aalborg, Study visit

May 2015 members of the NORFAC group visited Himmerland Boligforening, HB, and some of their construction sites in Aalborg. After this a mini workshop was held together with people from HB to identify Sustainability issues (environmental, social, economical) in relation to the beta case for the NORFAC project.

The various observations during the visit to the construction sites are summarized here. The outcome from the workshop is presented as part of WP2.

- Typical use of prebaricated façade modules with windows but without cladding.
- Various types of cladding used; tree, screen brick, glass
- The facades are not particular thick, only 25-30 cm
- HB do not want the residents to stay during renovation. Prefer to relocate residents, also to avoid charges of theft from apartments during the work in the apartments.
- The U-values for the windows observed in the range from 0.93-1.33. The later is not particular low.
- Ventilation: Genvex too expensive for single units. Bad experience with central genvex solution. Mounted fixed extraction from kitchen and bath, which gives problems with suction of cold air through valves in windows.

Before

During construction

After

Surroundings/users – demands to the solution

Kildeparken , Aalborg, Study visit

- In HB it is HB that takes decisions and has the overall responsibility. However, they must seek to get the ideas supported by a majority of the residents. HB believes that this gives more professionalism in e.g. major renovation projects.
- HB experiences a good communication with the residents and 5-10% of a given project is based on input form the residents.
- HB has experience a 50% reduction of the construction time / block during the project.

During construction

Almost complete facade

Surroundings/users – demands to the solution

In light of the three previous cases and the other cases given in the separate report there are some relevant questions that can be asked to potential clients and points to notice;

What kind of flexibility is required / asked for, for the interior façade?

What kind of flexibility is required / asked for, for the exterior façade?

Materials for the outer façade?

Should residents preferably stay during the renovation – this will save quite some money for the project and make it much easier for the residents.

Heating – what are the existing heat source – local conditions, plans e.g. in Aalborg the district heating is very cheap due to the proximity to Aalborg Portland generating waste heat for more than 45.000 homes.

Requirement/ interest in solar panels?

Is there / what are the requirements for energy efficiency after renovation.

Gables – changes to these with e.g. windows

Requirements for lifts – interior/exterior

Entrances – must also be seen as part of the façade

Ventilation – central with heat exchange or in individual apartments?

Other renovation handled at the same time that can have influence on the interior / exterior living space?

and of course various building technical questions on existing facades.

Finally one important general point is to involve the residents and give the residents influence on the process and the expression, materials and giving the residents various individual possibilities seems also to be beneficial.

Links, references, relevant reports / material

http://www.sci-network.eu/fileadmin/templates/sci-network/files/Resource_Centre/Innovative_Technologies/State_of_the_Art_Report_Multifunctional_Facade_Systems.pdf

http://www.sci-network.eu/fileadmin/templates/sci-network/files/Resource_Centre/Guide/09_Innovative_technologies_template_-_final_Prefabricated_facade_modules.pdf

http://www.sci-network.eu/fileadmin/templates/sci-network/files/Resource_Centre/Guide/10_Innovative_technologies_template_-_final_Refurbishment_facade_system.pdf

Case report: Examples from Denmark and Sweden on various façade refurbishment projects.

Report on BIM implementation in NORFAC

NORFAC BIM presentation

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