Smart Grid School Renovation in Copenhagen

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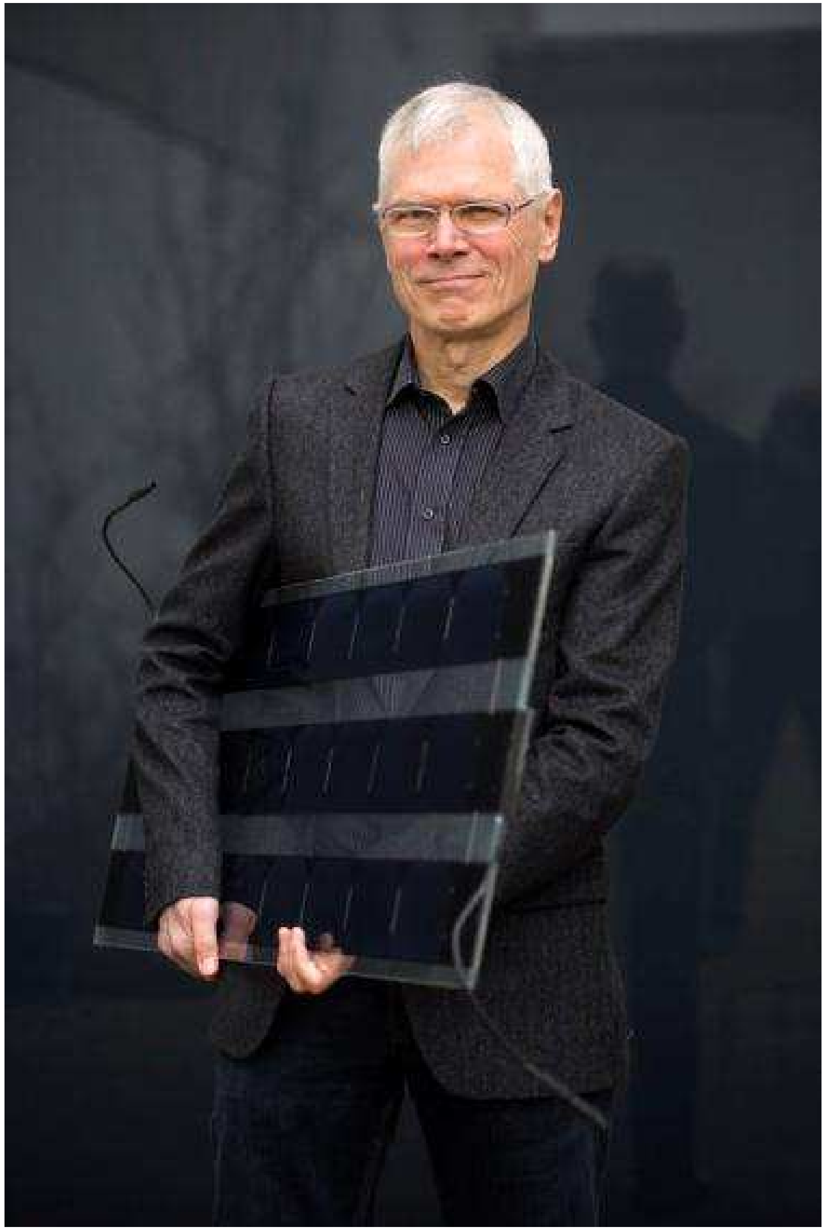

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Undersøgelse vedr.
prisbillige systemorienterede BIPV løsninger
i en
Smart Grid energirenoverings sammenhæng

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Udvikling og test af udvalgte BIPV prototype løsninger
med samtidig fokus på lagringsmuligheder
for solcellestrøm og brug af ”smart meters”.
(samarbejde med bl.a.
Gaia Solar, Racell, Factotec og Scandek)

Udviklingsarbejde vedr. solcelledrevet CO_2 neutral ventilation og performance dokumentation i samspil med BYG-SOL programmet

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Arbejde med konfigurering af systemløsninger og fuldskala test i forbindelse med skoler i København

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Performance dokumentation og målinger i samspil med ”Active House” specifikationerne

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Resultat udbredelse

Projekt koordinering

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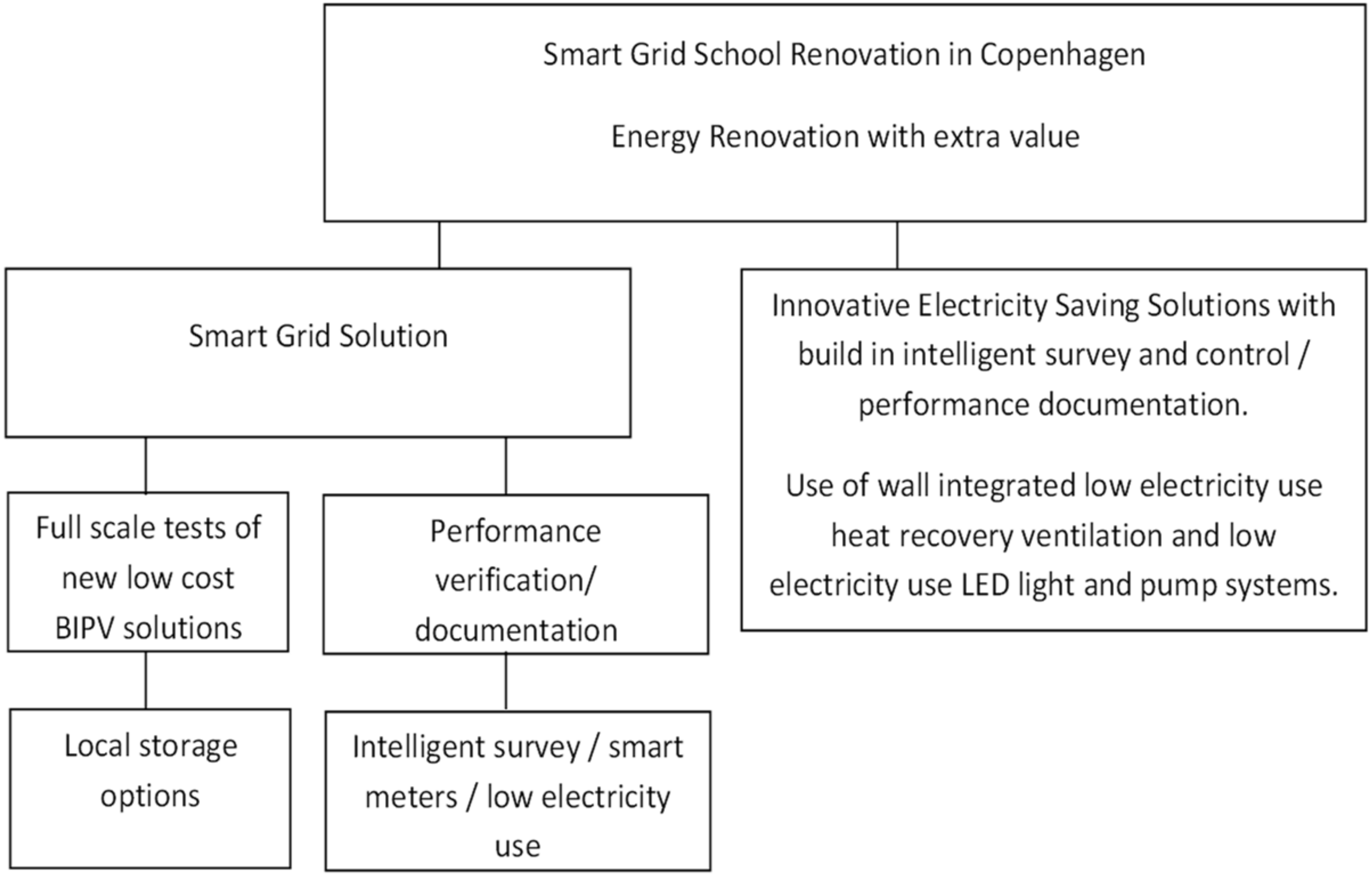

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Typical example of east/west oriented PV solution on a flat roof with a high utilisation of the available space.

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Example of BIPV solution where frameless PV modules are mounted on top of an asphalt layer roof for the renovated Valby School in Copenhagen. Ways to handle ventilation exhaust needs to be handled in a much better way than here; to avoid use of a large number of dummies and to secure that rain penetration will never happen. In this case PV cables came in conflict with the flashing of the ventilation and rain actually penetrated the roof. The actual building renovation were only made according to the normal standard so electricity use is near the Danish mean for schools (23 kWh/m², year)

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Example of completely new roof with PV modules mounted on top. This must be considered to be the opposite of a well-integrated and configured BIPV system.

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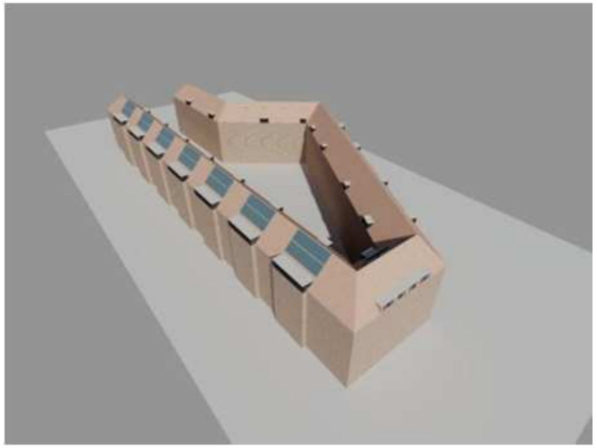

Example of integration of PV modules in typical red tile roofs in Copenhagen according to dialogue with Centre for City Design

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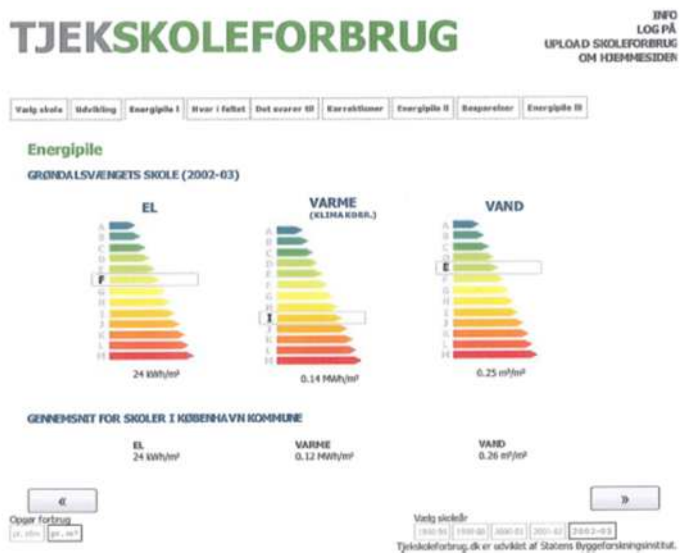
Grøndalsvænge School / Public School

Build: year 1924 and 1975



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Overall energy saving and economy based on Grøndalsvænge School.

If we look at the Grøndalsvænge School in Copenhagen it has a district heating energy use of 140 kWh/m², year. Calculation shows that this should be possible to reduce to 73 kWh/m², year by insulation of the whole climate shield excl. the walls, but including energy efficient heat recovery ventilation, energy efficient windows and sunscreens. If you also include wall insulation you will in principle be able to reach a yearly district heating use of 47 kWh/m², year if the quality of the solution are right. For electricity use the existing level of 24 kWh/m², year is aimed to be reduced to 6 kWh/m², year by the most advanced solutions for energy efficient ventilation, pumps, lighting and appliances.

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With electricity costs of 1.47 DKK/kWh and district heating costs of 0,52 DKK /kWh the existing costs and the possible energy savings can be calculated as follows:

Existing energy costs:	24 kWh/m², year x 1.47DKK/kWh+ 140 kWh/m², year x 0,52 DKK/kWh=	108 DKK/m²,year
Value of energy savings:		
District heating	140 – 47 = 93 kWh/m², year x 0.52 DKK/kWh=	48 DKK/m², year
Electricity	24 – 6 = 18 kWh/m², year x 1.47DKK/kWh=	26 DKK/m²,year
	Total	74 DKK/m², year
	Total saving	(68 %)

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For the energy frame value with a year 2020 factor of 1.8 for electricity compared to heating and 0.6 for district heating the existing energy frame value can be calculated as:

140 x 0.6 + (24 x 1.8 = 43) = 84 + 43 = 127 kWh/m², year

This is reduced to:

47 x 0.6 + (16 x 1.8= 29) = 28 + 29 = 57 kWh/m², year (45%)

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And if a CO2 neutral electricity use is aimed for, we then need to cover:
6 kWh/m² x 5620 m² = 33,720 kWh electricity use, which can be done by 42 kWp PV panels.

With 6 kWh/m² x 1.8 = 11 kWh/m², this will mean an energy frame value of
57–11= 46 kWh/m², year is possible near to a low energy class 2015 standard.

For use of renewables in connection to the school renovation area of 5,620 m² it is needed to utilise 42 kWp PV panels (300 m²) which can produce approx. 35,700 kWh solar electricity per year equal to 6 kWh/m², so a CO_2 neutral electricity use is obtained.
At 16,000 DKK/kWp a payback time for this is 13 years in a smart grid situation.

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Suggestions for energy improvements in Energy Audit report of Grøndalsvænge School and related savings and costs.

Initiative	Estimated savings	Payback time	Investments (DKK)
Insulation of pipes	25.44 MWh district heating	2.7 years	35,718
New lightning system	121,749 kWh electricity	7.2 years	1,280,000
New roof. The whole roof is in a bade shape and is going to be replaced	-	-	
100 mm insulation of massive façade	310.54 MWh district heating	30.6 years	4,940,000
Replacement of toilet flush	8.00 m^3 cold water per unit	12.5 years	80,000
Replacement of glass in the windows	104.34 MWh district heating	18 years	976,600
Installation of decentralised balanced mechanical ventilation with heat recovery / low electricity use	191 MWh district heating	11 years	1,100,000
All solutions	631.3 MWH x 520 + 121.75 x 1460 + 200 x 40 = 514,055	16 years	8,412,318
All solutions excl. facade insulation	352,300	10 years	3,472,000
All solutions incl. 42 kWp PV and excl. facade insulation	404,400	10 years	4,144,000 (737 DKK /m^2)

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