

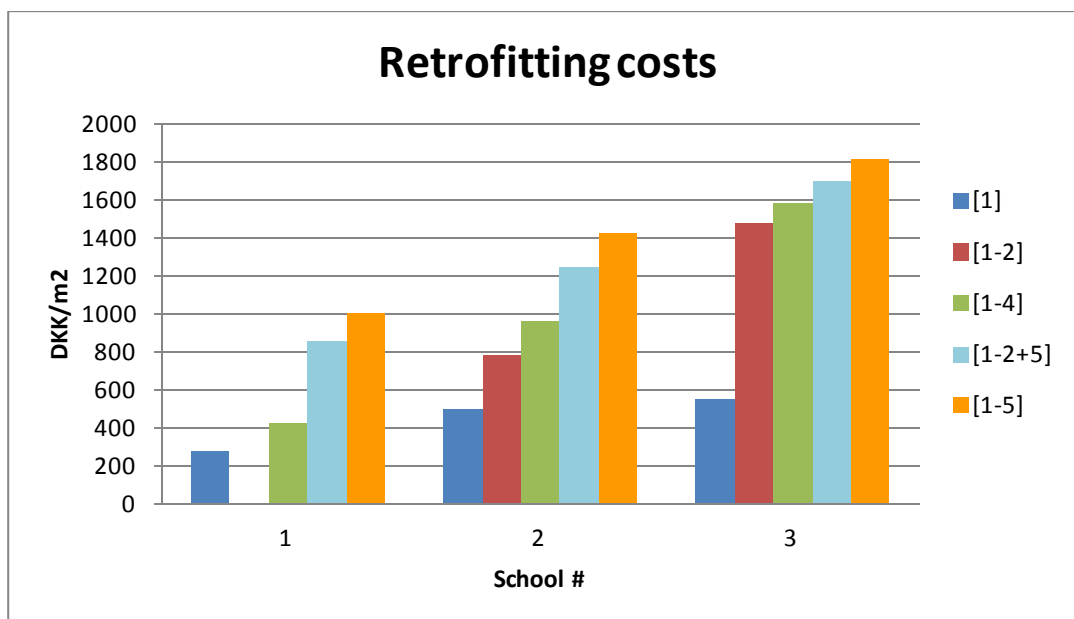
What is the retrofitting cost of a good indoor climate in public schools?

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A large study in 2009 of 330 Danish schools showed that poor air quality and high temperatures are common in many schools. At the same time heat is wasted through leaky, uninsulated facades. A European research project initiated to find cheap retrofitting solutions sparked two DTU students to investigate the costs of improving indoor climate and lowering energy consumption to the statutory Building Code requirements of three Copenhagen schools. Results indicate that a reduction in energy consumption and a healthy indoor environment can be achieved for an investment of less than 1.50 DKK/pupil per day.

The investigation is based on registration of classroom wings at the three schools and the Building Code during construction. Current and renovated energy consumption is calculated with five different retrofitting initiatives as set out in the table below. The retrofitting actions are performed individually and in combinations to obtain the most interesting initiatives. The retrofitting costs are obtained by price books for the Danish building sector and can be viewed in the figure below.

Solution	Description
1	New 3-layer windows U-value 0,8 including external solar shading
2	Balanced mechanical ventilation with heat recovery of 85% and SFP of 1,6 kJ/m ³ Airchange based on Building Code requirement
3	Extra insulation of roof with 300 mm
4	Extra insulation of ground floor with 120 mm
5	New light facade with 300 mm insulation



The study indicates that the investment necessary to cut energy consumption and create a good indoor climate is large. For an investment of 1000-1700 DKK/m² it is possible to achieve savings of around 35 to

50%. With a payback of over 50 years on energy savings alone interventions appear immediately as an investment with a long horizon (figure below).

The conclusion is that energy in itself is often not viable over a foreseeable horizon. But energy is a minor cost of operating a school where teaching salaries is a heavy record in the budget. The positive effect of improved indoor climate and comfort temperatures is up to 15% better learning ability. A conservative estimate of 5% savings on payroll budget in public schools due to less special education corresponds approximately to 2.20 DKK/day per pupil.

Retrofitting costs and energy savings over a child's school period from 0 to 9th grade corresponds to an investment of less than 1.50 DKK/ day per pupil. Net released is approx. 0.70 DKK/day per pupil which can be converted to a general improvement in teaching.

