MINERGIE-P® – A Building Standard of the Future

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SUMMARY

Already 20 years ago, Gro Harlem Brundlandt stated «I believe the time has come for higher expectations, […] for an increased political will to address our common future» ([1], p. 13). Indeed reading the newspapers one could get the notion that finally politicians (at least in Europe) are re-thinking those lines.
This paper presents the low-energy label for buildings MINERGIE-P® launched in Switzerland end of 2002. MINERGIE-P® demands a decrease of the heat demand by 80%. Solutions are shown of how to comply easily with these demands that appear severe on first sight. Furthermore the historical and political necessity to act is outlined and put into perspective.
Of utmost importance regarding MINERGIE-P® is not only the massively decreased heat demand. The used technologies and appliances furthermore guarantee a high indoor air quality and the long-term conservation of building value. This is easily communicated and in the meanwhile broadly accepted by banks offering better conditions for real estate mortgages.

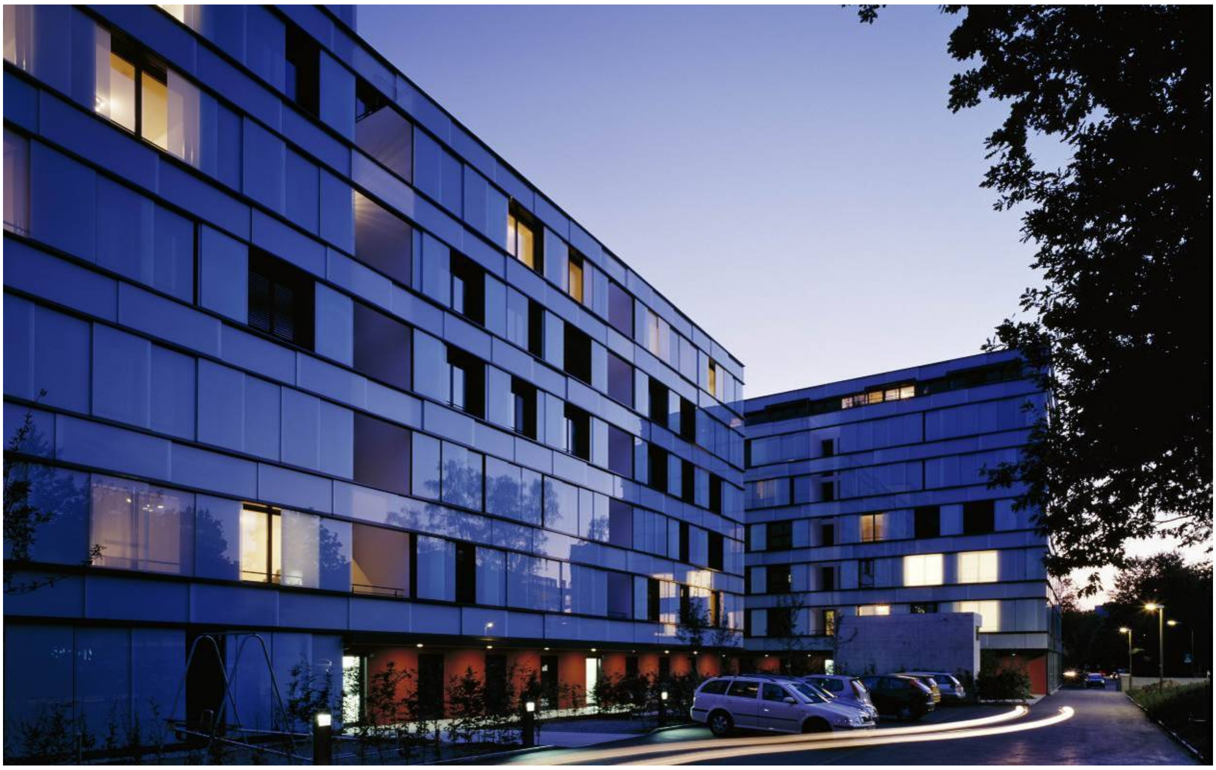

Figure 1. Multiple-family dwelling offering 90 apartments close to Zurich designed to comply with the demands of MINERGIE-P®. (Picture courtesy of Senn BPM, Switzerland)

INTRODUCTION

At the moment of writing, energy consumption and cutting down on CO_2 output are highly pressing matters (and hotly debated at least in the European Community). One of the central points to get the matters at hand under control is of course the augmentation of today's energy efficiency. This is especially true for buildings. Nowadays it is possible using existing technology to reduce consumption for heating by 80%.

In Switzerland energy calculations are standardised since 1988. More and more the legally allowed energy consumption is reduced according to the energy label MINERGIE and the still more rigorous label MINERGIE-P (harmonised with the German *Passivhaus* of Dr. Wolfgang Feist). In the paper presented the historical and political background of MINERGIE-P as well as the demands imposed by MINERGIE-P are illuminated. The paper presents both precise values of energy consumption and the consequences for low-energy buildings.

MATERIALS

Not only the European Performance of Buildings Directive (EPBD) postulates steps towards a more efficient way of handling our resources. NOVATLANTIS in cooperation with the SIA (Swiss Society of Engineers and Architects) and the BfE (Swiss Federal Office of Energy) map out in [3] the need to realise the so-called "2000-Watt society". The thought which stands behind this programme is the realisation that the worldwide average energy consumption in 1990 equalled 17,5MWh/y which amounts to a constant power consumption of 2000W per person. As could be shown in [4], 2000W in the long run guarantee a sustainable development covering all three aspects of sustainability. The authors postulate a "window of energy consumption". Thus it shall be ensured that we are not «compromising the ability of future generations to meet their own needs» ([1], p. 24).

This "window of energy consumption" takes the energetic poverty line of economic development to define the minimal possible energy consumption whereas the maximum is defined by the amount still compatible with our planet's ecological equilibrium. Lastly the distribution of consumption among consumers serves as an indicator of social stability. The industrialised countries obviously still need to take large steps to make this idea come true whereas the developing countries mostly lie well below the consumption of 2000 Watt per capita (Fig. 2).

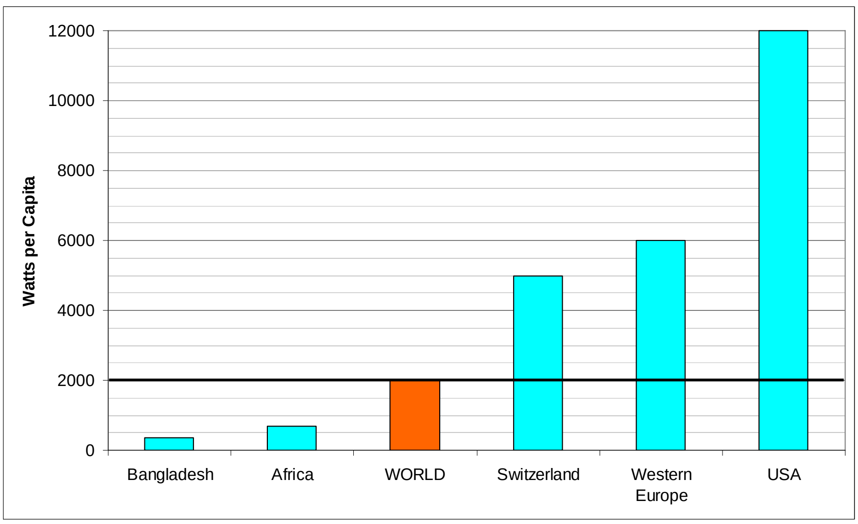

Figure 2. Comparison of the energy use per-capita in selected areas. Adapted from [5].

The association MINERGIE®, which is financially sponsored by the Swiss Federal Government as well as by the Cantons (cf. Federal States), took up those ideas in 2002, and the standard complies with them. It generated the building energy standard MINERGIE-P® which adopts mainly the ideas of *Passivhaus* elaborated by Dr. Wolfgang Feist during the 1990's in Darmstadt/D [6 and 7]. The differences between *Passivhaus* and MINERGIE-P derive mainly from the different standardisation in Germany and Switzerland. In addition, there are always different (political) points of view on the conceptual design of the optimal low-energy houses, of course. Here MINERGIE pursued perspicuously the following ideas:

- High living comfort due to surfaces of uniform temperatures,
- High indoor air quality due to mechanical ventilation,
- Better noise control since it is no longer necessary to open windows,
- Low energy consumption (not first but equal among others, see below),
- Long-term conservation of building value due to less structural damages such as caused by mould,
- Viable with a minimum of extra cost (less than 10% to 15%),
- Feasible with technology that is proven and existing.

It is of utmost importance to follow the idea of MINERGIE closely. Quite obviously the name derives from MINimal enERGIE (spelled with "ie" instead of "y" in German). The central focus of the MINERGIE agenda is not so much the absolute minimal use of energy but providing the comfort expected today at the lowest possible energy consumption. Otherwise one could just lower the room temperature to 16°C and thus generate energy savings of up to 25%! Another important point concerns the reasonable use of proven technology. It is not the goal to provide a playground for prospective technologies but to define a standard that can be met easily using existing technology and appliances.

Yearly the Swiss Federal Office of Energy (BfE) provides up-to-date data on energy usage [8]. Fig. 3 shows clearly the sectors featuring the highest potential for energy saving being traffic and housing. At the time, housing in particular offers a realistic fulcrum to start cutting down energy usage. This is the starting point for the definition of MINERGIE-P.

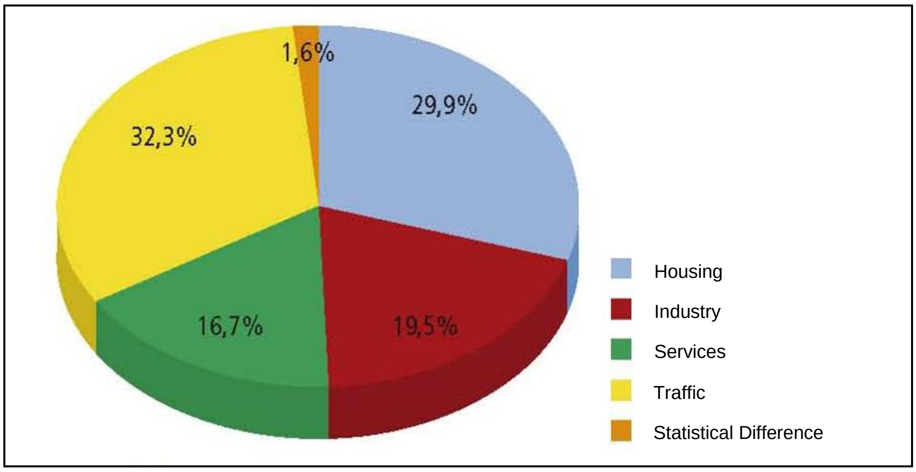

Figure 3. Energy use divided into sectors. From [8] p. 5.

In 1988 the SIA published its normative paper SIA 380/1 [9]. For the first time a standardised mathematical method was created to provide information on the predicted energy use of houses and moreover to demand a certain upper limit of energy use (as has recently been imposed by the EPBD). Thus the energy flows for the heating period were characterised and divided into heat flow due to transmittance (loss), heat flow due to airing and leakage (loss), heat flow due to persons and electricity (internal gain), and heat flow due to solar radiation (external gain), whereupon the difference between total loss and total gain, of course, needs to be provided by an additional heating system as shown in Fig. 4.

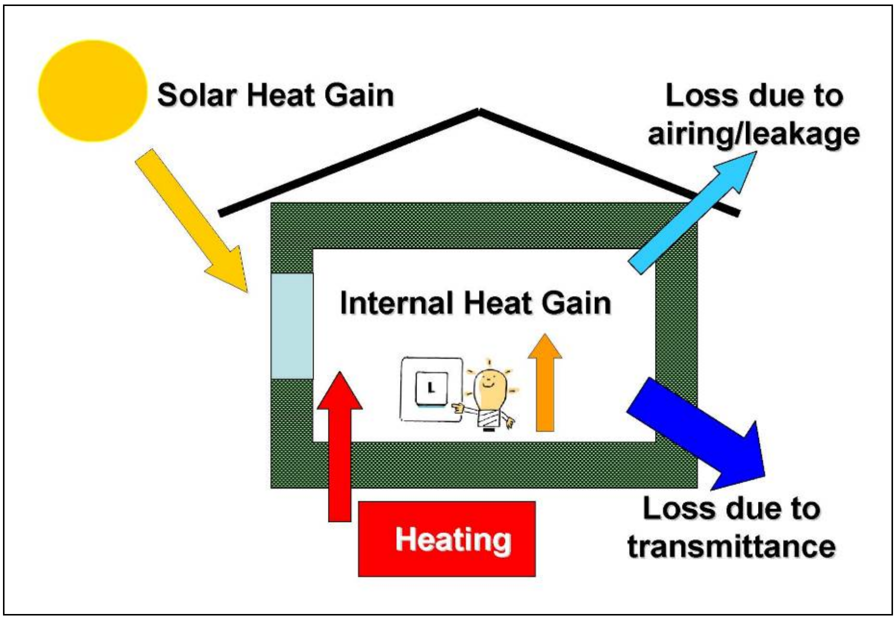

Figure 4. Energy flows following [9].

Obviously, one attempts to minimise losses and maximise gains for buildings that should consume as little energy as possible. Consequently the package of measures includes:

- Very well insulated walls (U-values $\leq 0.15 W/m^2K$, tending towards $0.10 W/m^2K$),
- Very good windows, consisting of three panes (U-value transparent $\leq 0.6 W/m^2K$, U-value including frame $\leq 0.9 W/m^2K$, total solar energy transmittance ≥ 0.5),
- Minimised thermal bridges and therefore a homogenous heat insulation of the building envelope,
- Highly airtight outer shell ($n_{50} \leq 0.6 h^{-1}$ – air change rate at 50Pa pressure difference),
- Controlled ventilation using high performance heat recovery.

Moreover the building's main façade should face southeast to southwest featuring a minimum of 30% transparency of the outer shell. These orientations provide massive solar gains even in winter so that windows facing these directions contribute to the reduced heat demand. Windows in façades to other orientations and above all to the northwest to northeast produce losses and should therefore be quite small. (These statements are true for average Swiss meteorological conditions as in [10].)

Very often architects and energy engineers underestimate the importance of the realisable gains and concentrate on minimising the losses. This will never suffice to comply with the label MINERGIE-P. Indeed one could state that the "P" stands for "passive solar gains". Every factor that reduces those gains in any way (shading, skyline, and regulation) increases the heat demand considerably. The second most and often ignored point concerns thermal bridges. Common houses may feature a considerable amount of thermal bridges with losses of almost 5% of the heat demand. After having eradicated a good part of losses due to transmittance, thermal bridges (even in very well constructed and thought-through buildings) add up to 10%. If proper construction to avoid thermal bridges is neglected, the associated loss can increase considerably! Thus the ambitious goal of saving a very good part of the heat demand compared to standard houses may be missed.

RESULTS

To give the reader an idea of the dimensions we are talking about, we take an ordinary Swiss single-family detached house of $200m^2$ total area. The area in Switzerland is always measured grossly therefore including structural components as well. All the statistical energy values are based on this so-called energy reference area (ERA) and looked at over a whole year. The outer surface of the house amounts to $400m^2$ thus resulting in a ratio of thermal exposed area to ERA of 2 ([11] describes the ERA as "conditioned space" and does not explicitly specify a ratio of ERA to enveloping, thermally exposed surface). The annual energy consumption allowed by law amounts to $75kWh/m^2_{ERA}$. MINERGIE-P allows 20% of the legal energy consumption. This means that only $15kWh/m^2_{ERA}$ per year might be used as maximum heat demand. This is the primary of four conditions. The German energy label *Passivhaus* also allows $15kWh/m^2$ but measures the area differently (net instead of gross).

Second, the demand of energy including hot water production, auxiliary energy for pumps and ventilation including weighting factors must not exceed $30kWh/m^2_{ERA}$. Weighting factors always hold a political component and shall not be discussed here. Table 1 shows the weighting factors of MINERGIE together with those of *Passivhaus* and SIA to give an idea of the different points of view. All those weighting factors try to take into account the conversion between secondary energy (i.e. the amount of energy delivered to the property) and primary energy (i.e. the energy including losses due to extraction, transport, and the like).

Table 1. Weighting factors to express the conversion from primary to secondary energy

Heat producer	*Passivhaus* (D)	MINERGIE (CH)	SIA (CH)
Heating oil	1.08	1.0	1.1
Natural gas	1.07	1.0	1.1
Wood (any form)	1.01	0.5	0.1
Electricity	2.97	2.0	2.9

The Swiss mathematical method to calculate the energy demand standardises not only the internal gains, ventilation rates, and room air temperatures but also the demand of heat for production of hot water for sanitary purposes. The amount is referred to the ERA. Thus the examined single-family house needs $13.9kWh/m^2_{ERA}$ or a total of 2778kWh per year. This is enough to heat 130 litres of water from 10°C to 60°C per day. Assuming typical values for ventilation ($150m^3/h$) and auxiliary purposes ($1.5kWh/m^2_{ERA}$), Table 2 provides an overview of the energy demand so far.

Table 2. Overview to the energy demand

Energy demand by	Demand [kWh/m^2_{ERA}]	Form of energy	Weighted energy
Heating	15.0	Heat (wood)	7.5
Sanitary hot water	13.9	Heat (wood)	7.0
Ventilation	3.0	Electricity	6.0
Auxiliary energy	1.5	Electricity	3.0
Total			23.5

Of course, the exact values may vary as well as the way to produce the energy for heating and hot water. At the same time the presented values represent the typical case of a MINERGIE-P single-family house.

The second to last condition involves that the outer shell must be very airtight. Air tightness is determined by applying a pressure difference of 50Pa and measuring the air change rate.

MINERGIE-P requires an air change rate below $0.6h^{-1}$ at 50Pa (average of both overpressure and vacuum). Taking into account the consumption of electricity, the last condition demands that all domestic appliances hold the European energy label A, and A^{+} for freezers, respectively.

Statistical interpretation of 100 Swiss MINERGIE-P houses

As a matter of course the statistical interpretation of all realised MINERGIE-P houses are of interest. The following figures show the evolution of the label, which was launched at the end of 2002 (Fig. 5). Furthermore the heat production systems (Fig. 6) as well as the heat distribution systems (Fig. 7) are shown and give a distinct idea of the most common solutions to both challenges. All values are based on the last statistical review of mid-February 2007.

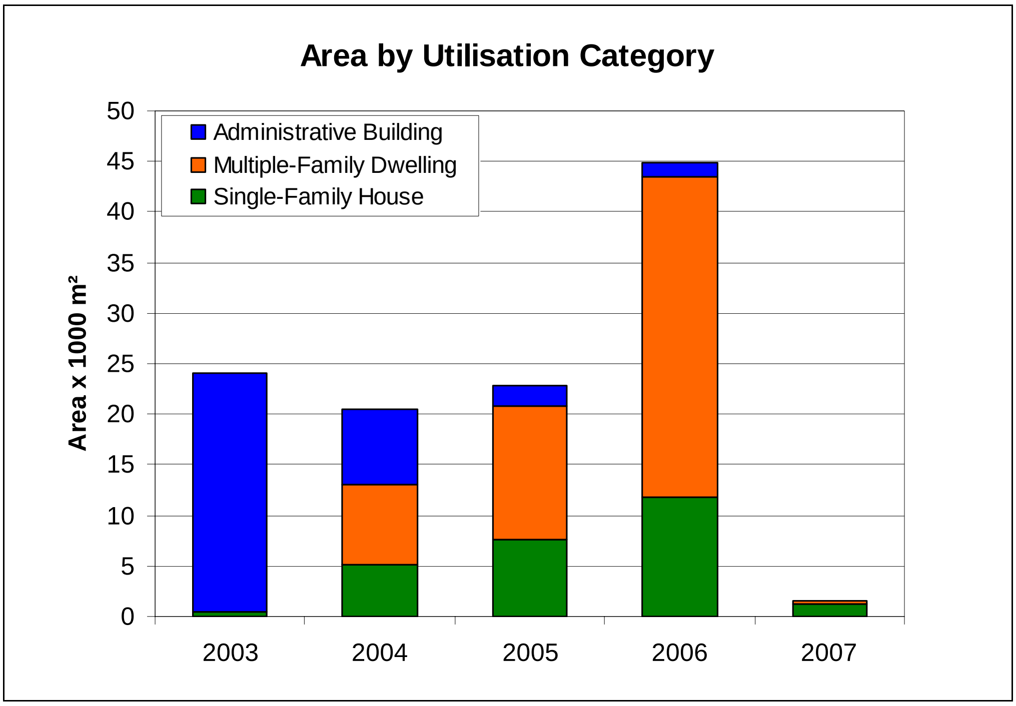

Figure 5. Evolution of area certified each year as MINERGIE-P.

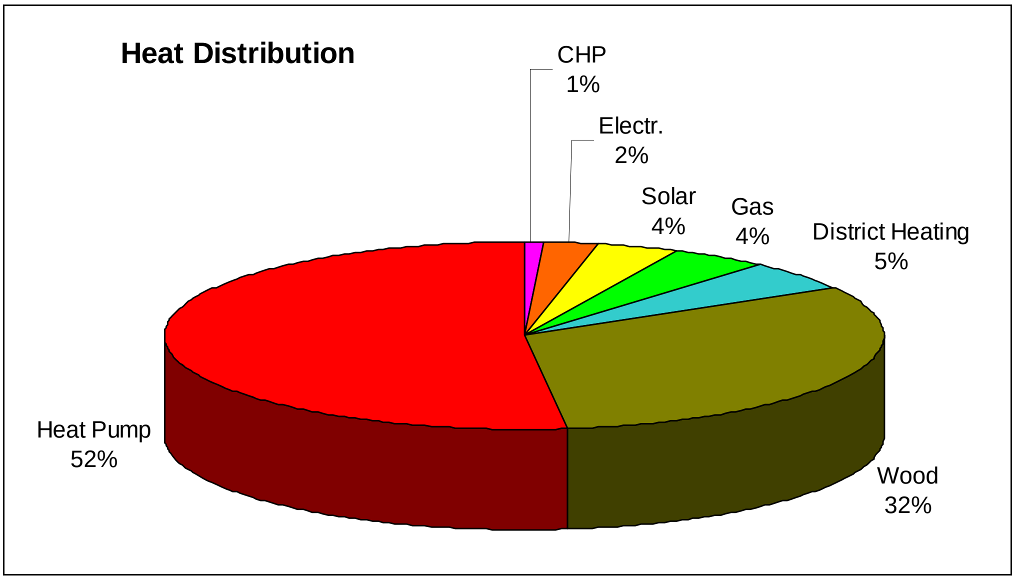

Figure 6. Statistical interpretation of used heat production systems.

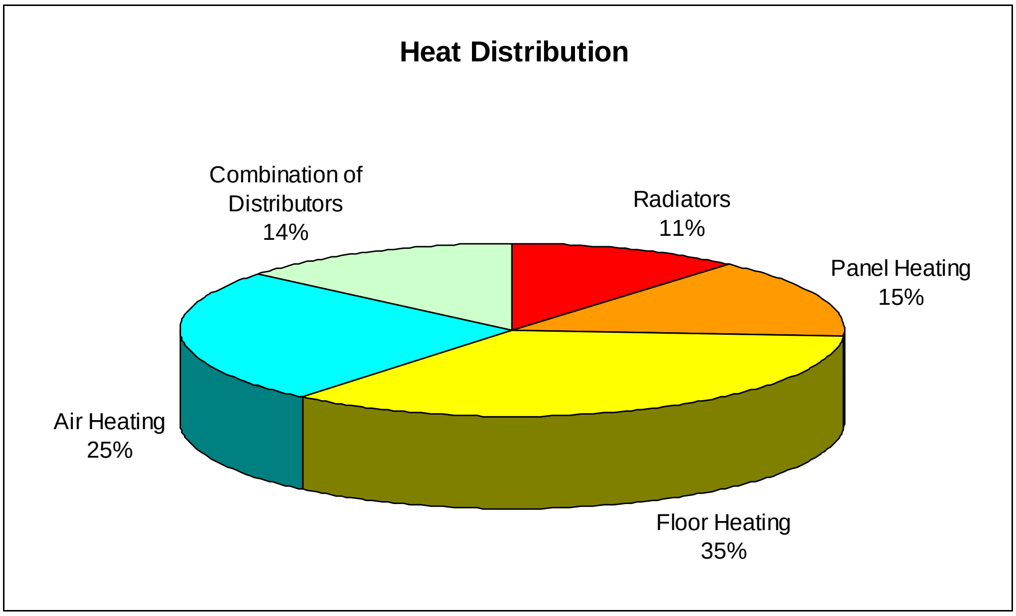

Figure 7. Statistical interpretation of used heat distribution systems.

DISCUSSION

The energy label MINERGIE-P presents a valuable way of classifying energy-efficient buildings. The perspective lies both on energy saving and, in particular, presenting an excellent comfort providing high indoor air quality and minimising the risk of structural damages due to mould and the like.

It could be shown that using proven technologies and appliances of today's state of the art one can decrease the heat demand by 80% without taking any risks. Furthermore, the importance of realising feasible energy savings could be shown. In particular the housing sector, which consumes roughly one third of the energy in Switzerland, still holds a huge potential to reduce the massive output of CO_2.

Experience shows that the presented standard can easily be communicated not only to energy-interested pioneers or idealists but to the broad public as well. The astonishing evolution of the still young label is demonstrated by the increasing rate of newly built living area with the high MINERGIE-P standard. Recently the better conservation of building value even convinced several banks to offer better conditions for home mortgages.

The complete success of all MINERGIE energy labels presents a prime example of an effective marketing strategy. (To date there are four energy labels assigned by MINERGIE – compare [12].) MINERGIE as a brand has consistently been built up over the last years. Without the tireless work to establish the vision of energy saving buildings in the minds of both the public and politicians, in Switzerland population and building industry would probably still be waiting for «an increased political will to address our common future» ([1], p.13).

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