BARRIRES FOR PROGRESS OF LOW-ENERGY CONSTRUCTION

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Abstract

Energetic level of new buildings built in The Czech Republic is not very satisfactory. Although all proper standards are adhered, results we get aren't energy-saving buildings.

In support of Ministry of Environment of the Czech Republic EkoWATT worked up two-year research project whose result refuted fables that low-energy buildings are capital-intensive.

Several tens of new buildings were analyzed during this research and alternative solutions with regard to construction materials and building services were searched. It turned out that almost in all projects could be found some possibilities to reduce investment costs and spared money could be invested to energy-saving solutions. Consequently it's possible to reduce energy intensiveness of building without increasing investment costs and without changing object appearance and dispositions.

Reasons of buildings' low quality are underestimating of project preparing, unwillingness to leave groovy practice and architects' lack of interest about later operating costs. Mistakes in projects aren't uncovered even by control mechanisms of present legislative and competent authorities.

EkoWATT deals with optimizing of residential building projects as well as storehouses, administration buildings and industrial plants. A few particular examples of optimizations are mentioned it this report.

Present situation won't change until investors start to call for guaranteed energy-economic solutions. The way to change does not consist in another regulations increase but in generating of demand.

A wide freeway bridge was erected by the incremental launching method. The original design was changed in order to satisfy the requirements for a short construction time. Many innovative technologies were tested and applied to satisfy the conditions of the client. Although the structure is rather thin-walled, the complete more than 30 m wide bridge deck belongs to the heaviest launched bridges in the Czech Republic and possibly in Europe.

Keywords: Low-energy, building, HVAC, construction, optimization, renewable energy, energy efficiency, research

1 Research project VaV-1I_3_35_04

In 2004 and 2005 Ministry of Environment of the Czech Republic supported by grant research project "System approach to reducing environmental stress in connection with construction and building exercise with accent on construction-energetic context. This project was disposed by EkoWATT in conjunction with group of prof. Ing. Jan Tywoniak, CSc. from the Faculty of Civil Engineering of Czech Technical University in Prague.

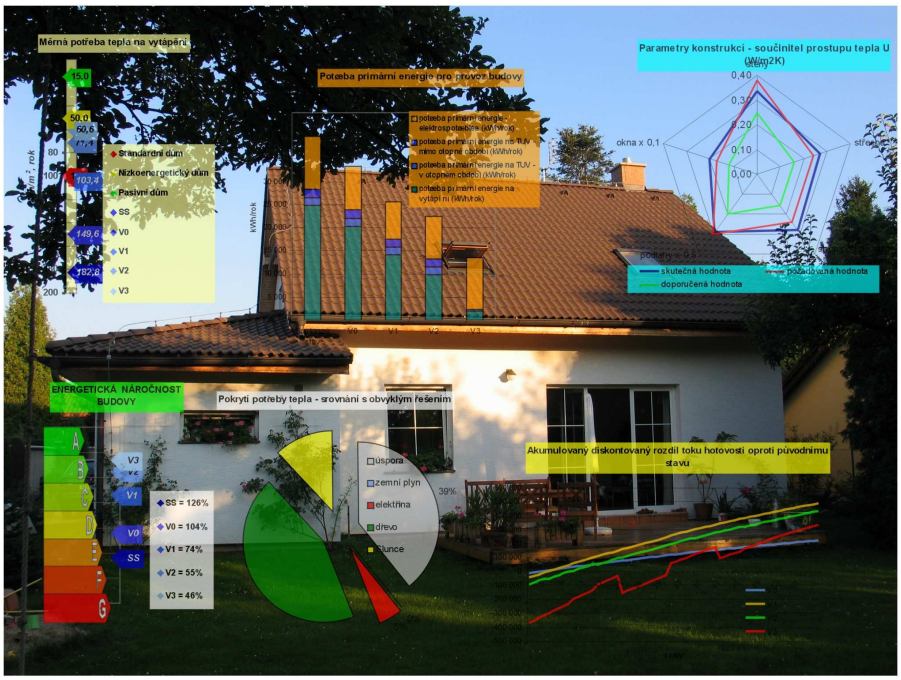
Main goal of the research was clarifying of barriers in energy-economical building construction in the CR and recommending the steps to ensure their better subvention.The bridge across the Rybny Creek is being built on the Freeway D8 from Prague to Dresden that crosses the mountains forming a border between the Czech Republic and Germany.

In terms of the research were solved following themes

- What's the quality-level of present construction?
- What are the differences between present standards and energy-economic buildings?
- Is increase of embodied energies in energy-economic houses significant?
- Are energy-economic buildings expensive?

Following sources were used for colleting information:

- Inquiry in surveyor's offices
- Detailed work on tens of projects
- Energetic audits
- Energy-economic model



Inquiry in surveyor's offices brought principal information – their staff is overlabored by administration and they have no clue about energetic characteristics of buildings.

That's why we can't expect any success even if better control of new buildings qualities through surveyor's offices would be enacted.

Attempts to get present state of construction from energetic audits came across problem with inequable contents of audits.

That's why these two sources of information were shaded as less important and attention was focused on qualitative research methods.

That's why the base for data collection finally were c. 40 closely documented family houses.

These objects all were built in recent years so they should respect modern methods of construction. Fifteen of them were declared as energy-economic other twenty-five of them had no special properties mentioned.

We set up a model for each of these houses, where we could alter construction types, sources of heating, types of heating regulation, ventilation types, water warming, tariffs for electricity consumption and other system parameters. Each modification was dynamically displayed in building energetics (e.g. different losses in distribution, different heat gain, etc.) as well as in operation economics. Changes in operation-costs were caused not only by different price of heat, but also by coherent change of tariff for electricity purchase including possible change of main power switch type.

Each of these modifications was also given different investment costs and reinvestments resulting from lifetime of particular system parts. Analogically were to every altered item assigned changes in embodied energies and emissions, which were compared with change of operational energy and operational emissions. Environmental assessment was done in relation to primary energy sources.

Working team made following conclusion:

Increase of values of embodied energies and emissions caused by construction modifications towards more economic standards is insignificant comparing with savings of operational energies and emissions.

Almost all projects could be improved in terms of effective energy utilization. Mostly it was possible to achieve 10-20 % savings without investment-costs enhancement, with minimal additional costs 2-5 % could by saved up to 33 % of operating energies. Low-energy standards could be achieved by increasing investment-costs by 10 %.

Decreasing of energy consumptions below certain limits wasn't followed by corresponding decrease of operation-costs. This fact was verified via more detailed modelling on low-energy solutions with typical combination of solar system working together with storage tank which was used also as heat source for warm-air heating. This system turned out to be economically less advantageous then e.g. installation of condensing gas boiler with low output. Mostly in the year the solar system wasn't able to produce sufficiency of heat so that the storage tank must have been supported by additional electric heating which is less economical with regard to system emissions as well as to economic costs.

Especially in these cases, which are automatically considered as fixed and unalterable, actually more various solutions exist. Order of convenience isn't definitely established. It depends on other factors as householders' habits, way of building operation, etc. When we think about above mentioned case in regard to emissions the solar system combined with additional electric heating is rather unsuitable; in regard to operational

economics it can't be definitely claimed. If electricity would be purchased for common tariff price, heating would be as expensive, that pros of low-energy solution would be vanished. That why it's more suitable to change the common tariff to electric-heating tariff which is joint with low energy price but also with high monthly taxes for extraction site on the other hand. With low electricity consumption for non-heating purposes this could be still less suitable than other sources. Anyway there is a break point where the situation changes because the tariff prices effects irreplaceable electricity consumption in household (fridge, PC, etc.) which can in total almost equal cost for low-energy house heating. Reducing the price of this consumption could bring higher benefits than cheaper heating.

As it's visible from previous text, selection of proper alternative depends on many factors and any generalizing rules can't be established. The only right way to find optimal solution is calculation.

2 Specific example from the research

One of the evaluated objects was this family house. It was built in 2000 with investment-costs of 2.45 mil CZK. Even the quality of constructions isn't any bad its specific heat consumption is 183 kWh / m^2 / year and thermal loss is 9.5 kW. High specific consumption is caused by unsuitable object geometric characteristics – the house is quite small and this small capacity is defined by relatively large surface of cooled constructions. In present state this house is being heated by gas boiler.

Fig. 1 Views and ground plan of the house

First step (V0) was null-cost optimization which suggested using thinner supporting structures and thicker thermal insulation.

Second step (V1) was further enhancement of thermal-technical properties of construction.

In third variant (V2) was mechanical ventilation was added which prevents from useless ventilating in unused rooms.

Last variant (V3) wasn't focused on costs sparing, but on maximal cut down of environmental stress by house operating – in addition to high quality constructions was installed controlled ventilation with heat recuperation and as heating source was installed wooden pellets boiler combined with solar system.

Tab. 1 Results of particular variants

Variant	Investment costs change	Operational costs change	Operational emissions of CO_2 change
V0	0,6%	-15%	-16%
V1	3%	-31%	-35%
V2	5%	-37%	-39%
V3	16%	-50%	-55%

Primary energy consumption necessary to provide operation of particular variants is demonstrated in **Fig. 2**:

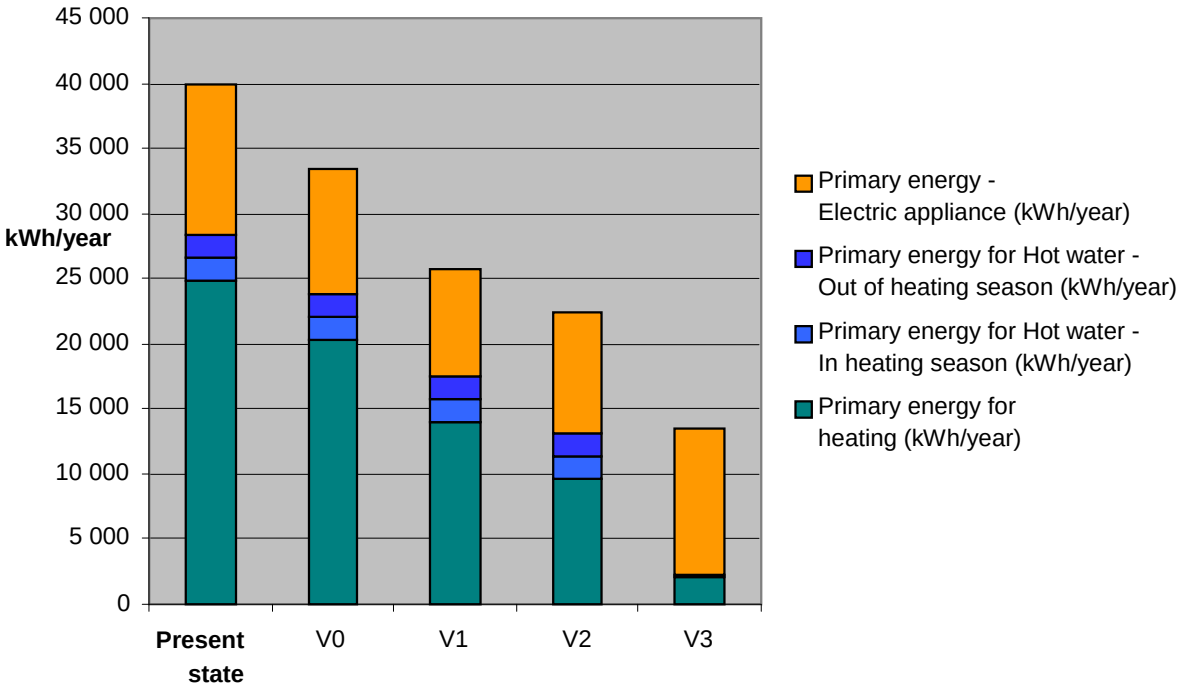


Fig. 2 Primary energy necessary to provide building operation

In the last variant is obvious decrease of energy consumption for heating and hot water. Main amount of energy is supplied from renewable energy source. This effect is reduced by increase of electricity consumption for recuperation because emissions production related to electricity consumption are approximately three times higher that e.g. by gas.

3 Project optimization in use

Practical utilizations of research project are numbers of optimizing studies that EkoWATT elaborated in 2005-2007. It's repeatedly proved that in most cases it's possible to find more suitable solution without additional costs. Optimizing method was successfully used for family houses as well as for administration buildings, commercial halls, etc.

First of examples is optimization of family house project which should be used in developer project of satellite village nearby Prague. Original project comes from USA and is characterized by specific thermal consumption of 172 kW / m2 / year. The project was localized by Czech Bureau of Architecture so that particular constructions meet regulations of ČSN 73 0540: 2005. Specific thermal consumption was decreased to 101 kW / m2 / year.

Investor submitted optimization study to EkoWATT with following limitations. Shapes of objects, unaffected ventilation and investment costs can't be changed. The result of our study is optimized project with specific thermal consumption of 59 kW / m^2 / year. Interesting thing of this all is that optimized house isn't more expensive but relating to investment costs even by 78 thousand CZK cheaper then previous version.

Second example of project optimization utilizing is extensive logistic zone nearby Prague. This zone was built after year 2000 and almost all of its parameters meet present regulations. Regarding to enormous operational costs (thermal consumption was c. 11 thousand GJ / year) it was necessary to find ways to decrease energy consumption.

During analysis was found out, that even if all systems are all right on their own they don't fit one by one to make smoothly working complex. Because the zone was projected with typical haste and submission changed again and again, designers of particular parts did not have any possibilities to communicate with each other and they even weren't prepared for it, because of lack of knowledge from other professions. The whole system was finally such complicated that there was no one to know how the whole zone runs as a complex. One of employees knew localization of system parts but didn't know which of them belongs to which part of zone. Another one knew technical data but didn't know how particular parts run. The last one, programmer, he knew all operation modes of equipments, but even didn't know where they are and how they work.

Optimization suggested fierce modifications as replacement of some (almost new) parts of air conditioning, so that it was possible to implement some mode changes in zone operating.

Removing of unnecessary energy consumptions and behaviour changes led to 40% spare of energy for heating. Thanks to this it won't be necessary to install another source of energy for newly built part of zone that is planned for this year. Even the costs of changes would be in millions, these expenses will be returned in two years.

4 Barriers for faster progress of energy-economic construction

What are the barriers of energy-economic construction? Why are we constructing so many buildings with such high energy consumption?

Research and it's practical applications repeatedly shows that most of present projects could be radically improved, economic solutions aren't contingent by extreme increase of investment costs even by increase of embodied energies and emissions. The most important problem seems to be systematic underestimating of pre-project preparation.

Each investor well knows how much construction material he gets for his money. In cases of projects, calculations and other brainwork many of investors tries to spare money. That's why new houses are built according to outmoded project which was just cheap or free addition to the material supply. The same situation is about catalogue houses which didn't change their projects for last fifteen years (except change in five cm of added

insulation to meet the new regulations). This wouldn't be such tragic, but these houses got to our catalogs from abroad as old fashioned and almost insufficient 15 years ago.

Another often problem is that projects are prepared with haste which leads to wrong sequence of each part. That's the case of above mentioned logistic zone.

When we sum time stress and unwillingness of investors to pay high-quality projects, we get another factor that makes limits for high-quality constructions. It's fear of designers to come with new projects. New better projects need time and cooperation with other designers – that all cost more money. And time and money is what investors hate to give. That's why designers use old routines.

Special chapter is cooperation with architects. Some of them are highly overestimating design of building against energetics and sometimes even against functionality. That's why each architect should cooperate with consultant dealing with energetics and economic building operation.

Even if investor gets over all difficulties of preparation and project process, there is another trap lurking for him. It's realized quality of building construction. If investor wouldn't be vigilant enough, he could get shoddy building with technologically wrong constructions that can totally depreciate the whole building. The only way to prevent this is to get quality works and author inspector and well written contract that specify ways of work parameters checking. This also increase investment cost but repairing of possible appeared problems and damages usually cost much more money.

5 …how to overcome?

Our traditions coming from Austrian monarchy advise us to get over problems by pressure, especially by authoritative pressure. We have one of the most perfect standards which are regularly novelized. We set up new energy management law, we proclaim public notices, we did energy audits for everything from Bohemian Forest to Jeseník and proposal for public note about energetic labels looks like we would need new generation of computing systems. Nevertheless we still build non-economic buildings.

We are trying to find methods of stricter control, setting new duties for surveyor's offices and property owners. We made new professions of auditors, controllers and certificators and property owners have to pay for something that law tells them to order. Ordinary designer starts to getting lost in his own branch and investors are jinking between regulations and trying to find cuts. In situation when investor feels the pressure of offices usually lead cuts over getting round the regulations. New swindling auditors appear who work for fragments of usual prices and who are "elaborating" hundreds of building audits which they have never seen even on a photograph. Paradoxal is that government sets up new regulations so chaotically, that it's not possible to control their realizing. One example for all is force of law whose implementing ordinances do not exist even at the time of their force. In this situation is much easier to disrespect the rules than respect them.

It is similar to pushing opposing ass in font of us. Once we realize that it's easier to stop pushing him and start pulling. Grass roots found out even better method – they put a carrot ahead of donkey's mouth. This method can be applied anytime, anywhere in any sphere of humans' life.

If investors understand that economic construction is in their behalf, then they will insist on completion of all their requirements that they paid for and that their building should meet. To get to this state we need the whole society to move forward and that

would need public information campaigns. Where can we get money for them? If we invest less effort to regulations and bureaucracy, it wouldn't be big problem to get some resources for public opinion influencing.

Another suitable way is to take advantages of economic instruments. We are discussing about ecological fiscal reform for years, but none of previous governments had the face to set it up. Now here are sheet lightnings. We soon realize that non-economic buildings are very inconvenient and their value decrease during years much faster than value of those well projected and constructed.

With energy savings it's like with nature protection. Years ago nature was full of rubbish and garbage. It took long time before intensive pressure of conservationists and public organizations helped to improve the situation. Nowadays person throwing papers on the ground is exposed to the critical eyes and strictures of passer-bys. We learned that that's something that shouldn't be done. Let's hope, that soon we'll be in situation when even small kids will know that wasting of energy and building non-economic buildings is something that shouldn't be done!

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