ENERGY BALANCE MODELING OF THE BUILDINGS

Jiří Karásek
CTU in Prague, Faculty of Civil Engineering, Thákurova 7, 166 29 Praha 6, e-mail: jiri.karasek@fsv.cvut.cz

Summary

Sustainable Buildings designing covers knowledge of the building material parameters, high efficient technologies, quality of processing and practical experience of all participants. Designer needs lots of data´s about building structures and future using of the building. Energy balance modeling is one of the methods, which can find the best choice for designer and stakeholders. Creating of balances can reduce energy demands during the Whole Life cycle of the building in pre-realizing phase of the Project. Energy balances commonly used mainly in power industry are useful to find and display energy flows and losses of the thermal energy and electricity in nets, but also economic parameters. In Civil Engineering are mainly used to find heating demands, but there are more opportunities of theirs using. The main aim is to make balances of different building parts, create Sankey diagrams and compare different variants or find a new solution that is the first step to optimize. Contemporary structures analyzing by energy balance method leads to better understanding of the process in different periods and quantify all energy and financial flows.

Keywords: energy balance, long-life cycle, energy flows, sustainability, economics

1 Approach to the Sustainable Development

Nowadays, there are two basic approaches to the Sustainable Development in Civil Engineering, economical and energetic (ecological). Economics deal with how the energy demands reflected in economic indicators - prize, rent, savings of heating costs and energy sales revenues to the network and forms of subvention. Energy approach seeks to quantify the energy demands or other environmental parameters on the search for solutions to minimize energy demands of buildings or structures and the possibilities for optimization. The energy approach deals with the reducing of primary energy resources influence the production of atmospheric CO_2 and other greenhouse gases [7].

Not always are both two approaches entirely appropriate. Economic approach does not include environmental issues of Sustainable Development or expresses it indirectly, energetic approach, often does not include all the relevant categories of energy demands associated with economic concepts.

In narrower economic concepts such as the developer we only concerned with investments cost and other economic parameters such as the heating costs and recycling of materials are important for us only from a marketing point of view [1]. In broad economic concepts such as public investment become other cost categories more important. Process is based on the LCC analysis or on WLCC analysis [2]. Then the solution starts approaching stronger economic solutions to energy solutions.

Energy concept normally deals with the energy demands of buildings, heat loss, heat gains, and heating demands, hot water and heat sources, including renewable energy sources. But all this is just one phase of the Life Cycle of buildings [3]. The solution found by evaluating the energy demands of buildings often differs from the solutions created an economic approach.

Why? Neither of the approaches does not include all phases of the Life Cycle buildings and does not cover all affects. To achieve the objective results is necessary in both approaches economic and energy to deal with problem comprehensively. The following calculation deals with the comparing the standard energy approach and comprehensive approach. The difference in the standard approach and comprehensive approach shows an example of measurement the structure facade under specified edge conditions. A simple example of a model approach to square metre facade shows us a significant difference in the results.

1.1 Calculation parameters

To the standard calculation of heating losses is necessary to use the technical parameters of the wall, but take in the calculation parameters of the building and its equipment and inhabitants. It is necessary to determine the dimensions of object, its heat gains, losses and norms to square metre of construction. The calculations include the heat loss of the facade that resulting from the desired internal temperature and external temperatures. The balance includes heating energy, heat appliances and metabolic heat. Energy for heating includes the primary energy, which depends on the effectiveness of resources [4].

1.2 Basic description

As an example, is used a newly reconstructed family house from the early 20th century, situated in northern Germany. Floor space is 372 m^2 and the area of the facade over the ground is 228 m^2. Types of wall construction includes an indoor stucco, ceramic full brick 300 mm, 60 mm spilled thermal insulation, from the outside 150 mm ceramic clinker brick and outdoor stucco [6].

Fig. 1 Annual energy balance expressed per m^2 of the façade

Energy balance shows the basic processes that take place in 1 square meter area of the facade. In calculating the balance of the facade are not covered solar gains particularly influenced by windows, loss of ventilation, technological heat resources and hot water

warming, recuperation, because the balance of the wall does not participate. Balance affects the delivery of energy heating system, solar and internal gains. Energy flows affect the above parameters of the building and the thermal parameters of the calculation of heat losses.

1.3 Advanced description

This simplified method of calculation includes all major categories that affect the operation of the building. But if we look at the calculation of the economist perspective, we do not see acquisition costs of the construction in Fig. 1. In this case, our calculation is incomplete [5]. We need to create balance, which will include the Whole Life Cycle of buildings. A similar logic applies to the whole building, because missing out all major categories of energy significant effects; we cannot get adequate results [8].

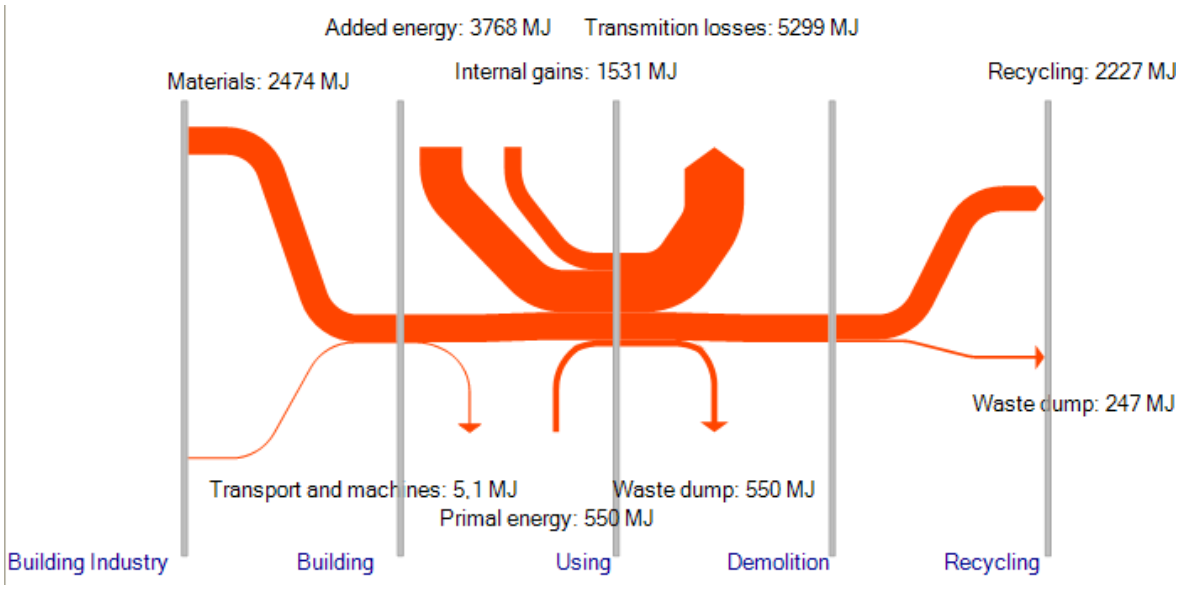

Fig. 2 Energy balance in LC expressed per square metre of the facade

Energy balance includes the energy flows in various phases of the building, during its Life Cycle. The balance shows initially high energy demands during the construction phase, continuous flows of energy during the use of energy levels and decrease phase of recycling. Energy demands phase of using are multiplied with 75 years of using. In the evaluation process can be inserted as the process of maintenance and renewal. But both processes are significantly influenced by the user's behaviour and strategies. Diagram advanced to the next phases of the building, better reflects the technical and economic realities. Activity, which includes material demands and economic demands, brings energy demands [9].

2 Conclusions

A simple example square metre of the facade shows the relevant energy balance in the using phase and the Whole Life Cycle. Energy approach and economic approach to the construction are just two distant approaches, which are starting to be closer. Simplified vision of the building put off both approaches and their solutions. In recent years,

deepening the use of LC analysis of the two approaches became significantly closer. Energy-efficient building must become also economically efficient.

References

[1] STERN, N. *Stern review: The Economics of Climate Change*, 2006, 5.3.2010, p. 576. WWW: <http://www.hm-treasury.gov.uk/stern_review_report.htm>.

[2] BERAN, V., DLASK, P. *Life Cycle Cost Optimization and Rational Cash Flow*. In: Advancing Facilities Management and Construction through Innovation, Helsinki 2005, Technical Research Centre of Finland, vol. 1, p. 152-153, ISBN 951-758-455-5.

[3] BERAN, V. *Management of the Sustainable Development the Long Life Cycle Buildings, Building Industry and Territories*,1.ed. Prague 5005, p. 149, ISBN 80-01-03380-5.

[4] HROMADA, E. *AIP-RS,* software for the Cash Flow, NPV, IRR and the Sensitivity Analysis computing, Prague 2008, 5.3.2010, WWW: <http://eko.fsv.cvut.cz/simul/ Program AIP-RS>.

[5] PROSTĚJOVSKÁ, Z. *Financial Analysis of Projects and Loans*, 1. ed. Czech Chamber of Certified Engineers in construction, Prague 2007, p. 52, ISBN 80-87093-19-4.

[6] *Thermal Protection of Buildings ČSN 730540-2v*, Prague 2007, Czech Standards Institute, p. 44.

[7] *Sustainable Development Strategy of the Czech Republic*, Prague 2004, 5.3.2010, p. 54. WWW: <http://www.cenia.cz/web/www/web-pub2.nsf/$pid/MZPMSFHDHBNA/$FILE/SUR_CR_FINAL_2004.pdf>.

[8] GEISSLER, S., at al. *TQ Tool software for building evaluation,*2008, 5.3.2010 WWW: <http://www.iswb.at/>.

[9] PAČES, V., at al. *Report of the Independent Expert Commission to Assess the Needs of the Czech Republic in the Long Term*, 2008, 5.3.2010, p. 276. WWW: <http://www.vlada.cz/assets/ppov/nezavisla-energeticka-komise/aktuality/Pracovni-verze-k-oponenture.pdf>.