Abstract

Dynamic changes in the economy of natural resources and their impact on the volatility of energy prices is forcing engineers to pay attention to flexible and sustainable management in the construction industry. Limitation of energy consumption is governed by the Technical Conditions [1]. More restrictive rules were made in 2014, 2017 and planned for 2021. Another document, which regulate the building performance, is European Union directive 2010/31/EU [24]. The authors seeks to demonstrate the importance of testing various solutions for heating a single family building on the basis of life cycle in terms of cost, solution flexibility and environmental impact. The analysis is preceded by an introduction to the LCC analysis and key milestones in the system life cycle. A very important factor in the analysis is the operating time of the systems, which may vary depending on the solution. Long time horizon also generates the difficulty of predicting changes in both energy prices as well as the usage of the building. This is why the next point will be the issue of flexibility as well as the ability to adapt to changing needs, conditions and costs. Both aspects will be presented as components of sustainable solution approach based on the balance between economy, ecology and comfort. The aim of the study is to compare the available heating systems for single family housing in the light of aspects of sustainable construction and modular construction of single – family housing. The analysis was aimed at introducing the subject and defining the direction of further research.

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1. Introduction

Sustainable buildings require optimally fitted system of heating. In Polish climate most energy of the building in life cycle is dedicated to heating that is why authors decide to make comparison between heating systems in Poland. In comparison one can find innovative system and traditional based on coal. Investigation touches sustainability aspects: environment, user comfort and economy. The goal was to check weather concerns about sustainable energy solutions are justified and shows profit from implementation of modern systems.

2. Sustainability

Sustainable development is one of the most crucial aspects in the contemporary World. The main idea is to keep balance between user comfort, economical aspect with the limited impact on environment. Many regulations like ISO standards namely ISO 14000 family [2-5] all courtiers can follow the instructions with ease. This trend helps to take attention from economic aspects and notice environmental issue. The crucial aspects in environmental aspect are listed below:

- Exhaustion of resources
- Depletion of the ozone layer
- Creating smog
- Eutrophication
- Climate change

Thank to massive and rapid changes new technologies are introduced in global scale and become available for regular client. One of the biggest development can be observed in photovoltaic panels making it competitive system for building heating in Polish climate. That is why authors decide to take it into consideration.

3. Adaptability

Sustainability depends on many aspects especially in changeable environment. One of the means of improving sustainability is long life of the product. Because of that it is so important to design products that could adapt to changing conditions. The system needs to provide the opportunity to change if it is design for long service time. The possibility do adjust to changeable needs is called adaptability and one can find diverse definition of the term in the literature. In the housing heating context the most important seems to be the ability to change volume, function or performance [6], ease of response to the changed conditions [7], presence of less common but more dramatic changes [8]. On the other hand, adaptability of buildings means to remain ready for change in order to respond the needs or reduce the mismatch [9]. Considerable theoretical and practical dissertation can be found in the book Adaptable Architecture [10]. Another important analyses are based on existing buildings subjected to continue adaptation process. Investigation concerns British terraced houses, blocks of flat in Sweden and office buildings with open space designed for self-development based on open plan idea. Model which helps in receiving a feedback from the user is presented in Kelly and Smith paper [11]. Another authors emphasis the need to design facilities to enable adaptation: “If the building does not support (technologically and technically) change and reuse you have only the illusion of sustainable construction [12]. This is an extensive analysis of the literature with the attempt of creation a holistic definition of adaptability. Interesting in terms of flexibility is looking for the answer the question: how to design once, but for a long time [13] Also doctoral dissertation of Manewa takes into account economic aspects of the adaptation of the of buildings [14]. According to Schmidt et al. [15] ability to adapt can be divided into several categories Fig.1.:
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