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METHODOLOGY FOR MEETING OBJECT´S ENERGY DEMANDS BY RENEWABLE ENERGY SOURCES

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The article deals with methodology for meeting heat energy demands of specified object. In first part, the written program is evaluated, its principles and logic. Object is described as well. Second part describes the decision algorithm, which is used for obtaining optimal results and choice of devices.

Key words: methodology**,** assessment, energy, Excel, measurement, decision diagram.

Introduction. In present days we are observing how fragile and unstable our current energy system is. It is based on fossil fuels as a primary energy sources, which are limited and their price per unit rises. This price increase of raw material leads to more expensive services, transport costs, and mostly more expensive heat and electrical energy. Because the demand for energy will rise, as the world´s population is increasing, the current system is not possible to maintain forever. Alternative is needed and such alternative is possible with renewable energies like wind, sun and geothermal energy, which are available to whole world and are free. Their mass utilization proves to be imperative when the fossil fuels will be depleted and energy demand would need to be covered.

Problem statement. The task is divided into several parts. First part is to find a way how to find how much energy the any specified object needs. Currently we will consider just heat energy needed. In order to solve this part, program had to be written. The second part is to find how much energy is available in current region, so the local weather conditions must be evaluated with the whole year measurements of the devices used, like for example photovoltaic panel.

Experimental part and result obtained. Under the term „object“ we understand building, which we want to evaluate. For the purpose of evaluation, program was written in MS Excel utilizing the embedded Visual Basic for programming the essential functions and calculation.

The object can be up to 2 floors building, where every storey can have from 1 to 15 rooms. Every wall can be specified (its size, construction material, type of plaster and/or insulation, also additional features like windows and/or doors).

From electrical point of view, the storey can be imagined in following way (fig. 1)

The drawing of this scheme is very simplified, as at the beginning we consider that all the rooms are connected with each other. In terms of logic it is of course nonsense, however the not defined joints would not interfere with the equations, as there will be zero value.

The resistors represent the total thermal resistance of walls (including any extra options like windows, doors, as well as ceiling and floor). The second resistor represents the air resistance. Every room has two sources, one is common to all, this is the outdoor temperature, which has to be specified. The second source represents the temperature of heater, which will be counted after you specify the needed temperature in every room, which was specified. Needed thermal power output is counted as well.

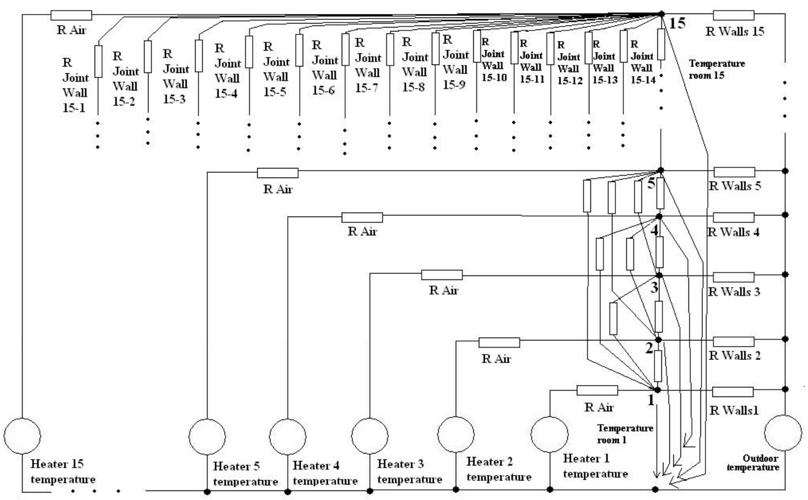


Figure 1 – Simplified scheme of one storey

Such scheme describes every storey, however in case of more storey, than just ground floor, the scheme includes additional resistors, which describe the thermal resistance of combined ceiling/floor and all of its features.

The system is as modular as possible, it is easy to add more storeys if needed, or even more rooms.

To obtain correct values for thermal power output, we must specify as most accurate values as possible. The thermal properties of construction materials are included in program, however for having a complete results, we must use the measured temperature values, ideally from whole year. Average temperature values from 2005-2010 years from Košice´s region will be used (fig. 2).

The sample screen of the program interface is shown in following figure (fig. 3).

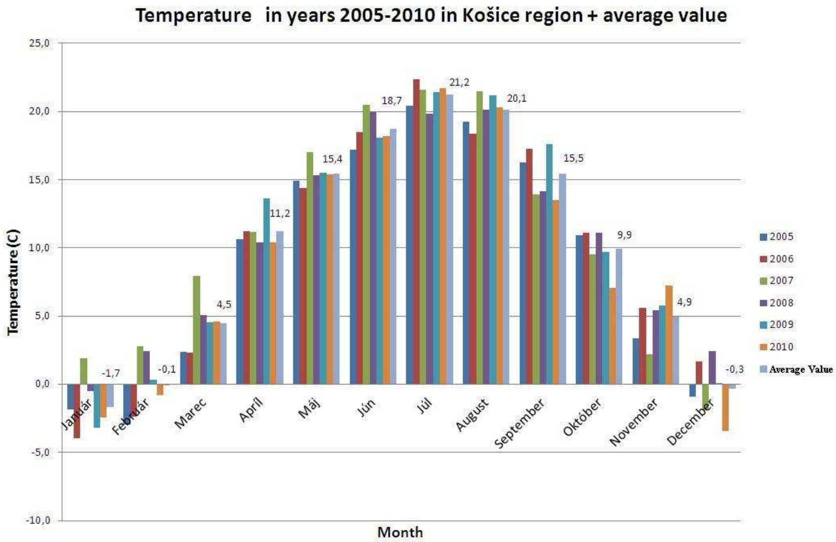


Figure 2 – Temperature statistics for model

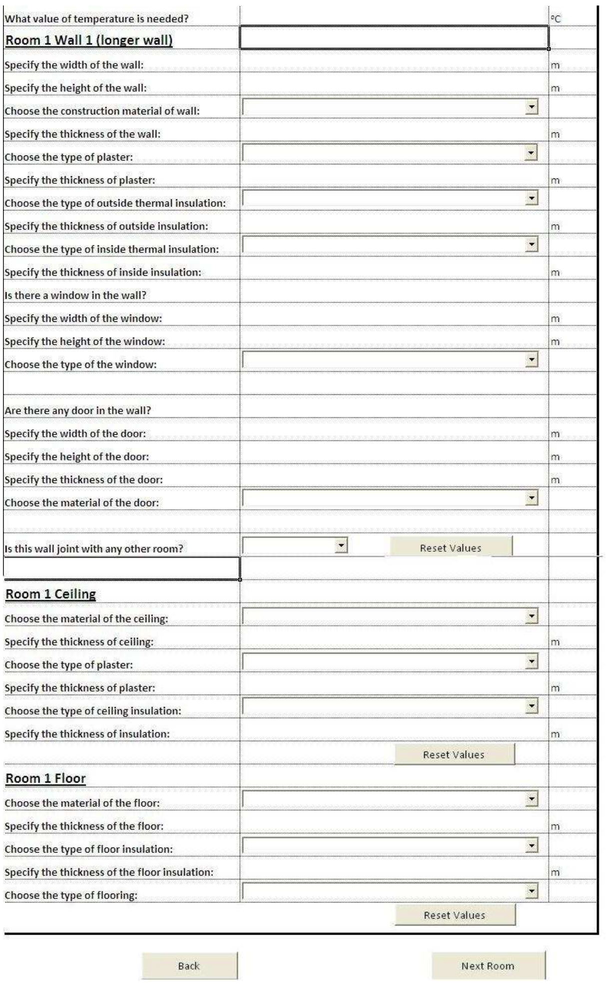


Figure 3 – Sample screen of the program

As a reference object, we have considered the older residential house with one additional storey above the ground floor, which was made of older type full burnt brick, as it was the most common material, from which most houses are made from. The ground floor as well as the upper storey contain 4 rooms, so the total number of rooms is 8, which is quite standard. The outside temperature was chosen from the graph (fig. 3) and the inner temperature was set to 20 ºC to represent approximately the most common situation. We didn’t consider any insulation, plaster or flooring materials, although it is possible, and needed for more precise results. The results in graphical form using MS Excel can be seen in the following picture (fig. 4)

Next step lies in determination of proper devices, which can be used to meet the energy demand, and their operating expenses for 25 years have to be the lowest.

The devices, which are considered, are: the gas cauldron, electrical cauldron, thermal heat pump. The electrical cauldron and thermal heat pump can be operated using the electrical energy from mains, or using the energy generated by solar cells, wind turbines, or combined. In order to determine the best possible solution (or better said the solution with lowest operating expenses) some sort of decision algorithm is needed. The amount of available devices is very large, and due to non existing general guidelines the choice is difficult and confusing.

The following algorithm (fig. 5) presents one possible approach to problem solution. The algorithm is divided into several parts for easier viewing.

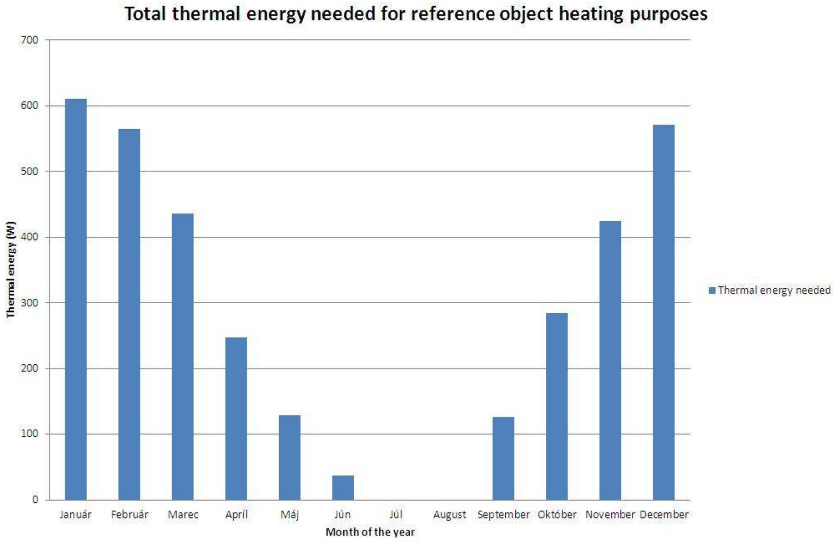
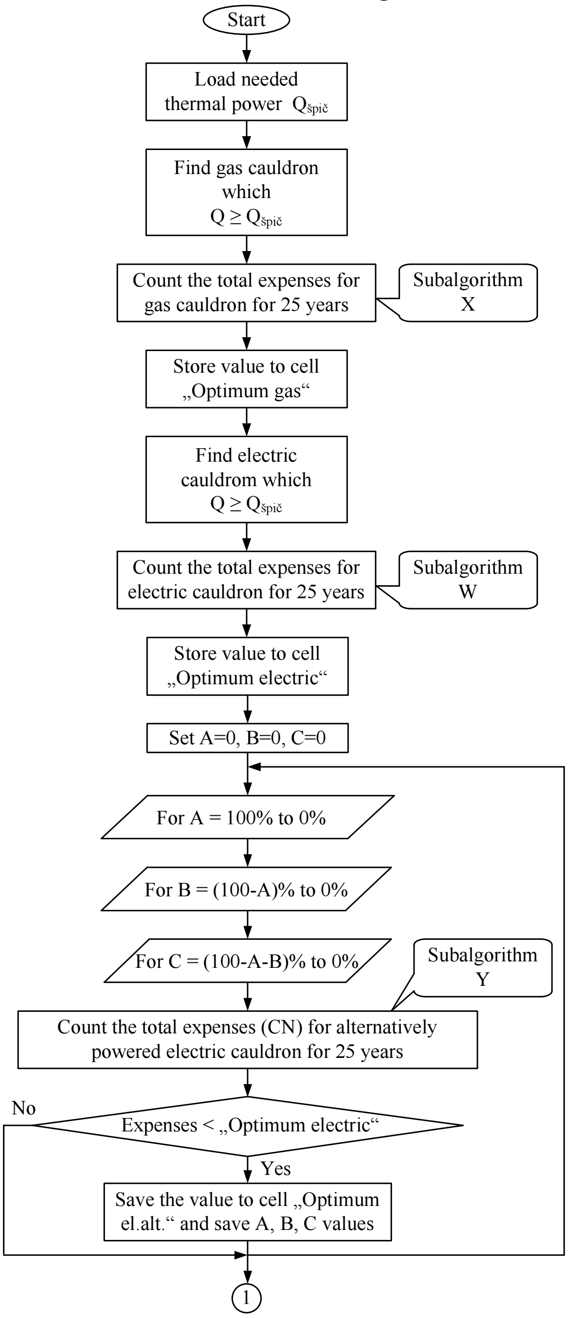


Figure 4 – Thermal power output needed for object



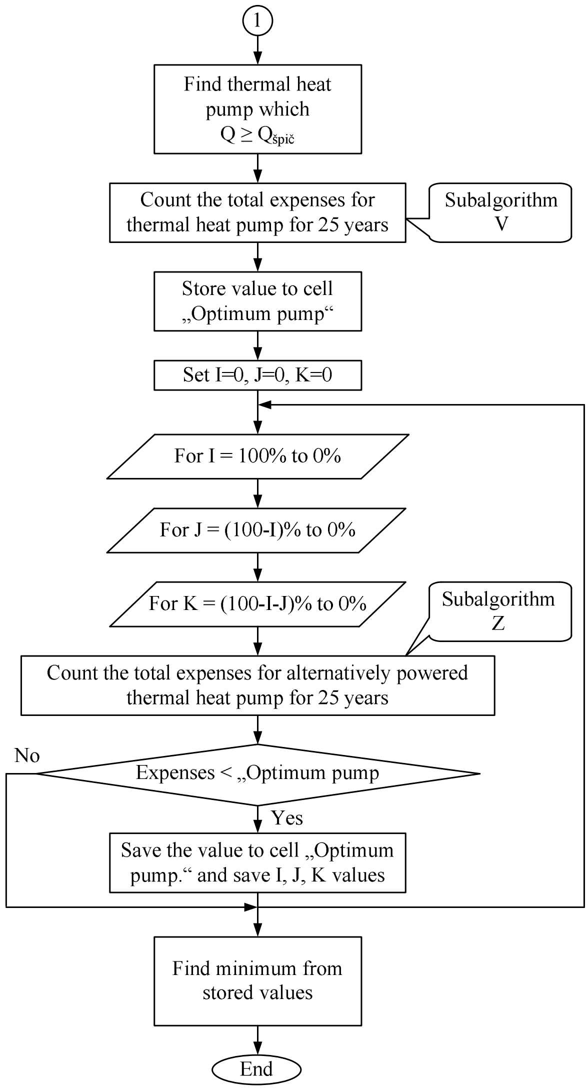


Figure 5 – Decision algorithm

The capital letters A, B, C represents the percentage of electrical energy which is delivered by A – traditional electrical energy from mains, B – electrical energy delivered by photovoltaics, C – electrical energy delivered by wind turbine. The same is valid for thermal heat pump, which needs electricity for compressors, but the letters are I for traditional electrical energy from mains, J for photovoltaics and K for wind turbine, to avoid possible confusion.

The program counts every possible variant of A, B, C (I, J, K) which meet the initial condition, that A + B + C = 100%. The incrementing/decrementing step is set to 1%.

The value of expenses for gas cauldron, electric cauldron, thermal pump (and expenses using alternative sources) are stored, and then minimum value is determined, which is the result of program.

The subalgorithms (fig. 5) are used for calculation of total expenses for every device for the period of 25 years. The cost of electrical energy and gas is predicted for future. The prediction is based upon the real prices from the past, where the linear increase is predicted. Due to limited availability of traditional energy sources and gas and shortening global reserves, the price increase is logical and expected in the following years.

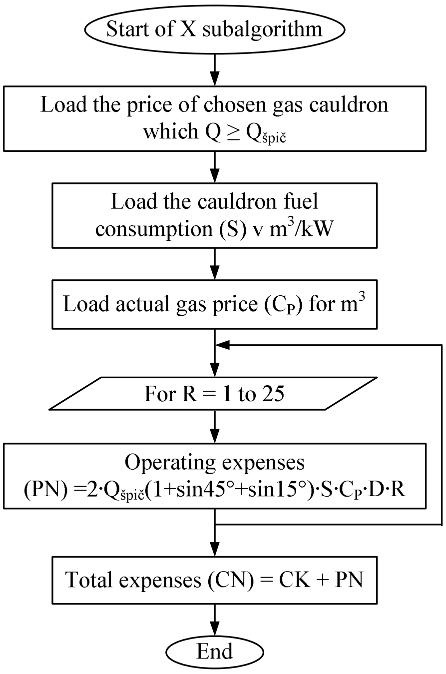


Figure 6 – Device subalgorithm

The subalgorithms X, W, V are very similar in principle, so it is not necessary to describe every one of them. In this case the letter D stands for coefficient of gas price increase, which was obtained from statistical data. The differences lies only in different input values, when in case of electrical cauldron, the consumption of electrical energy is used as well as price of electrical energy. Of course different coefficient for energy price increase is used, as the price of gas rises more slowly than the price of electrical energy.

Above subalgorithm (fig. 7) is the subalgorithm Y (again subalgorithm Z is very similar to Y, with just a minor changes in constants and coefficients). As mentioned previously, letters A, B, C represents the percentual portion of electric energy from traditional mains supply, from photovoltaic and from wind. F represents efficiency of photovoltaics, G represents the efficiency of wind turbine.

Conclusion. The described program is still in development. Next stages will consist of filling the database with real market devices using real technical specifications. The results, which will be obtained by program after its finalization, will have to be then verified by simulation. It is worth to note, that this program and algorithm has wide use of application and is not necessarily bound just to building, as an object it is possible to consider for example car. After some adjustment, the program can be used in automotive electronics.

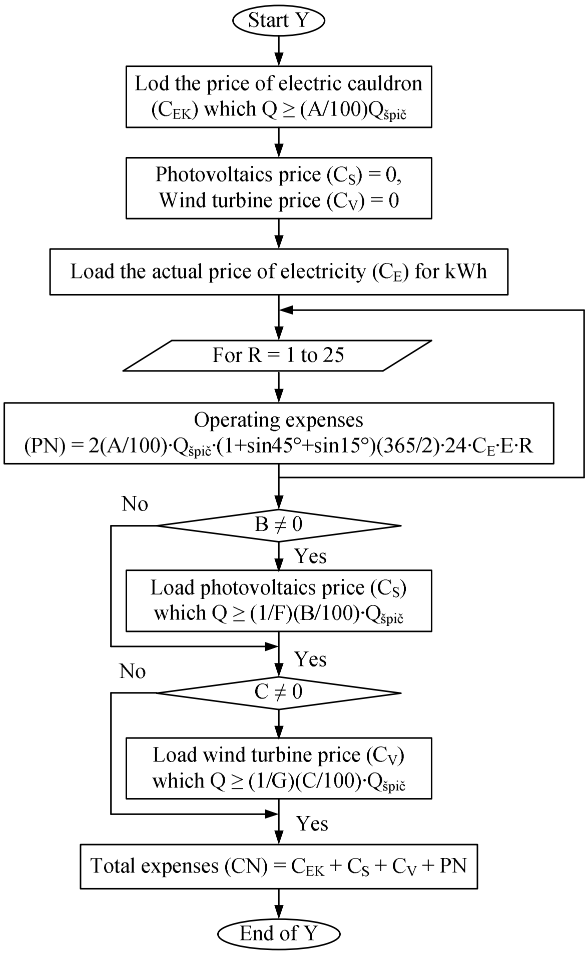


Figure 7 – Subalgorithm for alternative power

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REFERENCES

1. Freris Leon, Infield David. Renewable Energy in Power Systems, 2008 West Sussex.

2. Sorensen Bent. Renewable Energy, Physics, Engineering, Environmental Impacts, Economics & Planning, 4th Edition, 2011, Elsevier Ltd. United States of America.

3. Kováč D., Vince T., Molnár J., Kováčová I.. Modern Internet Based Production Technology. In: New Trends in Technologies: Devices, Computer, Communication and Industrial Systems, Book edited by: Meng Joo Er, Publisher: SCIYO, November 2010. – P. 145 – 164. – ISBN 978-953-307-212-8.

4. Kolla I., Kováč D. Communication interfaces for measuring systems, In: Acta Electrotechnica et Informatica, 2007, No 4, Vol. 7. – P. 31–35. – ISSN 1335–8243.

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МЕТОДОЛОГИЯ ОПРЕДЕЛЕНИЯ ЭНЕРГЕТИЧЕСКИХ ПОТРЕБНОСТЕЙ ОБЪЕКТА ПРИ ИСПОЛЬЗОВАНИИ ВОЗОБНОВЛЯЕМЫХ ИСТОЧНИКОВ ЭНЕРГИИ

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Предложена методология оценки потребностей объекта в тепловой энергии. В первой части представлена созданная программа, ее логика и принцип работы. Объект описывается так же. Во второй части описан алгоритм принятия решения, используемый для получения оптимальных результатов, и выполнен выбор устройств.

Ключевые слова: методология, оценка, энергия, Excel, измерения, решение диаграммы.

МЕТОДОЛОГІЯ ВИЗНАЧЕННЯ ЕНЕРГЕТИЧНИХ ПОТРЕБ ОБ'ЄКТА ПРИ ВИКОРИСТАННІ ВІДНОВЛЮВАНИХ ДЖЕРЕЛ ЕНЕРГІЇ

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Запропоновано методологію оцінки потреб об'єкта в тепловій енергії. У першій частині представлена створена програма, її логіка і принцип роботи. Об'єкт описується так само. У другій частині описаний алгоритм прийняття рішення, що використовується для отримання оптимальних результатів, та виконано вибір пристроїв.

Ключові слова: методологія, оцінка, енергія, Excel, вимірювання, розв’язання діаграми.