

Opponent's review to the dissertation thesis

## Long-term combined heat and power production and trade planning

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### **Significance and topicality of the dissertation**

The subject of the thesis is practically oriented. It deals with modelling and optimization of the work of combined heat and power plants. This way of production of electrical power is very desirable, as it saves energy and prevents air pollution. From this point of view, the thesis is really significant.

### **Methods of solution**

The dissertation consists of two parts. The first one is devoted to developing of method for construction of model of the combined heat and power plants which can be used for mixed integer linear programming. The second part produces an algorithm for solution of the optimization problem which is feasible and efficient. The solution is based on an expert knowledge of the problem, however, it is general and can be used for various types of the plant. The solution itself reduces the original problem which is too large to be solved by exact optimization ways. Several types of metaheuristics have to be introduced and use to achieve a feasible solution.

The work starts with practical description of the combined heat and power plants and problems connected with them. Here also the goals of the thesis are stated.

In chapter two, the state-of-art is recapitulated and review of the existing literature is provided.

The most important chapters are three and four. Chapter three is devoted to modelling. The model of so called generalized component is based on the laws describing thermodynamic cycle. This generalized component is then specialized to individual components and interactions between them. In the end a way how to use these partial models for the optimization task is demonstrated.

In chapter four, the solution to the optimization problem is demonstrated. The problem would be relatively simple (could be decomposed in time) if it were not the so called coupling restrictions that interconnect individual components of decompositions. That is why the main effort of the solution is a reduction of the too large mixed integer linear problem to some manageable form. The solution is described in this chapter.

Chapter six deals with testing of the developed algorithm. The tests are performed for three plants representing the real applications. The results are promising.

### Results and their contribution

The results of the work are summarized in last chapter Conclusions. Here the three points are declared as the result. They are (i) usability of the produced algorithm for various plants, (ii) knowledge of the difference between optimal and achieved solution and (iii) capability to obtain good solution at least for two hours ahead. It can be declared that all these three results have been really achieved.

### Processing and quality of the dissertation

The thesis presented is well elaborated. It comprises all what it should have as a dissertation. From the formal point of view it is also OK.

The only weakness is that it is very difficult to read. This difficulty is not given by the complexity of the problem described but by a clumsy way of expressing. Some sentences must be read several times than they make sense (at least for me). According to my experience, the work should have been still rewritten - if the ideas are clearer the exposition can be simpler and better understandable. I would go as far as to say that some paragraphs are explained so that only he who fully knows the problem can understand them.

I have the following comments/questions

1. There is too many abbreviations in the work explained only once (and even in abstract) and then they are used without any recollection. An example is on page 19 - ... it is modelled using PWL functions (PWL - not explained).
2. At page 22 in the formula (3.7): some weighting coefficient  $\lambda_i^{B1}$  appears and is not commented.
3. At page 36 the first sentence "At each step of ..." is not a sentence.
4. At page 38 the formula ( $MILP(y)$ ) is strangely positioned.  
The paragraph below is very confusing. Especially the exposition about segments  $a$  and  $c$ .

5. Pages 36-37 seem to me not sufficiently described. I would appreciate if the candidate could once more briefly explain the principle of breaking the task into segments with dropping variables. Especially I would be interested in justification of this procedure.
6. In chapter five describing experiments, the results obtained are compared to those achieved by Gurobi. So the question arises: is the problem so large that it needs a special treatment or is it manageable by some existing software?

However, all these comments are not crucial with respect to the goals of the thesis and do not reduce the importance of the work.

#### **Publications of the candidate**

The publications of the author are more than sufficient.

#### **Conclusions of the opponent**

The thesis presented demonstrates a large amount of work that has been done. The experimental part shows that the results are correct and useful. The candidate brought new scientific results. That is why I can recommend his thesis for a defence and in the case it is successful I recommend to grant him the degree Ph.D.

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