

Theoretical Justification of the Model of Evaluation of Renewable Energy Sources Integration on Fossil Fuel Energy Sources Operation Efficiency

Māris Balodis¹, Remigijs Počs², Valērijs Skribans³, Polina Ivanova⁴

¹ Riga Technical University, Latvia, maris.balodis@latvenergo.lv

² Riga Technical University, Latvia, remigijs.pocs@rtu.lv

³ Riga Technical University, Latvia, valerijs.skribans@rtu.lv

⁴ Riga Technical University, Latvia, polina.ivanova@latvenergo.lv

Abstract

This document provides the information about the opportunities of situation evaluation. There are two methods for situation evaluation: complex approach and analysis of situation. In details the complex approach is going to be studied. According to complex approach situation is evaluated using theoretical model. This document provides the main points about situation evaluation methods, explanation of evaluation methods choice and aspects about theoretical model creation.

Keywords: complex approach, situation analysis, systemdynamics, theoretical model

Introduction

Energy problems are common worldwide, but it has own character in each country [1]. The current situation in Latvia can be described in such way [2]: competition increase between energy production companies; changeable situation in fuel and electricity market; new market regulation mechanisms; increase of energy efficiency demand and penetration of renewable energy sources (RES) in energy production process. So there is a big competition in energy sector in Latvia. So it is necessary correctly evaluate situation and its influence on the investigated object to stay competitive. According to evaluated results appropriate actions should be taken.

The situation can be evaluated using *complex approach* or *situation analysis*. The *situation analysis* means orientation to the certain problem, which concerns only investigated object. Using the *complex approach* the situation is evaluated in system and investigated object is a part of this system. Man creates system according to situation and desired results. Situation is modelled using the appropriate software.

Systemdynamics is approach, which deal with *complex system*. *Systemdynamics* investigate how some facts and variables influence investigated object using mathematical relationships [3, 4]. In this research authors use *systemdynamics* approach to create the theoretical model to evaluate the integration of RES on the investigated object.

As investigated object AS Latvenergo Riga CHP-1 and Riga CHP-2 plants were chosen. Both CHP plants are up to date power plants, which operate under competitive conditions. For example, before 2008 Latvenergo CHP plants were the main energy source, which produced thermal energy on the right bank of Riga district heating system. After 2008 the situation has changed, because new fossil fuel energy sources appeared. So competition for load distribution has increased [3]. Moreover, it is forecasted that in near future the level of competition will increase more due to increase of RES use. Authors want to evaluate the RES influence on AS Latvenergo Riga CHP-1 and CHP-2 power plants in large scale, so *complex approach* is chosen.

Methodology of Research

Firstly, the theoretical model should be created, which can be used to evaluate RES integration and its influence on fossil fuel energy sources operation efficiency. Secondly, the structure of theoretical model should be developed (Fig. 1). It means that structure's elements (blocks, *sub-blocks*, variables, connections, causal relationships, etc.) should be identified. Thirdly, according to the theoretical model and its structure the *systemdynamics* model should be developed. Figure 2 shows the example of *systemdynamics* model. It is a *systemdynamics sub-model* of *sub-block* "Small CHP plants".

To show difference between both methods – *complex approach* and *situation analysis* – it is planned to reflect the examples of second approach (*situation analysis*), too.

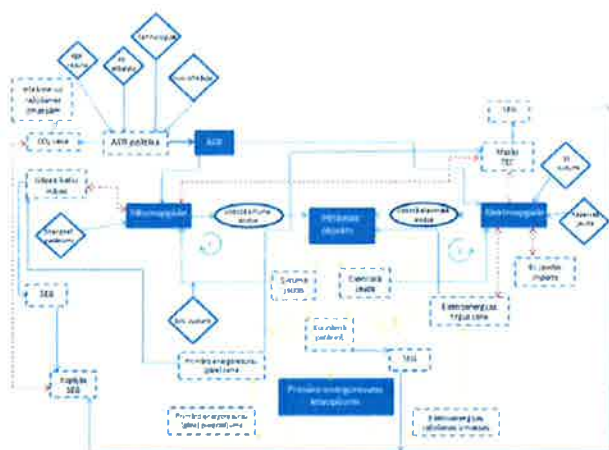


Figure 1. The structure of *theoretical model*



Figure 2. The example of *systemdynamics* sub-model

Findings

The model creation is the most challenging step in *complex approach* - all elements and connections of model structure should be observed. That is why cooperation of experts and academics from different scientific fields is necessary. Moreover modelled situation should be evaluated from different point of view: energy sector, economic sector, legislation, etc.

Conclusions

The choice of *complex approach* or *situation analysis* is depend on results, which are planned to obtain. *Complex approach* evaluates situation globally (in system). *Situation analysis* focuses on certain situation and object.

References

- Skribans V. Latvijas energosektora sistēmdinamikas prognozēšanas modeļa izstrāde. *Enerģētika un elektrotehnika. Nr.26, 2010.*
- Žīgurs A., Kunickis M., Balodis M., Linkevics, O., Stuklis I., Ivanova P. Evaluation of Exhaust Gas Condensing Economizer Installation at Riga CHP Plants. *No: Proceedings of REHVA Annual Conference 2015, Latvija, Rīga, 6.-9. maijs, 2015. Rīga: RTU PRESS, 2015, 149.-154.lpp.*
- Skribans, V. Jauna produkta ieviešanas tirgū modelēšana, izmantojot sistēmdinamikas metodi. *Tautsaimniecība – teorija un prakse. Nr.17, 2008, 99.-105.lpp.*
- Hollmann M., Voss J., Modeling of Decentralized energy supply structures with „System Dynamics”, Amsterdam: IEEE, 2005, 6 p.
- Kunickis, M., Balodis, M., Sarma, U., Cers, A. Efficient Utilisation of Cogeneration and Fuel Diversification. *No: International Symposium, Dedicated to the 150 Anniversary of the Faculty of Transport and Mechanical Engineering: Scientific Program and Book of Abstracts, Latvija, Rīga, 16.-20. oktobris, 2014. Rīga: RTU, 2014, 35.-36.lpp.*

The paper was supported by the National Research Program 5.2. EKOSOC-LV