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Energy policy for energy intensive manufacturing companies and its impact on energy efficiency improvements. System dynamics approach

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Abstract

In this paper we evaluate Latvian Energy policy for energy intensive manufacturing companies and its impact on energy efficiency improvements using system dynamic approach. Since mid-2015, energy policy developments in Latvia are targeted to reduce energy costs for energy-intensive companies while imposing an obligation to implement an energy management system, which would increase the overall efficiency of the manufacturing industries. Simulation of theoretical energy-intensive manufacturing company behaviour showed interest in energy efficiency measures until its energy intensity closes to the benchmark stated in the energy policy, and then following corrective actions are taken to maintain the energy intensity above the benchmark. This results in lost energy efficiency savings. To minimize energy efficiency effect on the energy intensity calculation, the amendments to the energy policy is offered and its impacts are simulated using system dynamic modelling.

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Keywords: energy intensive industry; policy evaluation; system dynamics

1. Introduction

Currently there are little doubts that energy costs are a major factor for the competitiveness of manufacturing industry. Study [1] had shown than different levies related to support schemes are currently raising the price of

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electricity and subsequently the energy costs of industries. The most affected are considered to be energy-intensive industries. Nowadays costs of European Union energy transition as well as new investments in conventional power generation are passed to the consumers mostly via energy prices. To limit the burden, the European Commission has adopted harmonized rules on how Member States can relieve energy-intensive companies that are particularly exposed to international competition from charges levied for the energy support schemes [2]. The description of European Union harmonized rules and Latvian energy policy on energy intensive industries can be found in the previous article by the authors [3].

Latvian energy policy for energy intensive industries stimulates energy-intensive companies to implement energy efficiency measures, yet maintaining rather high level of energy intensity, which are mutually contradictory. Implementation of an energy management system is one of the key aspects for removing barriers for energy efficiency measures at the company's level. Studies [4–10] indicate that energy management systems facilitate new energy metering and monitoring methods, which play a significant role to achieve energy savings. At company's level decisions of implementation of energy efficiency measures would be based on the business cases of measures with time lags of decision making and implementations of measures, effectively achieving energy efficiency saving compared to the baseline scenario and gaining financial benefits from reduced consumption. On the other hand, energy efficiency measures will reduce the company's power consumption and energy costs, subsequently reducing its energy intensity. If in this case the energy intensity goes below the policy threshold and the increase of electricity costs due to loss of renewable energy levy repayments outweighs the efficiency gains, energy intensive companies most likely would sacrifice efficiency measures just to keep intensity above the threshold or even deliberately increase electricity consumption in order to maintain energy intensity above the benchmark. From the energy policy point of view this is undesirable consequence that should be evaluated and addressed.

Evidently the undesirable consequences of energy policy occur, where the energy intensity of a company is close to the benchmark set in the policy and, as a result of changes of various external or internal parameters, energy intensity would cross the benchmark. If energy intensity of a company is well above or below the benchmark, the undesirable policy consequences most likely would not appear. Taking into account this consideration modelling is focused on case, where there is evidence of potential energy policy failure, namely on case where initial energy intensity of a company is close to the benchmark and relevant policy improvements are evaluated taking into consideration this aspect.

2. Methodology

Taking into account the complexity of company's potential behaviour, a system dynamic model is proposed in this study. System dynamic modelling can simulate the behaviour of energy-intensive companies with different input parameters and assess appropriateness of Latvian energy policy. System dynamic approach also provides the necessary tools to simulate different improvements in policy [11]. The modelling period is set for 7 years until 2023, which includes the period where the energy policy is in place and period without it.

Electricity consumption in manufacturing industry depends on various factors. Causal loop diagram is shown in Fig. 1(a). The stock correspond the company's electricity consumption, which increases every year as a result of growth of company's production output, while the outgoing flow of electricity consumption represents energy efficiency measures. Normally the model would have two causal loops – reinforcing loop (R1) and balancing loop (B1). The strength of two loops is determined by the consumption growth factor, which largely depends on company's gross value added (GVA) and gross domestic product (GDP) growth, and energy efficiency factor, which depends on company's identified energy efficiency potential to be implemented.

Since energy efficiency measures balance the consumption growth, but does not affect growing gross value added, company's energy intensity, which is calculated as total electricity costs to GVA, are decreasing. The manufacturing company may not be advantageous to reduce its energy intensity below the benchmark of 0.2, in which case it loses the energy-intensive status and consequently economic benefits of renewable energy levy repayment. If the company's savings from energy efficiency (reduce energy costs) is less than the levy refund, then the company should adopt a rational decision to stop delivering energy efficiency measures and to keep the energy intensity above benchmark. Consequently the system dynamic model has an additional reinforcement and balancing loops that essentially weakens the main balancing loop (B1) (see red causal links in Fig. 1a). This system conform to Senge (1990) "fixes that fail"