PEER-REVIEWED PAPER

A regional method for increased resource-efficiency in industrial energy systems

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Abstract

The impact of global climate change as a result of greenhouse gas emissions (GHG), primarily from the use of fossil fuels, is demanding actions from all sectors of society. The industry sector is one of the world's largest energy using sectors and GHG emitters. Improved energy efficiency in industry is one of the foremost means of improving energy efficiency and reducing GHG emissions. Research shows that despite large untapped potentials for improved energy efficiency in industry, cost-efficient energy efficiency measures are not always implemented, explained by the existence of barriers to energy efficiency, e.g. information imperfections and asymmetries. Moreover, research shows that a major energy efficiency potential lies in the energy system and the way it is governed. For regional governments, the industrial energy use is difficult to affect as they only have indirect power to influence the decisions in those organizations. This underlies the importance of developing methods on how a region can support and effectively contribute to energy efficiency improvements in the local industry. So far, methods are limited related to regional governance of industrial energy systems. The aim of this paper is to present a structured methodology for improved regional resource efficiency in the local industry from a regional perspective, inspired by the Triple Helix Model. Results display the county administrative board of administration's current method how to target industry, and ends with a proposal for how the methods could be improved.

Introduction

The impact of global climate change as a result of greenhouse gas emissions (GHG), primarily from the use of fossil fuels, is demanding actions from all sectors of society. The industry sector is one of the world's largest energy using sectors and GHG emitters. Improved energy efficiency in industry is one of the foremost means of improving energy efficiency and reducing GHG emissions (IPCC 2007). Research shows that despite large untapped potentials for improved energy efficiency in industry, cost-efficient energy efficiency measures are not always implemented, explained by the existence of barriers to energy efficiency, e.g. information imperfections and asymmetries (Thollander and Palm, 2012). Moreover, research shows that a major energy efficiency potential lies in the energy system and the way it is governed (Backlund et al., 2012a). For regional governments, the industrial energy use is difficult to affect as they only have indirect power to influence the decisions in those organizations. This underlies the importance of developing methods on how a region can support and effectively contribute to energy efficiency improvements in the local industry. So far, methods are limited related to regional governance of industrial energy systems. However, related to other areas, the Triple Helix Model (Etzkowitz and Leydesdorff, 2000) is a promising approach that previously has been applied in e.g. in Croatia regarding energy management public buildings (Pichler et al., 2012). The aim of this paper is to present a structured methodology for improved regional resource efficiency in the local industry from a regional perspective.

The paper begins with an introduction, then reviews the scientific literature related to regional governance, planning, policies and incentives. Then, a method is presented, on how the

administrative board are targeting industry today exemplified with a case from a Swedish region – the Gävleborg County. The reason for choosing the county was due to its high degree of energy-intensive companies. Finally, means to improve the method is proposed together with a discussion on its applicability, major advantages as well as its limitations.

Method applied today in the Gävleborg County

The current method used in the Swedish counties are goal oriented, based on the environmental goals set by the Swedish government. How the method is applied in the counties is exemplified by the Gävleborg County in the coming section.

Initially, a short PM on the prerequisites for the industrial sector in the specific county was written by board officers, exemplifying the perspective of the county administrative board. The PM included ideas proposed on how to reach increased resource-efficiency. The PM was sent out with an invitation to participate in the development of the action plan to the larger energy-intensive industrial companies in the region, representatives from the regional energy agency and the local authority energy and climate adviser, representatives from energy service companies, and one researcher. Two officers from the county administrative board were always present at the meetings. During the first meeting, a leader of the committee was assigned. In the current case, a representative from industry, a technical director of a pulp mill, was assigned to be the chair. Five meetings were then held during a five month period, ending up with a number of suggested measures for the industrial sector. Two major areas of importance were found: (1) industrial excess heat utilization, and (2) energy audits. In the area of industrial excess heat, the group was in agreement that the electricity certificate scheme in Sweden has created a disadvantage for the industry's possibility to deliver excess heat as the local energy utility could gain certificates for green electricity production while excess heat often cannot. Moreover, it was outlined that for some municipalities, this had made the local energy utility invest in bio-fuelled CHP (as certificates were gained) while leaving the available industrial excess heat unexploited. In the suggested action, it was therefore included that before a new bio-fuelled CHP was built, other alternatives must be considered, and even included in the EIA (Environmental Impact Assessment). The Group therefore proposed the following actions:

1. Promote the continued expansion and densification of district heating networks.
2. Work to ensure that electricity produced from industrial excess heat can be covered by the electricity certificate system.
3. Work for an investigation into the utilization of waste heat becomes mandatory in EIA for heat and electricity production.
4. Investigate the feasibility of producing electricity from, or otherwise exploit, industrial excess heat where no district heating networks are present, or are not sufficiently developed (CAB, 2012).

As regards energy audits, it was concluded that industrial SMEs have limited capacity to work with improved energy efficiency, and therefore should be encouraged to conduct energy audits in the county (CAB, 2012).

For the county as a whole, a full day was assigned for the whole county using the FSSD-framework for the region. The day included participants from the country's municipalities, but was not explicitly directed towards the industrial sector.

Results

In the following section, proposed improvements of the method applied today in Swedish counties are presented. The improved method is in brief suggested to be the following:

1. Determine the primary energy factors and emission levels for the various energy carriers.
2. Conduct an overview of major energy end-using industrial sectors in the county.
3. Conduct a mapping of the major national energy end-use policies and its effect in the county.
4. Conduct a study on industrial energy efficiency potential in the county.
5. Based on 1–3, conduct a review of the scientific literature of the major technologies of interest to improve energy efficiency in the largest energy end-using sectors.
6. Based on 1–4, create an action plan with strategic measures related to the county and the national environmental goals.

1. DETERMINE THE PRIMARY ENERGY FACTORS AND EMISSION LEVELS FOR THE VARIOUS ENERGY CARRIERS

The first step is to choose primary energy factors in line with the country's praxis. In cases where suggested primary energy factors are missing, it is suggested that the primary energy factors for each energy carrier is firstly chosen based on the size of the market. For example, the oil market is a global market wherefore it is emphasized that the global figure is used. For regional biomass, these factors should reflect the regional market. For strictly local markets like district heating, the local market's primary factors should first and foremost be chosen. In the case of district heating these factors are reported by the district heating company.

2. CONDUCT AN OVERVIEW OF MAJOR ENERGY END-USING INDUSTRIAL SECTORS IN THE COUNTY

The industrial sector accounts for a large proportion of Gävleborg County's total energy use. Backlund et al. (2012b) investigated energy efficiency potentials in the region, the study covered 9.4 TWh which is approximately 40 % of Gävleborg's total energy use. The results showed that biofuels and electricity accounts for the largest shares of energy approx. 63 % and 27 %, respectively. Fossil fuels accounts for 10 % and district heating and other fuels for about 0.5 % each. The study was based on a questionnaire sent to 58 industrial firms in the spring of 2012. The firms included in the study were all the manufacturing firms that were A- and B- classified in the

region. The classification is based on the firms' environmental impact where A- and B- classified firms have the highest impact. In total, about 10.4 TWh/year of energy use is used in pulp- and paper, as well as the steel industry, and 1 TWh is used in other manufacturing companies. In summary, the region is far above average when it comes to energy use in the energy-intensive industrial sectors.

3. CONDUCT A MAPPING OF THE MAJOR NATIONAL ENERGY POLICIES AND ITS EFFECT IN THE COUNTY

The available energy end-use policies are the PFE (Program for energy-intensive industry), the energy audit program, and the Swedish environmental code (Thollander et al., 2013). As regards energy supply policies, major policies affecting industry is the EU ETS and the electricity certificate scheme.

4. CONDUCT A STUDY ON INDUSTRIAL ENERGY EFFICIENCY POTENTIAL IN THE COUNTY

Fifty-six per cent of the firms in the previously mentioned survey had participated in a voluntary program (PFE) or conducted an energy audit in the past three years. These firms accounted for 94 % of the total energy use in the study (Backlund et al. 2012b). This was explained by the fact that only energy-intensive firms participate in the PFE. The firms estimated a total energy efficiency potential of 12 %. The estimation included both technology and energy management measures and in absolute numbers that sums up to 1.1 TWh/year. One interesting result from the survey was that firms that had not conducted an energy audit or participated in a voluntary program estimated higher relative efficiency potentials from both technological improvements and energy management measures compared to firms that had (Backlund et al. 2012b).

5. BASED ON 1–3, CONDUCT A REVIEW OF THE SCIENTIFIC LITERATURE OF THE MAJOR TECHNOLOGIES OF INTEREST TO IMPROVE ENERGY EFFICIENCY IN THE LARGEST ENERGY END-USING SECTORS

The previous steps revealed that the major energy-using sectors in the county were pulp- and paper, and the steel industry. Based on that, a review can be conducted on available energy efficiency technologies. For example Johansson and Söderström (2011), conducted a review of energy-efficiency measures in the steel industry, Broberg-Viklund and Johansson (2014) did a review on technologies for utilization of industrial excess heat, and Fleiter et al (2012) did a review of the energy saving potential including available measures in the German pulp- and paper industry.

6. BASED ON 1–4, CREATE AN ACTION PLAN WITH STRATEGIC MEASURES RELATED TO THE COUNTY AND THE NATIONAL ENVIRONMENTAL GOALS

The creation of an action plan should be carried out in close cooperation with the regarded companies. The currently adopted method in the Gävleborg County already incorporated a participatory approach in its model. However, the creation of the action plan using the model suggested in this paper, would; taken the already outlined steps, lead to more in-depth knowledge on the technology front, the energy end-use, the potential, and the current policy mix affecting the county.

Concluding discussion

Based on the already applied method in the studied county, the authors propose a novel approach on how to combine industry, the public sector, and the research society. The current model including respondents from industry, the regional energy agency, the local authority energy- and climate adviser, representatives from energy service companies, one researcher, and officers from the county administrative board means that it already includes a Triple Helix inspiration. However, the proposed model would include a more active and direct input from the research community. In particularly, this is related to the decision of primary energy factors, the potential study, and the technology review. The suggested model moreover, provides a more structured method on how to work with increased resource-efficiency in industrial energy systems.

In conclusions, methods to improve energy efficiency in industry from the county perspective are scarce, and the proposed method in this paper, inspired by the Triple Helix Model, is one means towards filling this gap. Further research is suggested in applying the proposed method.

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