Incentives for co-firing in bio-fuelled industrial steam, heat and power production [1]

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Various combinations of co-firing of biofuels and fossil fuels can be used as an efficient method to rapidly introduce biofuels into existing energy systems. It also offers effective utilisation of local, small fuel resources, used mainly by larger plants. This study analyses different factors and incentives that influence co-firing in bio-fuelled industrial production of steam, heat and power and case studies illustrating Swedish experience in single plants in the field. The greatest emphasis in this paper is on non-technical factors that affect the incentives for co-firing. The study calls for a range of driving forces to introduce co-firing, such as technological, economic and financial factors, fuel resources and environmental matters. The results show that co-firing has been very efficient and beneficial for the economy of the companies studied here. Moreover, the companies have achieved this with moderate investment costs and still have the flexibility to meet future changes in the sector. However, there are restrictions in combustion technology for co-firing. High activity in co-firing in some countries, especially in Sweden, is indicated in this study. The existing high activity in co-firing is expected to increase. New environmental legislation for recycling systems, landfill fees and international agreements to lower emissions of greenhouse gases will increase the supply of different fibres and fuels that can be used. This will promote the future development of co-firing.

Introduction

Co-firing of biofuels and fossil fuels in different combinations is an effective way to utilise resources mainly used in larger industrial plants. Co-firing can be done in different ways:
a) incineration or combustion of different fuels in the same boiler b) incineration or combustion of different fuels in different boilers but in the same plant and operated in the same system.
There can be: c) continuos firing or d) intermittent firing.
Fuels can be mixed: e) before they are fed into the boiler or f) in different feeding systems leading to the boiler.

The large-scale energy plants in which it is possible to co-fire are mainly in the power industry, forest products industry, agricultural industry and district heating sector. Co-firing is done in many different fuel combinations: coal, oil, rubber and wood-fuels such as sawdust, bark, forest residues, recycled wood, wood from Salix plantations, sludge from processes in the industry etc.

Theory and driving-forces

An energy system uses primarily three different production factors: real capital, labour and raw materials for energy. If the first two are assumed to be constant in this example, changes can take place in the distribution between different fuels.
Different fuels can be used depending upon the technology that the company has chosen. The choice of fuel mixture can be made according to the short or the long term, where the short term would be the time period (about 1-3 years) during which none or only a portion of the company's production factors are variable. The company's choices are considerably greater in the long term (approximately > 3 years) as all production factors are then assumed to be variable by virtue of the possibility for investments. This means that the possibilities for substituting fuels are greater as the number of possible choices increases over time.

In practice, several different fuels are co-fired (both biofuels and fossil fuel) and used in combination and perhaps also in a number of different burners, according to the description earlier, which complicates the analysis considerably

In a heating plant with simultaneous production of both electricity and heat (combined heat- and power plant, CHP), the internal economies effects are positive for the production level. Rising

electricity prices also increase production and, if the price of a fuel rises, the demand for this fuel decreases. The technical limitations in terms of heat basis can be reduced in the long term through investments in recoolers that allow condensation operation or flue gas condensation, where further heat can be made use of in the production process with an effectiveness often exceeding 100%. Beyond the monetary strategies described above there are also technical and other limitations controlled by the choice of fuel mix like:

?? Technology
?? Economy
?? Taxes
?? Production flexibility
?? Fuel resources
?? Green energy
?? Environment

Discussion

Co-firing is established in the Nordic countries as a result of fuel resources, technology and energy demand. Co-firing has also become established in other areas of Europe and in America for commercial production and sometimes demonstration.

The five Swedish companies studied here are very sensitive to changes in basic conditions and react very fast to changes in taxes and other exogenous factors outside the company. Owing to rapid changes in conditions influencing the fuel choice strategy, most decisions are made on a short term basis.

Companies react in a very rational way to fuel prices and energy policy, including taxes. The dominant industries that use different fuels for co-firing are those with commercial incentives, i.e. the forest products industry, district heating plants and power plants. Access to cheap fuels of different quality, sensitivity to energy taxation and strategic decisions concerning the production of green energy are the main incentives for co-firing among these industries. The very fast growing recycling industry that processes household waste and industrial waste is the most important source of these fuel streams.

The study shows that co-firing has been very positive for the economy of the companies involved. The position was reached with moderate investment costs and the companies still have the flexibility to meet future changes in the sector. This is valid for the cost minimising production of steam and heat in the companies. They do not use the same strategy for the more market exposed production of electricity and it seems as though they must develop new strategies for this, including shutdowns of production.

Reference

[1] Hillring, B. *Incentives for co-firing in bio-fuelled industrial steam, heat and power production.* Submitted manuscript.