R&D STRATEGIES OF CO_2 INTENSIVE INDUSTRIES IN AN UNCERTAIN WORLD – THE CASE OF THE EUROPEAN IRON AND STEEL INDUSTRY

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Overview

Driven by the emission of greenhouse gases (GHG), climate change is one of the biggest challenges of our time. Especially the consumption of fossil fuels leads to vast emissions of CO_2 (i.e. a key GHG) into the atmosphere. The industrial sector accounts for about 29% of total GHG emissions in 2010 (Fischedick et al. 2014). Out of this the iron and steel industry hold a share of 20-25% over the past three decades. The European steel industry is the world's second largest steel producer. One main option to reduce CO_2 emissions is putting a price on the emission of CO_2, either by a tax or by an emission trading system. The latter has been introduced in Europe in 2005 to which the European steel industry is subject to. At current conditions (free allocation, low price of emission allowances) the impact of the European Emission Trading System (ETS) on the European steel industry is limited. However, the EU ETS is perceived as a potential threat to the European steel industry in the future, especially after 2021 when free allocations and the benchmark are further reduced on an annual basis. CO_2 reductions within the steel industry based on current technologies is limited. Hence, new technologies and processes have to be developed to cut CO_2 emissions drastically. However the economic situation of the European steel industry is tight. Domestic demand remains low since the economic crisis and production levels have not reached pre-crisis levels yet. Additionally overcapacities especially in China drive down steel prices. Thus, capital to invest in new technologies is scarce. This paper analyses research and development (R&D) strategies of the European steel industry in tight economic situation to reduce their CO_2 emissions in the short-, medium- and long-term in order to stay competive even in a world with high prices for CO_2 emissions.

Methods

This study reviews information on research and development on technologies and processes that reduce CO_2 emissions in iron and steelmaking. The focus is set on primary steelmaking that is more CO_2 intensive than the recycling route. The latter is limited by the availability of scrap and by the produced steel quality. Primary steelmaking makes up about two third of the European and global steel production. Steelmaking is a large emitter of CO_2 since it depends on the consumption of coal. Coal is not only used as a source of heat. Its key purpose in ironmaking is being a reducing agent, i.e. the carbon reduces iron ore to iron and carbon dioxide in a chemical reaction.

The study evaluates publically available data. First, publically funded R&D programs are analysed. The Research Fund for Coal and Steel is the major funder of research projects in the European iron and steel industry. R&D projects of the steelindustry are also funded by the Horizon2020 programm, i.e. the EU framework for research and innovation. A database of R&D projects that lead to reduced CO_2 emissions in the steel industry is established. The technologies/processes that are developed are categorized by the type of technology (e.g. heat recovery, improved use of by product gases, energy management).

Next to analysing research programs, major steel companies are evaluated based on annual reports, companies' websites, press releases, conference papers, and publications. Additionally interviews with members of these companies as well as with steel associations are conducted.

The obtained data is analysed in favour of identifying strategies that European steel companies pursue to reduce CO_2 emissions. The strategies are qualitatively categorized. The first category are costs per less emitted CO_2. Second, the availability or the moment when the CO_2 emissions are reduced is qualitatively assessed. The degree of activity on behalf of the companies is estimated according to the effort put on the development. Finally, the amount of CO_2 reductions is considered as well (Table 1).

Table 1: Qualitative assessment of the characteristics of the identified strategies

Category	Qualitative assessment		
Costs	Low	Medium	High
Availability	Short-term	Medium-term	Long-term
Activity	Low	Medium	High
CO_2 reduction	Low	Medium	High

Results

This study identified four technological strategies to reduce CO_2 emissions in the European iron and steel industry. Additionally, there are two non-technological strategies which are followed to lower the impact climate policy on this industry.

Major CO_2 reduction potentials could be realized if either coal as key energy input would be substituted by low carbon energy carriers or if the emitted CO_2 would be collected and stored underground with the so-called carbon capture and storage (CCS). It seems that both strategies are not pursued intensively. Compared to the other strategies, these options imply high costs per reduced CO_2 emissions and these technologies would only be available in the medium- to long-term. Options for the substitution of coal could be low-carbon provided hydrogen or electricity. Applying CCS in the steel industry requires the development of new iron and steelmaking processes since the concentration of CO_2 in current top-gases is insufficient for carbon capture.

The use of carbon monoxide and CO_2 rich top-gases is a further identified strategy on which medium activities are recorded. Since this strategy does not imply the re-design of current steelmaking processes, this study assumes medium CO_2 mitigation costs. However, economics depend on energy prices and CO_2 costs. This strategy might be available in the medium-term.

Major activities are identified for the implementation of incremental improvements. This is the only strategy which mitigates CO_2 emissions in the short-term with comparably low costs, since only measures are realized with payback periods of less than 2-3years. However, the CO_2 reduction potential is limited.

Another low cost, but non-technological strategy with high activity is the political intervention of steel companies and steel associations to lower the impact of climate policy on the European steel industry. However, this strategy does not lead to the reduction of CO_2 emissions.

A second, non-technological strategy is the production of CO_2 intensive raw materials outside Europe and its import to European steel companies. Its CO_2 reduction potential for the European steel industry could be considered as medium. However, on the global scale CO_2 emissions are only shifted regionally.

Conclusions

The European steel industry is in a weak economic situation. Regional carbon costs limit its competiveness since this industry is exposed to the global market. Dealing with European climate policy, the European steel industry seems to focus on low-cost strategies (i.e. incremental improvements and political intervention). These strategies only offer limited or no CO_2 reduction potential. According to these findings do higher CO_2 reduction potentials imply higher costs and an availability only in the medium- to long-term. Clear long-term policies should enable this industry to identify and implement low CO_2 steelmaking strategies. Options for low CO_2 steelmaking are either carbon capture and storage or the substitution of coal by low-CO_2 energy carriers (e.g. low-carbon provided hydrogen and electricity).

References

Fischedick M., J. Roy, A. Abdel-Aziz, A. Acquaye, J. M. Allwood, J.-P. Ceron, Y. Geng, H. Kheshgi, A. Lanza, D. Perczyk, L. Price, E. Santalla, C. Sheinbaum, and K. Tanaka, 2014: Industry. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.