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U.S IRON AND STEEL SECTOR AND POTENTIAL TRADING WITH CHINA AND INDIA: ANALYSIS WITH ISEEM ENERGY MODEL

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Overview

Interests in energy consumption and greenhouse gas (GHG) emission reductions in the United States (U.S.) industry sector have risen with the international obligations towards reducing carbon emissions and introduction of new climate-change legislations and initiatives around the world. It is important to understand the impacts of various technologies and strategies on energy savings and emission reduction potentials. These developments intensified the efforts for an integrated assessment of GHG emission reduction and energy policy options (together with their economic impacts, technology and resource requirements) in the industry sectors in the short, medium and long terms.. Iron and steel industry is one of the highest energy and emission intensive sectors. According to International Energy Agency (IEA) [1], iron and steel sector accounts for about 5% of the total world carbon dioxide (CO_2) emissions. The U.S. is the third largest steelmaking country in the world with a production of 80.5 Million tonnes (Mtonnes) in 2010 [2].

From this point of view, the objective of this study is to analyze the energy and emission reduction potentials of the U.S. iron and steel sector in the long term by giving particular attention to the energy efficiency improvements and potential trading opportunities from China and India. Modeling has been carried out by the Industry Sector Energy Efficiency Modeling (ISEEM) framework [3], which was recently developed in Lawrence Berkeley National Laboratory (LBNL) under the supervision of the U.S. Environmental Protection Agency through the U.S. Department of Energy.

Methods

ISEEM framework is a global bottom-up optimization model, developed specifically for industry sector energy supply-demand planning, and capable of evaluating alternative emission reduction policies under cost minimization objective. The framework emulates the energy system, raw material and commodity flow, production systems, and trading mechanisms of industrial products. In addition to detailed representation of industrial production, ISEEM has the capabilities that allows commodity and carbon trading across regions and countries, thus, provides users the ability to support specific energy studies or more general energy and emission reduction policies.

The complex relationships of supplying and producing energy sources, raw materials, intermediate products, and final products are represented as realistically as possible. In addition, this new framework allows to analyze the effects of various trading characteristics such as tariffs, import/export taxes, emissions due to commodity trading (i.e., international shipping), which are not available for analysis using the other modeling frameworks.

The planning horizon is set in 5-year time intervals extending from 2010 to 2050. Besides the Base scenario (describing the existing trends), the model has been run under three types of alternative scenarios:

1) ER (Emission Reduction without Trading) Scenario: Annual emissions are restricted 20% below ~~of~~ that of the Base scenario; additionally, investments in energy efficiency measures on the national scale are allowed without other instrument via trading.
2) ET (Emission Reduction with Commodity Trading) Scenario: Annual emissions are restricted 20% below of that of the Base scenario; additionally, investments in energy efficiency measures on the national scale are allowed with commodity trading being available with China and India up to a limit.
3) EC (Emission Reduction with Carbon Trading) Scenario: Annual emissions are restricted 20% below of that of the Base scenario; additionally, investments in energy efficiency measures on the national scale are allowed along with international carbon trading being available with China and India up to a limit.

Results

Scenarios used in this analysis are primarily designed for the purpose of decreasing the energy consumption (thereby reducing CO_2 emission levels). Thus, we expect an increasing usage of efficient energy sources/technologies/production processes and trading instruments (if applicable). In each scenario, the results are

focused on the penetration of energy efficiency measures and efficient production processes, and the share of import. The ER scenario forces the model to make relatively clean energy choices (such as implementing energy efficiency measures and using fuels with lower emission factors), which correspond to additional investments and expenses throughout the planning horizon. Emission reductions in the ET and EC scenarios, in contrast, are achieved via replacement of domestic production with import from China and India. There is not any investment for energy efficiency measures, instead declining domestic production result in a decrease of the CO_2 emissions. Corresponding to the 20% annual carbon reduction target, annual energy consumption decreases by approximately 11% in the ER scenario and 19% in both the ET and EC scenarios in the medium term; and by approximately 9% in the ER scenario and 20% in both the ET and EC scenarios in the long term.

Conclusions

This paper presents a full-scale application of the ISEEM framework on the U.S., China, and India iron and steel sectors and focuses on penetration of energy efficiency measures, efficient production processes, and trading mechanisms, and how production process structure, energy consumption profile, emissions and system costs change under the alternative scenarios defined previously. The results aim to suggest various useful policy implications for an environmentally and economically sustainable development of the U.S. iron and steel sector and provide long-term prospects for effective and applicable energy policy solutions.

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