RITE-Global Warming Technology

Applying Optimization Technology in Response to Global Warming

The Systems Analysis Group performs evaluation and analysis of plans and actions in response to global warming. Although there are various causes for global warming, a major cause is the emission of carbon dioxide gas resulting from the use of fossil fuel energy (coal, petroleum, natural gas) on earth, and a reduction in these emissions will be an important action in combating global warming. So, we must consider many of the technologies involved in the entire process, from energy production to consumption, and analyze which of these technologies may contribute at some level towards combating global warming. For example, as shown in Figure 1, when we set reduction targets for ten and twenty years from now, we can discuss what methods are currently available, as well as what future technologies we could expect to become applicable, and possible combinations of these, to meet the targets as inexpensively as possible.

Figure 1

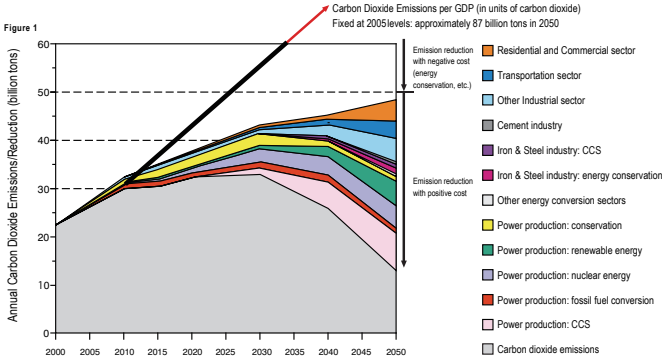
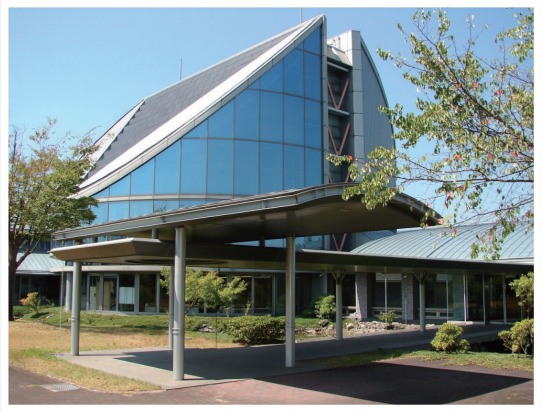


Figure 2 indicates the interrelationships between energy production (fossil fuel energy, renewable energy—wind power, water power, etc.—and nuclear energy), energy conversion, energy consumption and carbon dioxide capture and storage. The Systems Analysis Group looks at these interrelationships through mathematical modeling, and performs a variety of analyses on it. Expressing this type of problem in a mathematical model requires consideration of many variables, such as the amount of coal and oil still left to be extracted from the earth, the efficiency of various methods of power production, the amount of investment in power plants needed to bring new equipment on line, and, on the energy consumption side, the popularity of different vehicles and the resulting impact on overall fuel economy and costs.

The Systems Analysis Group create models that evaluate many countries around the world, and various points in the future, so the number of variables grows exponentially to over 4 million.

Building a model that employs a vast number of variables to find combinations that meet the requirements for carbon dioxide reductions at the lowest cost requires optimization technology. To perform these analyses, the Systems Analysis Group uses Gurobi Optimizer as their optimization engine.



Research Institute of Innovative Technology for the Earth in Kizugawa City, Kyoto Prefecture

An Overview—Research Institute of Innovative Technology for the Earth

The Research Institute of Innovative Technology for the Earth was established in July of 1990 through combined contributions from the Ministry of International Trade and Industry (now the Ministry of Economy, Trade and Industry), regional government agencies, academic organizations, and private businesses, and is located in Kansai Science City in Kyoto Prefecture.

Its principal mission is to perform fundamental research on technologies that can be used to address the global environment, particularly the issue of climate change.

The research institute is divided into four groups: the Systems Analysis Group, the Chemical Research Group, the Carbon Dioxide Storage Research Group and the Molecular Microbiology and Biotechnology Group. Each group is constantly involved in research and development specific to global warming issues. There are hopes that solutions addressing global warming on a global scale could result from the work of this research institute in the future.

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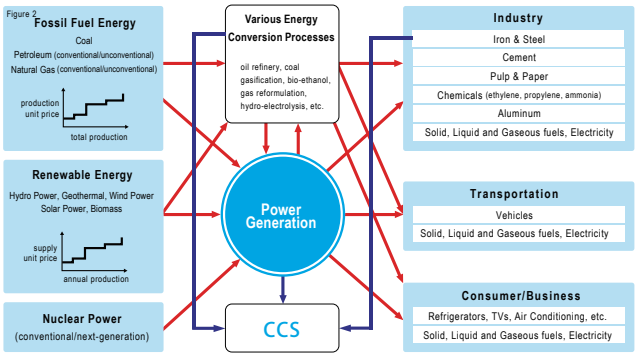

Using Gurobi Optimizer

The accurate and rapid compiling of extremely large-scale mathematical models is necessary for the evaluation and analysis of plans and actions to address global warming, which requires optimization. The Gurobi Optimizer has met all the requirements that the Systems Analysis Group is looking for. By using Gurobi Optimizer, it became possible for the Systems Analysis Group to solve large-scale problems such as this in around thirty minutes, which has further improved the efficiency of our research.

As we move into the future, the Systems Analysis Group, plans to continue developing and expanding the mathematical model of energy systems I mentioned above. To achieve this goal, the capabilities of our optimization engine are extremely important to the future effectiveness of our research. In addition, analyses employing optimized models, such as our energy systems mathematical model, are vital in other research fields related to global warming, so we plan to engage in further modeling using the advanced optimization engines.

For the future of optimization technology, we look forward both to advances in the theoretical background that underlies the technology and to further practical applications of it.

Research Institute for Innovative Technologies for the Earth

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Information in this case study is subject to change without notice.