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1st Korea Economic and Environmental Modeling Workshop

Proceedings

Seoul, Republic of Korea

2-3 March 2000

Sponsored and Hosted by the
U.S. Environmental Protection Agency
and the
Korea Energy Economics Institute

Organized by the
Korea Energy Economics Institute
and the
Pacific Northwest National Laboratory

Advanced International Studies Unit

Pacific Northwest National Laboratory

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Jeffrey Logan
Seung Jick Yoo

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Battelle Memorial Institute
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Acknowledgments

This publication documents the 1st Korea Economic and Environmental Modeling Workshop held in Seoul on 2-3 March 2000. The workshop brought together over 20 modeling experts from Korea and the United States to review existing tools, identify future opportunities, and build ties among modelers in both countries.

The workshop was made possible through support from the U.S. Environmental Protection Agency (EPA) and the Korea Energy Economics Institute. Paul Schwengels leads EPA's efforts to improve cooperation between Korean and U.S. modeling experts. Jin Hong Kim and Richard Garbaccio provide additional support for the EPA.

The Korea Energy Economics Institute (KEEI) made all arrangements in Korea for the workshop. Dr. Seung Jick Yoo of KEEI organized speakers on the Korean side and arranged logistics for the visiting U.S. team. Drs. Hyun-Joon Chang (KEEI) and Jung-Sik Koh (Ministry of Commerce, Industry and Energy) deserve thanks for their support and participation in the workshop.

Jeff Logan and Jae Edmonds organized the participation of experts from the United States and helped plan the agenda. Karen King, Paulette Wright, and Jay Wertenberger organized contractual and administrative details that made the workshop possible. Meredydd Evans and Tom Secrest reviewed earlier versions of this document.

We would especially like to thank the experts who gave presentations at the workshop. Their presentations generated excellent discussions and helped make the workshop a success. Finally, we offer our thanks to each of the workshop attendees for helping to strengthen the community of economic and energy modeling experts between Korea and the United States.

William U. Chandler
Director, Advanced International Studies Unit

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Foreword

Korea Energy Economics Institute

I am pleased to report the successful completion of the 1st Workshop on Economic and Environmental Modeling held in Seoul on 2-3 March 2000. The workshop brought together modeling experts from the U.S. and Korea, helping them understand efforts to analyze global climate change issues and develop analytical methodologies to make informed policy formulation.

Over the past few years, Korea has become more conscious of climate change issues and its linkage with energy conservation. In 1998, the Korean government established an Inter-ministerial Committee on Climate Change. The Committee—in close collaboration with research institutes such as the Korea Energy Economics Institute (KEEI) and academia—has begun formulating relevant response measures.

For more than a decade, KEEI has developed analytical tools and models focusing on the energy-economic-environmental nexus. As a result, KEEI now plays a key role in analyzing and promoting economic and environmental policy options to limit emissions of greenhouse gases. Our efforts to develop top-down economic models and bottom-up technology models have benefited greatly from expertise around the world, especially in the United States.

This modeling workshop, without doubt, suits Korea's needs to collaborate globally on issues related to global climate change. Participants from Korea and the U.S. showed their seriousness in the workshop by exchanging information on climate response strategies and learning technical details from each other related to their models.

As demonstrated in this workshop, researchers at KEEI have constructed an impressive set of analytic models, with the advantage of having access to the most accurate data sets and familiarity with the circumstances in Korea. The workshop also showed that there is still much room for improvement, which certainly can be aided by U.S. expertise.

Hence, one of the major fruits of the workshop turns out to be that cooperation among the modeling experts from Korea and the U.S. is an effective way to advance modeling research a step further and bring mutual benefits. I hope these kinds of modeling workshops continue to enhance our understanding of the economics of climate change and advance cooperative relations between Korea and the United States in the future.

I would like to take this opportunity to convey sincere appreciation to U.S. EPA and the Pacific Northwest National Laboratory for their dedication to this work.

Dr. Hyun-Joon Chang
President
Korea Energy Economics Institute

United States Environmental Protection Agency

I am pleased to report on a new avenue of cooperation between the United States and the Republic of Korea on modeling of economic development and protection of the local and global environment. This document provides a record of the first of what I hope will be a series of meetings, joint activities, and products under a Korea-U.S. program on economic and environmental modeling.

The United States Environmental Protection Agency and other U.S. agencies have been collaborating with Korean agencies for over a decade to help understand and address the environmental problems associated with rapid economic growth. This cooperation has become more significant and detailed over time. The joint development and application of state-of-the-art analytic tools and approaches for integrating environmental improvement into sustainable economic development policy is a powerful and needed addition to this cooperation. Both countries stand to learn and benefit by working together.

Over the past several years, the U.S. Government and other institutions have invested major human and financial resources to analyze the economic implications of alternative policies for responding to domestic and global environmental concerns. In the climate change area, economic modeling and analysis have played an important role in development of U.S. policy. In the process, U.S. analysts and policymakers have learned a number of valuable lessons. The complexity of this policy issue has required a range of analytic tools including top-down economic and bottom-up technology-rich models at national, regional, sectorial, and international scales.

These analyses have demonstrated that realistic targets and timetables, consistent with economic decision making and capital turnover horizons, and including flexibility measures, can substantially reduce costs and enhance political feasibility of needed climate actions. They have also illustrated the global nature of the problem, and the benefits of global cooperation in the solutions. These analytic tools are beginning to address the role of technological change in determining the levels and types of economic activity, energy use, and pollution in the medium to long term, and to illustrate the importance of technology policies in reducing long-term economic impacts. Economic models with other tools have also been used to quantify the relationships between strategies that reduce greenhouse gases and produce “ancillary” reductions in other pollution burdens, public health, and economic impacts.

All of these results have contributed to the identification of policy options that can achieve environmental goals efficiently and effectively, consistent with continued economic growth. This is, in fact, part of a larger trend in environmental policy in the U.S. and around the world—the movement toward integrating environmental goals into basic policy and economic activity through market mechanisms and other innovative pollution prevention incentives.

Economic, energy, and environmental modeling will become increasingly important in Korea as market reforms continue to reshape the economy. Policymakers will need realistic models to explore energy and climate change policy options and to minimize total costs. As demonstrated in this workshop, Korea has made tremendous progress in building models to analyze energy, environmental, and climate issues, and a number of U.S. modeling groups are working with Korean colleagues to further this development. Nonetheless, the workshop has also shown that more work is needed to capture accurately the unique characteristics of Korea's economy while accounting for international flows of capital and technology.

While the U.S. Government clearly recognizes the need for Korea to carry out its policy development and decision making independently, continued collaboration on the development of methods, databases, models, and other analytic tools can provide better information, and better inform policymakers in both countries. The U.S. Environmental Protection Agency in cooperation with other U.S. Government and non-governmental partners will continue to work with the Korean Ministry of Commerce, Industry, and Energy and other ministries and technical institutions to help address these technical and analytic needs.

I am greatly impressed with the quality and diversity of the presentations and the progress that has been made in this first workshop. On behalf of the U.S. Environmental Protection Agency and the U.S. Government, I would like to thank all of the participants in both countries for their efforts, and encourage them to continue and expand the work. In particular, our thanks go out to the Korea Energy Economics Institute for co-sponsoring the workshop. I look forward to future joint products with great interest.

Paul Stolpman
Director, Office of Atmospheric Programs
U.S. Environmental Protection Agency

Summary

The 1st Korea Economic and Environmental Modeling Workshop was held at the Temf Hotel in Seoul on 2-3 March 2000. It brought together 25 Korean and U.S. experts to discuss technical modeling issues and to build bridges between practitioners in both countries. During the two-day workshop, experts from Korea and the United States gave presentations on their modeling efforts that led to lively discussions and sharing of new information. Presentations included the following:

1. **Jung-Sik Koh**, Ministry of Commerce, Industry, and Energy: *Update on Energy and Environmental Issues in Korea*
2. **Richard Garbaccio**, U.S. Environmental Protection Agency: *Key Issues in Climate Change Modeling and Policy*
3. **Seung Jin Kang**, KEEI: *Bottom-Up Models Used by KEEI*
4. **Philip Tseng**, U.S. Department of Energy: *An Operational Framework for the Clean Development Mechanism and Sustainable Economic Growth*
5. **Jin Kim**, U.S. EPA: *Co-benefit Analysis of GHG Mitigation Strategies in the United States*
6. **Richard Garbaccio**, U.S. EPA: *The Health Impacts of Controlling Carbon Emissions in China*
7. **Yoonyoung Kang**, KEEI: *Overview and Application of the KEEI National Top-down Model*
8. **Gyeong Lyeob Cho**, KEEI: *Overview and Application of the KEEI Global Top-down Model*
9. **Ronald Sands**, Pacific Northwest National Laboratory: *The Economics of Emissions Mitigation*
10. **Thomas Rutherford**, University of Colorado: *Carbon Emission Abatement and International Trade: Multiregional Modeling with the GTAP Database and GAMS*

The collection of presentations and the discussions that ensued provided a useful basis for future cooperation and documented a substantial number of high-quality existing models and ongoing activities with application to Korea's economic and environmental policy issues. Substantial capacity and expertise exists and great progress has been made over the past few years in development of economic and environmental models. There was a clear consensus that this event should be the start of an ongoing effort to continue and expand technical cooperation of economic, environmental, and climate policy modeling.

Notable conclusions reached during the workshop include:

- Workshop participants believed that comparing various baseline and policy simulations and analyzing the findings would be a helpful way to improve understanding of the models' strengths and weaknesses. This activity would be similar to that used at the Energy Modeling Forum (EMF) hosted by Stanford University.

- Researchers need to close the gap between detailed bottom-up models (optimization models) and big-picture top-down models (computable general equilibrium models) so that effective policies can be crafted. Practitioners using these two types of models need to work together more closely so that they can learn how to better support one another.

- Benefits associated with greenhouse gas emission mitigation, such as a reduction in local pollutants including particulate matter and sulfur dioxide, is an important consideration in modeling. Participants discussed the possibility of a joint study between China, Japan, and Korea to consider the co-benefits of emissions mitigation. This study would build on existing co-benefits analysis conducted in Korea with U.S. EPA support.

- U.S. modelers value meeting with Korean colleagues because it helps them improve their understanding of the Korean economy and, thus, improve and justify results from their own models. The Second Generation Model (SGM), for example, now plays a more important role in defining many of the baseline scenarios used in official U.S. policy. Developers of the SGM must maintain an accurate and up-to-date module for Korea to support their policy recommendations to the U.S. Government.

- Korean researchers expressed their desire to improve the collection of modeling tools available to help influence climate policy in Korea. The country might be more willing to take on a voluntary target if officials and industry leaders could be convinced that doing so would not harm the economy. The current set of top-down and bottom-up models in Korea could be improved to give more accurate simulations of policy action. There is, thus, strong support within Korea to continue collaboration on economic modeling.

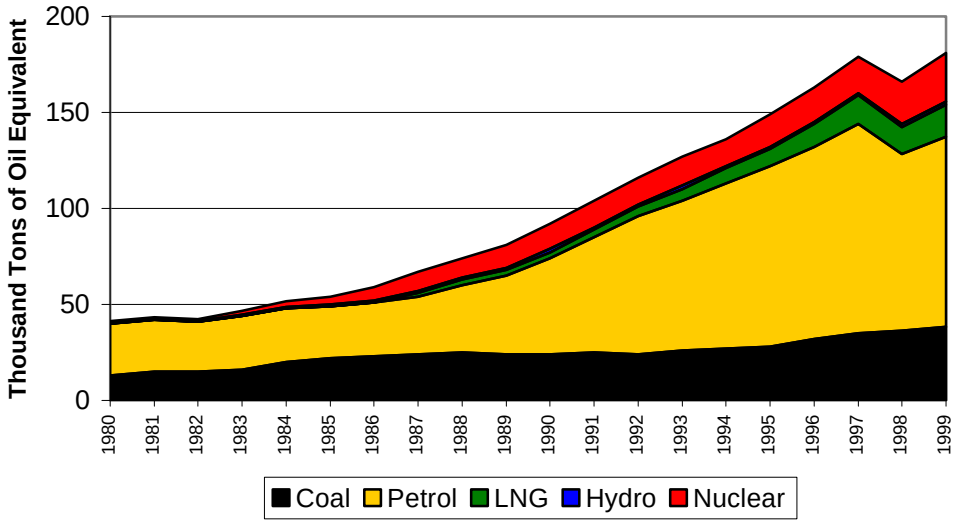
- KEEI will get assistance from the University of Colorado in updating its global computable general equilibrium (CGE) model. DOE is discussing the possibility of a collaborative study on the Clean Development Mechanism with the Korea Institute for Energy Research (KIER).

Introduction

Korea[1] occupies a unique place in energy use and climate change. A member of the Organization for Economic Cooperation and Development since 1996, the country is similar to many developed nations in per capita income and energy use, but is counted among the developing countries by the United Nations Framework Convention on Climate Change. Korea's economy has sustained three consecutive decades of rapid economic growth and the country now ranks tenth in the world in total energy consumption. The energy choices Korea makes may influence the global response to climate change out of proportion to Korea's geographic size. Understanding how to simulate the impact of Korea's economic, energy, and environmental choices is, thus, critical to Korea and other countries.

Despite a rapid reversal of economic growth—and associated energy consumption—during the Asian financial crisis of 1997-98, Korea's economy has returned to the pre-crisis level. Energy consumption has also rebounded sharply. (See Figure 1.)

Figure 1 – Primary Energy Consumption in Korea



Source: Korean Energy Economics Institute, February 2000.

Noting the importance of Korea's development decisions, the U.S. Environmental Protection Agency has collaborated with colleagues in Korea for many years, most recently on economic modeling related to climate mitigation policy. The 1st Korea Economic and Environmental Modeling Workshop was held in Seoul at the Temf Hotel on 2-3 March 2000. It brought together over 25 Korean and U.S. experts to discuss technical modeling issues and to build bridges between practitioners in both countries. During the 2-day workshop, 10 experts from Korea and the United States gave presentations on their modeling efforts that led to lively discussions and sharing of new

[1] In this document, Korea refers to the Republic of Korea, commonly known as South Korea.

information. The presentations given in this workshop provide a compilation of much of the ongoing work involving U.S. and Korean experts, including collaboration on co-benefits of emissions mitigation and technology cooperation. They also provide background on the relationship of modeling to policymaking in the U.S. and Korea, and the recent developments in economic and environmental policy modeling in Korea. Finally and most importantly, the discussions in this workshop produced a number of useful recommendations for further cooperation and specific priorities for future joint work.

Rapporteur Notes

The following notes summarize presentations made by Korea and U.S. modeling experts over the course of two days.[2] Presentation material for each speaker is contained in the appendixes.

2 March 2000, Day 1

Jung-Sik Koh directs energy policy within Korea's Ministry of Commerce, Industry, and Energy.

Koh focused on efforts to harmonize the 3 Es (energy, economy, and environment) in Korea. He outlined the country's extraordinary economic development, including the remarkable recovery from the Asian financial crisis. Reform within the government has been genuine, although incomplete. Foreigners are now allowed to own property in Korea and several foreign companies have recently purchased Korean firms, including banks.

Korea has relied on a unique development strategy that emphasizes state-guided investment in energy-intensive chemical, steel, and transport equipment production. Except for small amounts of anthracite coal, Korea imports all of its energy sources. Although energy intensity in Korea is high, the stock of industrial equipment is generally very efficient.

Koh stated that Korea has taken an active role in lowering greenhouse gas emissions, mainly through no-regret measures including demand-side policies, and wants to play a leading role among non-Annex I participants to the Framework Convention on Climate Change (FCCC). There is still significant room for development in Korea's economy, however, which at least partially explains why the country has not yet adopted a voluntary emissions reduction target similar to Argentina's. Koh noted, for example, that the number of passenger cars per 1000 people in Korea is 226 compared to 769 in the U.S. and 552 in Japan. Only 10 Korean households per 1000 have dishwashers while in the U.S. the number is 454 and in Germany, 755.

Koh argued that the government has an effective carbon tax in place in the form of import taxes on oil and LNG, the proceeds of which are used to fund efficiency programs and a phase-out of domestic anthracite coal use. He did not mention that imported bituminous coal is not taxed, improving its competitiveness against LNG.

Growth in energy consumption roared back in 1999 after falling the previous year during the height of the financial crisis. (See Figure 1.) Korea's gross domestic product (GDP) grew by a reported 10 percent in 1999, with primary energy demand up by approximately 9 percent.

[2] For an online color version of these presentations, please visit PNNL's Advanced International Studies Unit (AISU) web page at http://www.pnl.gov/aisu/publications.

A copy of Dr. Koh's presentation material is reproduced in Appendix A.

Richard Garbaccio of the U.S. EPA—who officially led the delegation in place of Paul Schwengels—summarized key issues in climate change policy and economic modeling in the U.S.

He outlined governmental and NGO modeling efforts such as the Interagency Analytic Team and Stanford Energy Modeling Forum, respectively. He discussed the sensitivity of mitigation costs to baseline assumptions on economic growth, technology penetration rates, and energy markets. Garbaccio noted that U.S. researchers struggle with modeling how the costs of mitigating greenhouse gases should be distributed across income classes and regions.

As an introduction to research he would later present, Garbaccio also outlined some of the co-benefits of mitigating greenhouse gas emissions. He noted results from the World Health Organization/World Resources Institute "meta-analysis," which considered the benefits to human health of reducing local environmental pollutants that accompany greenhouse gas mitigation. The study found that if Annex I countries reduced emissions by 15 percent below 1990 levels and developing countries 10 percent below BAU in 2010, the total number of emissions-related premature deaths between 2000 and 2020 would drop by more than 8 million.

Garbaccio completed his talk by mentioning further needs in modeling methodology, including: baseline and policy-induced technology change, sinks and other gases, supply curves for emissions trading and clean development mechanism (CDM) credits, better integration of co-control benefits, institutional and other constraints to flexibility, distribution of costs, and design of technology strategies.

A lively discussion followed the two presentations, with most of the talk focused on Korea's efforts to mitigate greenhouse gas emissions. Tom Rutherford asked why Korea does not just pick a [high] voluntary emissions reduction target given that it has taken steps to lower carbon dioxide emissions and wants to play a leadership role among non-Annex I countries in the FCCC. Jung-Sik Koh and Hyun-Joon Chang (President of KEEI) responded that there is a wide diversity of opinions in Korea about the country's role in the FCCC, but that most industries are against mitigation commitments in principle and have strong influence in the government, especially through MOCIE. The government is struggling with the idea and is trying to reach consensus among stakeholders. It is concerned that a target could affect economic growth. A voluntary target indexed to economic growth—similar to Argentina's—was also mentioned as a possibility for Korea, but many high-level government officials do not yet consider climate change a priority issue, according to one Korean participant.

Participants also discussed

- the possibility of a natural gas pipeline from Russia through North Korea,

- how U.S. agencies with different opinions about climate policy interact,
- the potential for coal to become an economic option in Korea if the international community moves to cut emissions (and international coal prices hence fall), and
- the potential for the CDM to impact Korea.

Two presentations were given on bottom-up models and their role in modeling climate change policy. **Seung Jin Kang** described the KEEI model for long-term energy demand and GHG emission forecasting, and the EFOM-ENV model that optimizes the energy system with respect to constraints. He described how the models work, major uncertainties, and plans for future modification. KEEI is interested in the National Energy Modeling System (NEMS), which is used by the Energy Information Administration of the U.S. Department of Energy, as a supplement to these bottom-up models.

A copy of Dr. Kang's presentation material is reproduced in Appendix B.

Philip Tseng gave a presentation on how MARKAL-MACRO could be used for CDM analysis. He first described some of the requirements and difficulties of the CDM and then how MARKAL-MACRO works. Tseng argued that the model, used in 35 countries, can answer how many certified emission reductions (CERs) will be available in a given non-Annex I country. One of the benefits of MARKAL-MACRO is that it avoids double counting CERs, unlike some top-down models.

Comments and questions after the presentation focused on the difficulties of establishing baselines (a recurrent theme), working with MARKAL-MACRO for CDM analysis given its large size, and simulating transaction costs and feedback effects with bottom-up models. A copy of Dr. Tseng's presentation material is reproduced in Appendix C.

The final two presentations of the first day focused on modeling health and environmental impacts. **Jin Hong Kim** presented findings from a co-benefit analysis of GHG mitigation in the United States. He described how carbon mitigation translates into a reduction in local pollutants that damage human health and how these damages are monetized. Co-benefits of carbon reduction can reach 30 percent of the costs of carbon mitigation. Through the 1980s, studies used cross-sectional, time series mortality as a key variable. Now they use daily mortality studies that help subtract other factors such as smoking. A copy of Dr. Kim's presentation material is reproduced in Appendix D.

Richard Garbaccio described preliminary results of the health impacts of controlling carbon emissions in China. Garbaccio worked with Dale Jorgenson and Mun Ho at Harvard University to develop a top-down CGE model for China's hybrid economy. The model can simulate the centrally planned portion of China's economy as well as the rapidly growing market portion. It can simulate the impact of carbon taxes, which are assumed to be revenue neutral and thus capable of providing double dividends, on approximately 30 sectors of the economy. Health impacts on the economy are simulated using dose-response functions for urban areas and willingness-to-pay values taken from studies in the United States and adopted to Chinese conditions.

A copy of a background paper related to Dr. Garbaccio's presentation is reproduced in Appendix E.

3 March 2000, Day 2

On the second day of the workshop, **Yoonyoung Kang** described the national CGE model KEEI researchers developed to simulate climate change policy. It is a multi-sector, recursive dynamic CGE model with 35 subsectors and nested Leontief-CES production functions. He discussed applications of the model and gave results from a reference case and two policy scenarios including various carbon dioxide emission targets and abatement mechanisms.

A tax of $24 per ton of carbon would be expected to reduce emissions by 10 percent, while the country's GDP would fall by 0.3 percent. A tax of $211 per ton of carbon leads to a 40 percent reduction in emissions and a 2.2 percent drop in GDP. Carbon emissions decline most prominently in the electricity sector due to introduction of new photovoltaic and nuclear technologies.

Kang also described how abatement mechanisms using trading would affect different sectors of the economy based on model results. GDP losses are lowest with auctioning and grandfathering of emission credits (about 0.1 to 0.15 percent). Unit abatement costs range from 21,000 won (~$18) per ton of carbon in the electricity sector to 204,000 won (~$175) per ton of carbon in the basic chemical sector.

Participants noted potential problems in the way the model allocates grandfathered permits to industrial owners. Tom Rutherford provided a page of useful comments to the Korean modelers relating to baseline assumptions for automobile ownership, electric power sector assumptions, taxes on energetic inputs, and global carbon markets.

A copy of Dr. Kang's presentation material is reproduced in Appendix F.

Gyeong Lyeob Cho then described the application of KEEI's global CGE model. He described how the model functions and gave results from different baseline and policy scenarios. In the baseline scenario, Korea's carbon emissions grow by 3.9 percent annually through 2020. Cho admitted that the model is already outdated as it is calibrated to 1986 data, but natural gas was introduced to Korea in 1987. Cho will visit the University of Colorado for several weeks in March 2000 to update the model and learn new techniques for database development. A copy of Dr. Cho's presentation material is reproduced in Appendix G.

Ron Sands described two models developed at Pacific Northwest National Laboratory (PNNL) for climate change policy analysis. Minicam is a partial equilibrium model used for integrated assessment while the Second Generation Model (SGM) is a general equilibrium model well known for its ability to simulate energy markets in detail. Sands described how different emissions pathways could achieve stabilization of atmospheric concentrations at different levels. After outlining the models and PNNL's history of work in Korea, Sands discussed the Energy Modeling Forum (EMF) held at Stanford

University and described EMF-16 (post-Kyoto) and EMF-18 (international trade between Annex I and non-Annex I countries) in greater detail. Sands also noted that meeting his Korean colleagues is valuable since he must be able to defend country-specific assumptions used in the lab's models, which are playing an increasingly important role in U.S. climate policy. A copy of Dr. Sand's presentation material is reproduced in Appendix H.

Tom Rutherford gave the final presentation of the workshop and focused on how he and his team develop models. Rutherford is best known in the modeling community for developing software that helps economists build models more easily. The Korean experts showed a high respect for Rutherford's work.

Rutherford began by describing the GTAP dataset (input-output tables) and its use with GAMS (General Algebraic Modeling System) programming. He gave sample applications and described interesting examples related to OPEC oil pricing and international coal markets given global efforts to mitigate carbon. He also described how his signature software, MPSGE (Mathematical Programming System for General Equilibrium), is used to help economists build models quickly and efficiently. It is extremely compact although it can be cryptic.

Key Findings and Discussion of Possible Next Steps

Participants concluded the workshop by summarizing key findings and discussing the most promising avenues for future collaboration. Some of the key issues are highlighted below.

- Phillip Tseng mentioned that he will work with Hee Sung Shin of KIER in the near future to develop a proposal on a potential CDM analysis using MARKAL-MACRO.

- Gyeong Lyeob Cho will visit Tom Rutherford in Colorado for several weeks to study options for improving the Korean Global CGE model. KEEI is paying Rutherford for his services.

- Researchers at KEEI expressed interest in learning more about NEMS, the modeling software used by the DOE's Energy Information Administration. The budget required to maintain and use NEMS is relatively high, but much of the model—especially inter-regional transport of fuels—surpasses the needs of simulating the Korean economy. Thus, it may be much cheaper to operate in Korea than in the U.S.

- Participants discussed the possibility of a regional study on the co-benefits of mitigating GHG emissions between Japan, Korea, and China. The three countries are currently holding high-level talks on environmental cooperation, with the next meeting scheduled for mid-March in Beijing. The topic of the next meeting will be the CDM. Some participants thought that China might not be interested in participating in a joint study of co-benefits, since it is already blamed for pollution that crosses international borders.

- Ron Sands explained that annual meetings with Korean colleagues are worthwhile in themselves because it gives him information needed to defend his assumptions used in the SGM. A KEEI researcher replied he is anxiously awaiting the updated version of SGM.

- A senior Korean researcher raised fundamental questions about economic development policy in Korea. He used the steel sector as an example and said that he would like to give recommendations to industry leaders on how to focus on future growth. He noted that Korea would probably lose competitive advantage to other countries in the near future, and that state-directed policy needed to better account for the likely changes in structural change when setting climate policy.

- KEEI indicated that a package of policies and measures that can be used to help set climate policy would be very helpful in communicating with government ministries and industries. For example, if Korea were to give a 5 percent target, how would it rationalize it to industry?

- Participants also mentioned the gap that exists between top-down and bottom-up models. What could be done to close the gap? Would it be useful to make some EMF-like comparisons between the models?

List of Attendees

Korea Economic and Environmental Modeling Workshop
Temf Hotel
2-3 March 2000

Name	Organization
Hyun-Joon Chang	President, Korea Energy Economics Institute (KEEI)
Jung-Sik Koh	Director of Energy Policy, Ministry of Commerce, Industry and Energy
Yoonyoung Kang	Director of Center for Climate Change Studies, KEEI
Jin-Gyu Oh	Senior Research Fellow, KEEI
Sang Yul Shim	Research Fellow, KEEI
Jong Duck Kim	Research Fellow, KEEI
Seung Jin Kang	Research Fellow, KEEI
Gyeong Lyeob Cho	Associate Researcher, KEEI
Sungwon Lee	Korean Transportation Institute
Songwhee Shin	Professor, Seoul University
Seong Jick Yoo	Research Fellow, KEEI
Hee Cheon Park	Professor, Inha University
Hee Sung Shin	Principal Investigator, Korean Institute of Energy Research
Seunghun Joh	Research Fellow, Global Environmental Research Center, Korea Environment Institute
Richard Garbaccio	U.S. Environmental Protection Agency
Jin Hong Kim	U.S. Environmental Protection Agency
Philip Tseng	U.S. Department of Energy
Thomas Rutherford	University of Colorado
Ron Sands	Pacific Northwest National Laboratory
Jeffrey Logan	Pacific Northwest National Laboratory

Workshop Agenda

Workshop on Economic and Environmental Modeling
TEMF Hotel, 2-3 March 2000

Korea Energy Economics Institute
U.S. Environmental Protection Agency

Thursday, 2 March 2000

09:30-10:00 Welcoming Remarks
Hyun-Joon Chang, President, KEEI

Session I ECONOMICS, ENERGY, AND CLIMATE POLICY

10:00-10:30 Update on Energy and Environmental Issues in Korea
Jung-Sik Koh, MOCIE

10:30-10:45 B*reak*

10:45-11:30 Key Issues in Climate Change Policy and Economic Modeling
Richard Garbaccio, U.S. EPA

11:30-12:00 Comments & Discussion

12:00-13:45 ***Lunch Break***

Session II BOTTOM-UP MODELS

13:45-14:20 KEEI Bottom-up Models
Seung Jin Kang, KEEI

14:20-15:00 An Operational Framework for the Clean Development Mechanism and Sustainable Economic Growth (MARKAL-MACRO)
Philip Tseng, U.S. DOE

15:00-15:30 Comments and Discussion

15:30-15:45 *Break*

Session III MODELING HEALTH AND ENVIRONMENTAL IMPACTS

15:45-17:15 The Health Impacts of Controlling Carbon Emissions in China
Richard Garbaccio, U.S. EPA

Co-benefit Analysis of GHG Mitigation Strategies in the United States
Jin Hong Kim, U.S. EPA

17:15-18:00 Comments & Discussion/Wrap-Up

Friday, 3 March 2000

Session IV TOP-DOWN MODELS

08:30-09:00 Coffee and Refreshments

09:00-10:30 Overview and Application of the KEEI National Top-down Model
Yoonyoung Kang, KEEI
Overview and Application of the KEEI Global Top-down Model
Gyeong Lyeob Cho, KEEI
The Economics of Emissions Mitigation
Ronald Sands, PNNL

11:00-11:15 *Break*

11:15-12:15 Carbon Emission Abatement and International Trade: Multiregional Modeling with the GTAP Database and GAMS
Thomas Rutherford, Univ. of Colorado

12:15-12:30 Comments & Discussion

12:30-14:00 Lunch

14:00-15:00 Discussion of Findings, Next Steps

15:00-15:30 Wrap-up

Presentation Material

Presentations from each of the speakers listed below are contained in the corresponding Appendix. Full presentation material is also available on Battelle's web site at: *http://www.pnl.gov/aisu/publications*.

Battelle Memorial Institute assumes no legal liability or responsibility for the accuracy, completeness, or usefulness of any information contained in the presentation material. The format of the presentations may be different from that given at the workshop, but the content, which is the sole responsibility of the author, has not been modified.

Appendix A – Jung-Sik Koh: *An Update on Energy and Environmental Issues in Korea*

Appendix B - Seung Jin Kang: *Bottom-Up Models Used by KEEI*

Appendix C - Philip Tseng: *An Operational Framework for the Clean Development Mechanism and Sustainable Economic Growth (MARKAL-MACRO)*

Appendix D – Jin Kim: *Co-benefit Analysis of GHG Mitigation Strategies in the U.S.*

Appendix E – Richard Garbaccio: *The Health Impacts of Controlling Carbon Emissions in China*

Appendix F – Yoonyoung Kang: *Overview and Application of the KEEI National Top-down Model*

Appendix G – Gyeong L. Cho: *Overview and Application of the KEEI Global Top-Down Model*

Appendix H - Ron Sands: *The Economics of Emissions Mitigation*

Appendix I – Thomas Rutherford: *Carbon Emission Abatement and International Trade: Multiregional Modeling with the GTAP Database and GAMS*. This paper is not available, however interested readers can find more information on Thomas Rutherford's work at <http://nash.colorado.edu/tomruth/>.