

# IRG MARKAL/TIMES UNDERTAKINGS

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## POLICY/PROGRAM EVALUATION

**Examination of Carbon Mitigation Strategies, Natural Resources Defense Council (NRDC)** Mr. Goldstein, teamed with Mr. Delaquil and Ms. Wright, are refining and applying the US national MARKAL model to examine various legislative proposals to reduce greenhouse gas emissions. The assessment focused on evaluating the differences of the various proposals in terms of system cost and technology pathways to achieve them, examining in particular the increased cost of waiting to take action.

**Northeast States for Coordinated Air Use Management (NESCAUM)** Mr. Goldstein, teamed with Mr. Delaquil and Ms. Wright, and OnLocation, Inc., are responsible the development and application of initially a six, later nine, and soon twelve-state integrated MARKAL model of the northeast states to examine air quality and greenhouse gas mitigation options. Said framework is also of great interest to various states in the region looking for example to use it to develop energy master plans (New Jersey) and examine the potential for coupled heat and power (Massachusetts).

**US Environmental Protection Agency (EPA)**, Mr. Goldstein and Mr. Delaquil developed a methane accounting framework for the US national MARKAL model, and applied it, on behalf of the Office of Air and Radiation, Office of Atmospheric Programs, Climate Protection Division, Methane and Sequestration Branch (MSB). The assessment examined cost-effective strategies to reduce methane emissions from the US energy system using the US national MARKAL model.

**Asian Pacific Economic Council (APEC)** Mr. Goldstein served as the project manager coordinating contribution from three APEC countries to examine the maximum cost-effective penetration of new and renewable technologies among said member countries. Mr. Delaquil prepared the renewable energy characterizations.

**Purchase of Carbon Rights by the Prototype Carbon Fund, World Bank** Mr. Goldstein served as the project manager and analyst participating on behalf of the Latvian government at the pre-negotiation meetings for the first purchase of carbon rights by the Prototype Carbon Fund of the Bank. His role was to help evaluate a landfill gas capture project under Clean Development Mechanism (CDM) criteria establishing baseline and additionality terms of reference using the Latvian MARKAL model, as well as estimate the displaced carbon resulting from the project and its marginal price.

### The IRG Team has unique knowledge of the MARKAL/TIMES Model

The IRG Team's MARKAL clients include:

- International Energy Agency Energy (IEA)
- US Department of Energy (USDOE)
- US Environmental Protection Agency (USEPA, Office of Research and Development, and Clean Air Markets Division)
- US Agency for International Development (USAID)
- IEA Energy Technology Systems Analysis Programme (ETSAP)
- Natural Resources Defense Council (NRDC)
- Northeast States for Coordinated Air Use Management (NESCAUM)
- Stanford Program for Energy and Sustainable Development China Gas Study (PESD-China)
- Regional Economic Modeling Inc (REMI)
- US-Department of Energy National Laboratories (BNL, LLNL, NETL, NREL)
- Asia-Pacific Economic Cooperation (APEC)
- China Council for International Cooperation on Environment and Development (CCICED)
- China Energy Research Institute (ERI)
- A major national oil company
- Asian Development Bank (ADB)

**Modeling China's Energy Future for the China Council for International Cooperation on Environment and Development.** Mr. DeLaquil was the lead MARKAL analysis working with Princeton and Tsinghua University to determine the impact of advanced technologies to meet China's future energy demand, improve urban air quality, limit oil and gas imports and reduce GHG emissions. The results of the studies, which were briefed to the Vice Premier in 2003, indicated an early need to develop renewable energy and energy efficiency, and a longer term need to transition away from coal combustion and towards coal gasification for both electricity generation and liquid fuels production. .

## **ANALYTICAL MODELING AND DATABASE ACTIVITIES**

**International Energy Agency Energy Technology Systems Analysis Primary Systems Coordinator (ETSAP)** From 1992, Mr. Goldstein has served as the ETSAP Primary Systems Coordinator overseeing the ongoing development of the MARKAL/TIMES energy system optimization models, the most widely used planning model globally. Responsibilities include design and implementation of model enhancements, coordinating research contributions by partner institutions, overseeing 3<sup>rd</sup> party vendors and ensuring the seamless integration of all the system components, and providing global support for the use of the tools.

**US Department of Energy, Energy Information Administration System for the Analysis of Global Energy (SAGE)** In support of the EIA, a major rewrite of the MARKAL model was undertaken to permit myopic optimization (rather than clairvoyant) and introduce a market share algorithm to foster the use of the methodology to support the annual publication of the *International Energy Outlook*.

**US Environmental Protection Agency Office of Research and Development Multi-region US Model (US9r)** Mr. Goldstein, teamed with Mr. Delaquil and Ms. Wright, and OnLocation, Inc., developed the key components of a nine-region US MARKAL model. As part of this initiative also augmented the MARKAL formulation to permit an open-ended number of time-slice to describe the electricity load, eliminating a longstanding shortcoming of MARKAL and introduce a goal program variant of the model. Are currently validating the calibration and reviewing the behavior of the Reference scenario.

**Northeast States for Coordinated Air Use Management (NESCAUM)** Mr. Goldstein teamed with Mr. Delaquil and Ms. Wright, and OnLocation, Inc., designed and implemented algorithms for "mining" the data and results associated with the National Energy Modeling System (NEMS) to enable the semi-automated assembling of multi-region MARKAL models at the census and/or state level. Utilities currently exist for handling the power, commercial and residential sectors.

**International Energy Agency Energy Technology Perspective (IEA-ETP)** Mr. Goldstein provides support to the ETP project, which is bringing technology detail to the IEA's *World Energy Outlook* scenarios, most recently introducing the ability to run MARKAL with n-period look-ahead rather than strictly myopically as done with SAGE.

**Regional Economic Modeling Inc (REMI)** Conducted a joint research activity to develop and methodology for bi-directional linking of the MARKAL and REMI models. The REMI-2-MARKAL link provides useful energy demand projections to MARKAL and MARKAL feeds investment, expenditure and fuel price/consumption indicators to REMI. The theoretical foundations have been established and an initial partial implementation is being considered for the Renewable Energy and Efficiency Modeling Analysis Partnership (REMAP) initiative employing the NESCAUM NE-9 model for the northeast.

**International Atomic Energy Agency (IAEA)** Mr. Goldstein served as project proponent, manager and architect for the development of software to support international nuclear safeguards. The resulting

system, the Inspection Field Support System (IFSS), proved to be a legacy application that transformed the fundamental approach to carrying out Safeguard inspections, variants of which are still being used today.

**Brookhaven National Laboratory (BNL)** Mr. Goldstein served as project manager and lead systems analyst for the development of the MARKAL-MACRO energy system model in conjunction with Prof. Alan Manne. Conceived and developed the first user support system for such complex models, the MARKAL User's Support System, which enable the model to be used by a much wider (less specialized) community.

**Lawrence Livermore National Laboratory (LLNL)** Mr. Goldstein is serving as a key member of the *California Energy Modeling and Analysis Consortium (CEMAC)* initiative which is looking to develop innovative new algorithms, tools, and techniques for dealing with uncertainty in complex models, using the US national MARKAL as the platform for developing the new capabilities.

## **INTERNATIONAL CAPACITY BUILDING**

**South East Europe Regional Energy Market Support** The countries of Southeast Europe are developing a regional approach to energy cooperation. The Athens MOUs of November 2002 and December 2003 and the Energy Treaty signed in the fall of 2005 provide the basis for this collaborative effort that focuses on creating regional electricity and gas markets. There are many dimensions to this initiative, both at the regional and national level as countries seek to adopt the EU Directives in preparation for membership. This Task Order involves a set of interrelated activities that support the Athens process and complement what the EC and other donors are undertaking. It is part of USAID's overall effort to advance the work of the Stability Pact for Southeast Europe.

### *Task 1: Regional Energy Demand Planning (Task Lead – Gary Goldstein)*

This task aims at creating a regional energy demand/energy efficiency planning capability. The analysis of future energy requirements and the implications of economic growth in the region for different sectors are of critical importance. IRG organized a planning group with representatives from the South East European countries, and is working closely with them to develop individual energy planning modes for each country, which ultimately can be incorporated into a regional planning model. MARKAL software for load and demand forecasting has been provided and a range of planning scenarios is being developed on a national and regional basis. Investment and demand management options are priority issues being examined.

**Stanford Program for Energy and Sustainable Development China Gas Study (PESD-China)** Coordinated the design, development and review of regional MARKAL models for Beijing, Guangdong, and Shanghai used to examine the implications of increased availability of natural gas in these regions.

**National Capacity Building** Conducted workshops for universities, research institutions and national planning organizations in numerous countries around the world. In virtually every instance the institutions trained successfully implemented MARKAL models that we used to advise national policy. In the past two years countries receiving such training included the United Kingdom, Singapore, Taiwan, South Korea, and Nepal; in total such workshops have been conducted for over thirty countries.

**Peoples Republic of China: Opportunities for the Clean Development Mechanism in the Energy Sector.** This project promoted reduction of greenhouse gases (GHG) through examining the opportunities for clean development mechanism (CDM) in the PRC's energy sector. IRG developed a set of guidelines for project stakeholders, and proposed a national strategy to promote such opportunities in China. Project output was a set of four feasibility studies for GHG reduction project designs that could be eligible for CDM financing. This project, under the leadership of Matthew Mendis,

worked with the government of China to prepare a framework for the promotion of CDM projects, with special attention to small-scale projects as defined by the 7th Conference of Parties (COP-7) to the UNFCCC. The team developed selection criteria and identified four candidate projects for promotion of renewable energy development and energy efficiency improvements in the localities of Nanning and Lanzhao. The candidate projects were designed for CDM financing and were assessed as to their social, economic and technical feasibility. The small scale pilot projects served as case studies to generate and promote workable institutional arrangements and mechanisms for project financing and for monitoring and verification of the emission reduction credits in China.

## **NEW AWARDS**

IRG has since October 2008 been the recipient of several major awards briefly mentioned here.

**Natural Resources Defense Council** turned to IRG to conduct an analysis of the proposed Lieberman-Warner Cap and Trade. The analysis was performed using an improved and extended version of the US national MARKAL model (US-NM50) originally developed by the Environmental Protection Agency's Office of Research and Development. The analysis shows that the Lieberman-Warner CO<sub>2</sub> reduction targets are achievable with minimal increase in the overall cost of the energy system. <http://www.nrdc.org/media/2008/080513.asp>

A **major national oil company** has awarded International Resources Group a contract to develop an energy modeling system that will provide insight into the evolution of that country's energy system to meet the growing demand for energy in the most optimal manner.

**US Environmental Protection Agency's Clean Air Markets Division** has engaged IRG, as a subcontractor to Research Triangle Park, in a model development and analysis support role to assist with the examination of multi-pollutant control strategies employing an integrated framework that can assess the interactions between multi-sector energy demands, fuels, and processes and their investment, energy cost, security, and emissions consequences.

**USAID/Hellenic Fund Regional Energy Security and Market Development**, building on the success of the SEE-REDP project, is looking to support the development of models and appropriate energy planning capabilities in Georgia, Moldova, Montenegro, and Ukraine. This initiative will be carried out through the joint support of USAID and the Hellenic Fund by IRG teaming with the Center for Renewable Energy Sources. The suite of countries models will be used to conduct assessments of the benefits and costs of improved energy efficiency and promoting renewable energy. The models can also be integrated to explore regional energy strategies and to support the development of a regional energy planning capability.

**Asian Development Bank Pakistan** has selected IRG to model the country's overall energy demand and supply situation using the MARKAL/TIMES integrated energy modeling framework. IRG will provide training and capacity building to local energy planners that will enable them to analyze possible energy futures, to assess the impacts of various policy scenarios and support more informed decision making. This Integrated Energy Model (IEM) undertaking will develop needed data, build the model, apply it for a set of relevant policy issues, establish an appropriate institutional structure for a Planning Team that will advise the government and provide ongoing stewardship of the IEM.

**National Energy Technology Laboratory** has engaged IRG to provide advanced training focused on MARKAL modeling techniques and most effective use of the data handling and analysis systems.