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IEA OECD ETSAP news

ANNEX VIII EXPLORING ENERGY TECHNOLOGY PERSPECTIVES

Carbon Sequestration Marginal Cost Curb for Colombia

Angela Duque, Angela Cadena - University of Los Andes

A methodological approach to estimate the marginal cost curve (supply curve of Certified Reduction Units (CER)) originated in the Land Use, Land Use Change and Forestry (LULUFC) for Colombia is proposed. We developed a model to identify and evaluate carbon sequestration projects under a linear programming platform. The model follows the principles and formulation of the MARKAL models (cost minimization objective function and available area, agriculture and forest products demands and sequestration constraints). In this way, it is possible to compare Colombian sequestration cost with those obtained by one of the authors of this work when estimating CO_2 reduction cost originated in energy projects by using the MARKAL family of models. We applied the methodology to evaluate several kinds of forestry projects in five regions of the country.

In the future we aim to formulate a LULUFC model version using the MARKAL family of models. For the time being we are getting the absorption index or curves for different species harvested in Colombia. At the end, we would be able to compare competitiveness of LULUFC projects versus reduction projects not only within the country but with other countries that use the same modelling approach, that those countries grouped in ETSAP.

ETSAP AROUND THE WORLD

IER contribution

In Germany, research at the Institute of Energy Economics and the Rational Use of Energy (IER) at the University of Stuttgart focuses on three activities. The first is the assessment of existing and new technologies in the power supply sector. The second is the development of methods and tools to study complex systems on different levels of detail with respect to time and geographical resolution. The third is technological and macroeconomic analysis of energy systems to answer energy related questions such

In this issue

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Information on ETSAP, its activities and members is also provided on the Internet. The home page contains the latest news, general information on ETSAP, and links to: ETSAP member; ETSAP 'outreach' activities; description of the MARKAL model and its users; archives of new item; selected publications and the ETSAP Newsletter.

as climate change protection strategies and the consequences of liberalization of energy markets.

For the federal state of Saxonia IER has coordinated the "Energy Programme Saxonia" which aimed to develop sustainable energy strategies in the context of the liberalization of the energy markets in Europe and climate change protection policies. Stakeholders from policy, industry and public groups and organizations were participating in this energy dialogue. In order to assess the effects of different measures on the energy system, a TIMES model of Saxonia has been developed /Fahl, et. al. 2004a/ . Within the climate protection programme of the Federal state of Hessen (InKlim2012), IER uses a TIMES model of Hessen to analyze strategies to reduce cost-effective greenhouse gases.

The fifth model experiment of the Forum for Energy Models and Energy Economic Analysis (FEES, www.ier.uni-stuttgart.de/forum), which is an open communication platform for energy modelers and analysts in Germany and is coordinated by IER, has started in March 2004 and is focusing on innovation and energy

Modelling the Natural Gas System by using the MARKAL model

Juan Bernardo Moreno, Angela Cadena – University of Los Andes

In this project we model the Colombian Natural Gas System in order to identify expansion requirements and options as well as to calculate efficient cost and tariffs for natural gas transportation. The natural gas industry, like the electricity industry sector, followed a reform process. It has unbundled production, transportation and distribution. It is aimed that production prices results from the introduction of competition. Transportation and distribution prices are defined by regulatory authorities. In this context, transportation and distribution companies must ask for efficient tariffs according to demands forecasts and investment and operation and maintenance cost required to supplying the foreseen consumption.

We represent the different sections of the pipeline and assign local energy demand by redefining national energy demands according to those pipeline sections. Competition among energy carriers to supply energy services takes place in a regional or local way. Natural gas (shadow) prices in each node allow us to estimate efficient tariffs for transportation and operation and maintenance cost of the national pipeline. These calculations are a good reference (price-floors) for ECOGAS, the national natural gas transportation company, to ask the regulator for prices definition. In the future we shall represent the electric transmission grid to evaluate competitiveness of natural gas vs. electricity expansion.

will require an understanding of the past. There is a need for disaggregated of good quality, consistent over time and consistent with international standards.

Integrated Environment - Energy – Economy (EEE) Evaluation for the Sustainable Local Planning of the Aburrá Valley Metropolitan

Ricardo Smith Quintero, Angela Cadena, Claudia Rave - Group of Energy Studies, National University of Colombia

An application was made with the MARKAL model for the Metropolitan Area of the Aburrá Valley, where the city of Medellín is located. This application aims to identify a sustainable development patterns of the Metropolitan Area according to environmental and energy policies. The project that is already in its final phase, required an extensive search, collection, processing and analysis of information for the assembly of the data base for the model, being the first time that a model of this type is applied locally in the Metropolitan Area. Thus one of the most important results of the project is the consolidation of an EEE data base for the Metropolitan Area.

The main objectives of the project are the revision of the mobility macro projects and massive natural gas penetration in the residential, commercial and industrial sectors.

- The mobility project for the region pretends to implement an integrated network of buses between the existing Metro lines and the non served zones, to complete the massive transportation system. The fuel consumption and the required technologies to implement the system, supported in the results of emissions and costs, have been analyzed for this macro project.

- The substitution of fuel oil and electricity by natural gas in the industrial and 'residential – commercial' sectors respectively has been evaluated under restrictions of fuel availability, emission of pollutants (CO, CO2, MP, Nox, SO2) and costs.

In this final phase some preliminary results have been analyzed and according to them, other development directions have been established following the model. A strong refinement of the transportation sector is proposed, to evaluate in greater detail the technological technology. The type of participating models (overall 15 models from 13 research institutions in Germany) comprises bottom-up models of the electricity sector on a national or European level, national bottom-up models of the entire energy system, top-down models (CGE models as well as econometric models) and a cross-impact matrix approach. IER is participating with two models, the global top-down model NEWAGE and a national TIMES model for Germany. The results of the fourth model experiment highlighting the long-term contribution of the German energy economy to the European climate protection have been presented on a final workshop in March 2004 / FEES 2004/.

Within a project for the national district heat association AGFW the long-term perspective of district heat in Germany using a national model TIMES has been studied /Blesl, et al. 2004a/. To better describe the regional aspects in the heat market, e. g. heat demand, building types, 11 sub-regions for have been introduced in the German model. In each sub-region the district heat supply and the residential sector have been modeled under consideration of the region-

specific conditions.

To analyze sustainable development strategies in Germany in a study for the Federal Ministry of Economics /Fahl, et. al. 2004b/, an integrated assessment model system consisting of the global resource model LOPEX, the CGE model NEWAGE-World, a European TIMES model and the environmental impact assessment model EcoSense has been developed including a linkage between TIMES and EcoSense, in which the external costs per pollutant derived by EcoSense are internalized in the TIMES-ES model. One part of the ongoing European project NEEDS (New Energy Externalities Developments for Sustainability) project, in which a multi-regional TIMES model of the European member states plus Norway and Switzerland will be developed, is to improve and apply the methodology for linking impact assessment and energy system models.

For a national utility IER has analyzed the impacts of emission trading on the European electricity sector. In order to study the interactions between electricity generation, electricity trade and emission certificate trading, IER has

options for the mobility project and the environmental effects of the general transportation system of the Metropolitan Area. Also a refinement project of the technological information at the industrial level is envisioned for the decision making on the improvement of efficiencies and processes and its environmental and economic impacts.

The project is developed by the Group of Energy Studies, National University of Colombia – Medellín, and co-financed by the following organizations: AMVA - Environmental Regulating and Planning Organization- and EEPPM – Electricity and Natural Gas Regional Utility. The participation of both organizations is a key factor in the implantation of the EEE scheme for the analysis of policies in the region and the interest of both is to rely upon the model for the decision making processes through joint work with the University.

Sweden: MARKAL activities at the Department of Energy Technology, Chalmers University of Technology, 2004

MARKAL activities at the Department of Energy Technology at Chalmers were in 2004 focussed mainly in two areas: a continuation of a study on the value of extended transmission capacities between the Nordic countries and northern Continental Europe, and work on a better representation of the transport sector in the MARKAL_Nordic model.

Chalmers were also active in the ETSAP activities during the year, including participation at workshops, seminars and both of the ETSAP meetings.

Since the deregulation of the Nordic power markets, the peak power dilemma has been high on the agendas of different energy sector stakeholders. However, since both the demand and supply patterns for power differ to a large extent between the Nordic countries there is much to be gained by collaboration between the countries and such collaboration may be able to solve at least some of the peak power problems since the demand peaks look different in

different countries and, in addition, differs between the Nordic countries as a whole and the northern Continental Europe countries, mainly Germany and Poland. In fact, there has already been such a collaboration going on for about a century between certain Nordic countries. In an earlier commenced project which was finished in 2004, MARKAL-Nordic was used in an attempt not so much for direct analysis of the peak problem but merely to improve the representation of power trade, in particular between the Nordic countries and the northern Continental Europe, in order to analyse the value of extended transmission capacity. It was found that especially assuming that the Swedish nuclear capacity is going to phased out that there are some possibly important gains from an extended transmission capacity. The results will be published.

It is generally accepted that CO_2-reducing actions in the transport sector are less cost effective than in the stationary energy sector. However, since many actions in the transport sector are complex and e.g. involves the polygeneration of power, heat and alternative fuels, there is a need for an expansion of the MARKAL_Nordic, which traditionally has been covering the stationary sector in great detail but the transport sector in less detail, to represent the latter in an improved way and to analyse the possible interplay between the stationary and transport sectors. This work is still on-going.

In addition, Chalmers also participated in the Swedish part of the work on linking the MARKAL_Nordic model to the global IEA-ETP MARKAL model together with the Profu consultancy company in Molndal, Sweden. Please see the Profu description for further details.

Activities at Profu related to the use of the MARKAL model

All activities during 2004 have been associated to the use of the MARKAL-NORDIC model, which describes the stationary energy system of the four Nordic countries Sweden, Norway, Denmark and Finland. Activities carried out during 2004 may be summarized into:

Analysis of the effectiveness of Swedish climate policy

The MARKAL analyses were developed a TIMES model of the electricity and public CHP sector (TIMES-EE) consisting of 30 countries and covering the time horizon until 2030 / Blesl, et al. 2004b/.

In the ongoing European CASCADE-MINTS project, which evaluates the possible development of the world energy systems and its implications for Europe regarding the perspectives of a hydrogen economy and the impacts of energy policies, IER participates with the electricity sector model TIMES-EE and the global CGE model NEWAGE /Uyterlinde, et. al. 2004/. In the EU project SAPIENTIA (Systems Analysis for Progress and Innovation in Energy Technologies for Integrated Assessment), which is a continuation of the SAPIENT project, IER uses a three-regional World TIMES model to study the impacts of R&D and learning on technology development.

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Uyterlinde, et. al. 2004/ Uyterlinde, M.A., Martinus, G.H., and van Thuijl, E. (eds.): Energy trends for Europe in a global perspective: Baseline projections by twelve E3 models in the CASCADE MINTS project, ECN report ECN-C—04-94, Petten, 2004

done within the "Control Station 2004" project and initiated by the Swedish Energy Agency. The purpose was to evaluate how well current Swedish policy measures perform in terms of meeting climate change targets. Different scenarios for e.g. future energy use and the time-frame for the phasing out of nuclear power in Sweden were investigated.

Updating of existing taxes and energy-demand projections compared to previous versions of the MARKAL-NORDIC model were two major modelling tasks during this project. The distinction between a tradable sector and a non-tradable sector with respect to CO_2-emission permits was also introduced in the modelling.

Analysis of a common Swedish-Norwegian market for tradable green certificates (so-called electricity certificates)

The work was initiated by the Swedish Energy Agency. The aim was to estimate the benefits from having a common market instead of two separate markets for electricity certificates in Sweden and Norway. Competition between different renewable technologies, electricity-certificate prices and electricity-certificate trade between the two countries were, among others, highlighted.

Refined modelling of the Swedish electricity-certificate system and the creation of a corresponding system for Norway were two essential model improvements during this project.

Analysis of a new set of energy and carbon-dioxide taxes

This project was also initiated by the Swedish Energy Agency. The aim was to evaluate effects on energy use, energy prices, electricity and district heating supply etc as a result of introducing new taxes on energy and carbon dioxide in Sweden.

"Linking" the regional MARKAL-NORDIC model to the global IEA-ETP MARKAL model.

In this project the Nordic MARKAL model and the global model of IEA-ETP (the ETP project: the Energy Technology Perspectives project) were used jointly. Common input data related to e.g fossil fuel prices and technology learning were used. One prime objective was to compare the results of a

global model to corresponding results from a regional model with a better data resolution on a regional scale. Consequences of different emission-permit prices, the introduction of targets for renewable electricity, the phasing-out of nuclear power, the role of carbon-dioxide sequestration and disposal etc could, thereby, be evaluated on a global and a regional (Europe and the Nordic countries) scale.

An improved and updated modelling of carbon sequestration and disposal options (based on a recent report by IEA) in MARKAL-NORDIC was carried out within this project.

Japan Atomic Energy Research Institute

In Japan Atomic Energy Research Institute, the Research Group for Energy System Analysis headed by Mr. Sato made a study on Japan's long-term energy demand and supply toward the year 2050 by applying the Japanese MARKAL model. This study was promoted under the Committee of Nuclear Reactor Development and Utilization of the Japan Atomic Industry Forum, and particular attention was paid on the potential role of nuclear energy in the context of depletion of fossil energy resources and climate change problem. The Research Group made in addition a study on long-term scenarios of developing advanced nuclear power reactors and fuel cycle systems in Japan. The analytical results showed that innovative water-cooled reactors with reduced neutron moderation (RMWR) have enough potential to build net plutonium breeding systems and thereby to contribute to assure sustainable use of nuclear energy from the viewpoint of uranium resource availability.

FEES 2004/ Forum für Energiemodelle und Energiewirtschaftliche Systemanalysen in Deutschland (Ed.): Energiemodelle zum europäischen Klimaschutz Der Beitrag der deutschen Energiewirtschaft, Münster, LIT-Verlag, 2004

Energy-Economic-Environment Modeling Group University of Cape Town, South Africa

The modeling group is a research team, housed in the Energy Research Centre at the University of Cape Town. The group undertakes techno-economic analyses of large energy systems, aided by the use of mathematical models. We also develop new tools, such as the Multi Criteria Decision Analysis program CLIMAX. Notable work to date includes the National Integrated Energy Plan, completed for the Department of Minerals and Energy in 2002, developing energy supply models for low income rural communities for Stanford University in 2003 and this year's National Integrated Resource Plan (in cooperation with ESKOM) for the National Electricity Regulator.

Why energy models and what can they do? Energy models are, like other models, simplified representations of

real systems. Models are convenient tools in situations where performing test or experiments in the real world are impractical, impossible, too expensive or outright impossible.

Computer models offer a several advantages over mental models and thought experiments in that:

- They are explicit; their assumptions are (should be) stated in the written documentation and open for review
- They compute the logical consequences of the modelers assumptions
- They are comprehensive and able to inter-relate many factors simultaneously.

Energy system models are thus useful as they depict immensely complicated systems that are beyond the ability of the human brain to comprehend and understand. These models can be used to perform comprehensive calculations and system analyses. They can help to identify market subtleties and unveil system dynamics that would otherwise have gone unnoticed. Furthermore, the assumptions that form the base of the models are explicitly and unambiguously stated (unlike thought experiments and mental models), so that they are open for critique and review. Further this allows for risk, hedging strategy and sensitivity analysis for policy makers and investors.

We undertake work for governments, utilities, NGOs and industry and services related to:

- Policy analysis;
- Energy system planning, strategy and design;
- Demand forecasting;
- Market and economic analysis
- Environmental mitigation analysis
- Multi criteria decision analysis
- Mathematical programming

The tools we apply consist of in-house models developed as well as standard software including: MARKAL/TIMES, WASP, CLIMAX, MAGNUM, GT Max

Papers, reports and resources

- Energy and environment scenarios for South Africa (coming soon).
- The National Integrated Resource Plan for electricity
- The National Integrated Energy Plan
- Rural energy modeling: MARKAL
- Rural energy modeling: TIMES
- An optimal GHG mitigation pathway for South Africa
- Multi-criteria-analysis: GHG mitigation ,jobs and other development objectives

Job creation and energy efficiency (an application) (a theoretical analysis framework)

- Demand profiles of newly electrified customers (pending)
- National Integrated Resource Plan (NIRP 2) for electricity
- Indicators of sustainable development and e3 modelling
- Modelling renewable electricity supply options in South Africa
- Modelling energy efficiency policies in South Africa
- A multi-regional e3 model of Southern African Countries
- An e3 model of the City of Cape Town

- Modelling the behaviour of low-income energy users
- Testing the hypothesis that correcting for market failure is a driver of fuel transitions

Finland

Finnish participation in the ETSAP program is officially administered by the National Technology Agency of Finland, but the actual work in the programme is carried out at the Technical Research Center of Finland (VTT). VTT carries out development and research on Energy-economy-environment (E3) models, and uses these models in various analyses for the Government of Finland and other contractors.

In the model development and scenario analysis work VTT cooperates with the Helsinki University of Technology (TKK), the Government Institute for Economic Research (VATT), and the Research Institute of the Finnish Economy (ETLA). In the beginning of 2004, VTT completed the development phase of a new comprehensive national energy system model, based on the ETSAP TIMES modeling framework. The new model has fully replaced the old EFOM-ENV modeling system, which was in regular use at VTT since the early 1990s until 2003. The national TIMES model is considerably detailed, well calibrated and tailored to the particularities of the Finnish energy economy. In addition, VTT, ETLA and VATT have jointly developed a stationary computable general equilibrium (CGE) model of the Finnish economy, which has a very detailed representation of the energy sector based on individual technologies instead of the usual smooth production functions. The TIMES databases can be utilized for both modeling approaches. Ongoing work aims at a seamless and efficient linking of the national TIMES model with the CGE modeling framework.

During 2004 and 2005 the national TIMES model has been utilized in a number of national studies. The impacts of the EU emission trading system on the national energy economy have been analyzed in two distinct projects. Possible longer-term energy futures have been studied and published in a celebrated textbook on the Finnish energy system edited by VTT experts. Scenarios focusing on fine particulate emissions have been modeled in the national FINE program. Background scenarios for the update of the Finnish national Climate strategy have been calculated for the Government.

Between 2002 and 2005 VTT has also been actively participating in the development and improvement of the TIMES model generator. The work on the model generator has been carried out in cooperation with the ETSAP primary systems coordinator and a few core ETSAP partners involved in TIMES development (IER, GERAD, KanOrs). The use of the TIMES model is now rapidly spreading into large multi-region applications. VTT is participating both in the Global TIMES modeling effort of EFDA, and in the EU-wide TIMES modeling project NEEDS within the Sixth Framework Program of the European Community. Within the NEEDS project, VTT is also responsible of coordinating the improvements needed in the TIMES model generator.

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Poland

At Gdansk University of Technology, a MARKAL model for the Pomerian region (North of Poland, Gdansk is the capital city of the region) is underway. The analysis focuses on the development of renewable energy sources (especially bioenergy) in regional scale. The methods of modeling the introduction of co-firing in existing coal boilers have been already elaborated. Additionally, different options of meeting quota obligation for electricity from renewable energy sources and electricity produced in cogeneration are being investigated.

According to Polish regulations by 2010, the share of electricity produced from renewables should amount to 9% of total electricity sold to consumers. The obligation concerns power distribution companies so far, but the amendment of the Polish Energy Act states that electricity producers will be obliged to produce electricity from renewables. Therefore, each company producing electricity will have to choose between production in own renewable-bases system (installation of wind turbine, biomass boiler or conversion of existing coal boiler to firing with biomass) and purchasing "green" electricity from other producers having an excess of this commodity.

The trade of "green" electricity will be based on the trade of "certificates of origin" – an idea proposed in EU Directive 2001/77/EC. Companies the fail to meet the obligation will have to pay a fine.

To assess possibilities of meeting the quota obligation in Poland, a model for one region seemed insufficient. In a regional model, professional power plants are not included and these are potentially the biggest producers of "green" electricity due to therefore, the MARKAL model for Poland will be created and the mechanisms of supporting the development of renewable energy sources will be studied.

Operating Agent

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