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C2E2 News

UNEP

Collaboration with IDEE/Bariloche Foundation

A new collaborative project has been started between the UNEP Centre and the Instituto de Economía Energética (IDEE), Argentina. The project extends the Centre's collaborative activities in Latin America, which are generally aimed at assisting energy planners in the region to develop tools and criteria for assessing environmental impacts and macroeconomic effects of energy policies.

In the first stage of a planned long-term collaboration with IDEE, the project will focus on a critical analysis of present policy criteria and on a first approach to the formulation of new criteria and planning methods, and their application to the Argentine context.

IDEE is a non-profit scientific institute, associated with the Bariloche Foundation, with its main office in San Carlos de Bariloche in the Río Negro province of Argentina. The institute also has an office in the capital Buenos Aires, facilitating regular close contact with the federal government.

IDEE was created with the purpose of developing a Latin American centre for research, postgraduate training and technical assistance in energy economics and planning. In this sense, IDEE constitutes the appropriate institutional frame for developing energy environment planning methodologies adapted to the needs of Latin American countries.

IDEE's research and teaching activities address the past, present and future energy problems of Argentina and Latin America, with the purpose of maintaining a complete and updated knowledge of the region's diverse energy systems. One of the institute's major regular activities is a three-month training course for Latin American energy professionals: "Energy Economics and Planning". 29 professionals from 18 nations attended the 1992 course. The UNEP Centre contributed to the course with a seminar entitled "Methods and tools for energy-environment planning in the 1990s".

The new collaborative project will benefit from and supplement UCC's involvement in other national energy-environment studies and act as a test case for an extensive proposed project which has been prepared jointly with the Latin American Energy Organization (OLADE). ■

RISØ

The UNEP Collaborating Centre on Energy and Environment is situated at Risø National Laboratory, Denmark and funded by the Danish International Development Agency (Danida), the United Nations Environment Programme (UNEP) and Risø.

The staff of the Centre:
John Christensen, Head of Centre. *Kirsten Halsnæs,* Senior Energy Economist. *Gordon Mackenzie,* Senior Energy Planner. *Arturo Villavicencio,* Senior Energy Scientist. *Jette Larsen,* Secretary

The work programme of the Centre is concentrated in four areas:
ENVIRONMENTAL IMPACTS of energy production and use in developing countries.
ENERGY POLICY in selected countries and formulation of guidelines for incorporating environmental considerations into energy policy.
INFORMATION on energy-related environmental effects, energy planning methods and models.
SCIENTIFIC AND TECHNICAL SUPPORT to UNEP on energy questions.

In this issue:

Argentina:

Environmental Implications of Energy Developments

by Carlos Suarez, Instituto de Economía Energética/Bariloche Foundation, Argentina

The energy sector in Argentina is currently undergoing a process of rapid institutional change, from a system dominated by state-owned companies, to a nearly totally privatized and deregulated one. The implications of this transformation in terms of future energy choices and environmental impacts will be among the issues addressed in the new collaborative study with the UNEP Centre. For example, the reconciliation of environmental concerns with the economic realities of private ownership and investment criteria in the energy system will clearly be a major area of interest.

The study commenced with an analysis of past trends in CO_2 emissions from the energy sector, relating these to developments within the energy system such as fuel switching. Subsequent work will concentrate on establishing scenarios, both for a reference case and with alternative options for reducing emissions.

The first results of the study on CO_2 emission during the period 1970-1990 are already available (see Figure 1), and the following preliminary conclusions can be drawn from them:

- Total CO_2 emissions increased on average by 2.3% annually during the 1970s, in spite of a drop in specific emissions of some 15% over the whole period, attributable to significant development of the total energy system;
- The most significant cut in the specific emission coefficient occurred in the power sector (–58% between 1971 and 1985) due to the replacement of thermal generation by hydroelectric and nuclear generation, and to the intensive use of natural gas for the production of thermal energy;
- The industrial, domestic and services sectors also reduced their specific emission substantially within this period, mainly due to a significant penetration of natural gas and electricity to replace oil products and coal;
- In contrast, the specific emission of the transport and the agricultural sectors remained practically stable for twenty years. Transport's share of total emissions stayed relatively stable around 30%, while agriculture and miscellaneous exhibited a slight increase from 13 to 15%.

The historical analysis focused on the substitution processes between energy sources within each of the sectors were evaluated, and the following preliminary conclusions were reached:

- Natural gas penetration is reaching saturation in both the industrial and the domestic/service sectors. There is thus little margin for further substitution of oil products by natural gas to contribute to a reduction in CO_2 emission in the future;
- There is a certain additional margin within the domestic/services sector for the replacement of LPG, provided that the distribution network is extended to improve the access to natural gas in low-income urban areas;
- Both sectors clearly experience a direct competition between natural gas and electricity. As long as the latter is generated from sources which do not emit CO_2 (hydro, nuclear, geothermal, other renewables), replacing natural gas in thermal uses by electricity could contribute to cutting down specific and total CO_2 emission;
- Specific and total CO_2 emission can be reduced within the transport sector by increasing the share of vehicles using compressed natural gas;
- Finally, with regard to power generation, only the renewed application of a strategy of intensive use of non-CO_2-emitting technologies/sources (hydro, nuclear, solar, wind, geothermal) will re-establish the downward trend in specific CO_2 emission which was registered between 1970 and 1985.

In the next part of the study, energy-related emissions will be projected until the year 2010. The IDEE will develop a new scenario reflecting recent institutional changes in the energy sector referred to earlier. This activity will take place in close collaboration with UNEP Centre, in particular one of the IDEE project staff will join the UNEP Centre as a guest researcher for a period in early 1993. ■

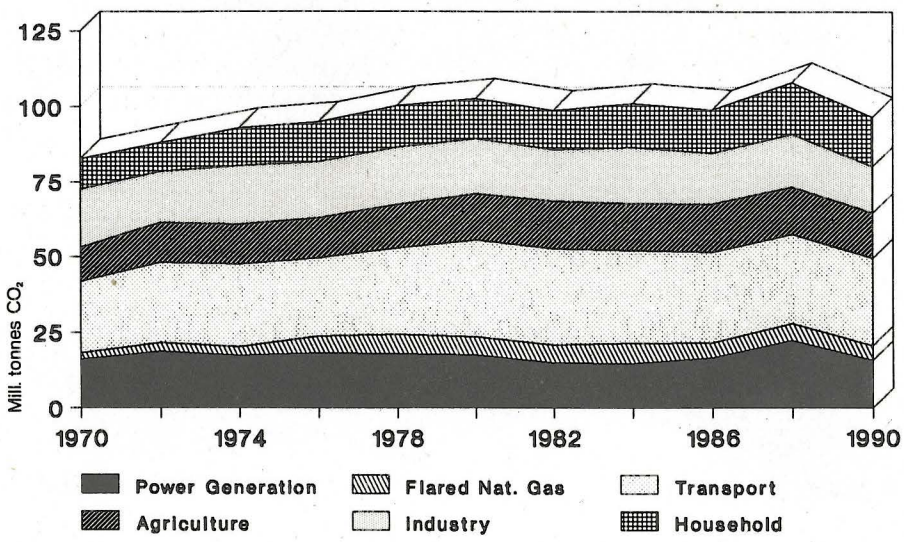

Figure 1. The development of CO_2 emissions from the Argentine energy sector from 1970 to 1990.

Energy Planning Trends in Latin America

Latin America is endowed with a large energy resource potential. Energy reserves have been estimated at about 70 billion tonnes oil equivalent, of which hydroelectric potential has the greatest share (36% of the total), followed by coal (27%), petroleum (9%) and uranium (4%). There are however large variations in energy resources from country to country.

For the last two decades, many Latin American countries have been making major efforts to adjust their consumption structure to meet their resource availabilities. Energy policies have been directed towards two major objectives: the achievement of self-sufficiency and diversification of sources. Countries have thus attempted to reduce the vulnerability of energy and economic systems to external contingencies such as the oil price increases and to reduce the share of hydrocarbons in the structure of energy balances.

The impact of economic crises, particularly the problems related to debt and financing in the energy sector, have hampered progress towards these objectives. The scarcity of external resources as well as the decline in internal funding capabilities meant that by the late 1980s the energy sectors in most countries were suffering from deteriorated financial situation, burdening national treasuries, and cutting back on essential maintenance and investment. These problems have developed within an institutional framework which has become out-dated in many countries.

Environmental Issues

Little attention was paid to environmental impacts in the establishment and development of energy systems. Environmental effects have become more apparent in recent years and energy development in Latin America in the 1990s is likely to be strongly influenced by the progressive incorporation of environmental considerations into the energy-planning and decision-making process.

According to the Latin American Commission on Development and Environment, the main energy-related environmental problems of Latin American and the Caribbean countries are: the deterioration of hydroelectric potential by inefficient management of high basins; the emission of air contaminants; the contamination of inland and maritime waters by oil spills and the thermal contamination of the water; problems related to the use of firewood (deforestation, indoor air pollution); the flooding of vast regions by hydraulic dams; the over-exploitation or venting of hydrocarbons, and inefficiency in the transformation and use of energy.

A great deal of effort over the past two decades has been devoted to the exploitation of the hydropower potential. The installed hydropower generation capacity increased by a factor of five during this period. At the same time, the share of oil in primary energy consumption fell from 63% in 1970 to 49% in 1990. There is no doubt that these changes have represented a positive advance in terms of environmental protection. However, increasing concerns about the social and environmental impacts of hydropower are imposing new constraints that limit electricity generation in favour of other uses of water resources. These aspects have become key factors in determining how much of the remaining potential is, in fact, available for hydropower.

Investment Requirements and Energy Efficiency

Energy demand in Latin America is expected to grow at a rate of 3%, which means a twofold increase of energy consumption in the year 2010 compared with the consumption level in 1990. According to the Latin American Energy Organization (OLADE) the investments required to meet projected energy demand during the 1990s have been estimated at US$ 320 billion of which 54% is for expanding electricity generation and transmission. The total investment requirement corresponds to 15% of the total exports from the region to the year 2000.

These facts indicate that the energy sectors in most Latin American countries face a complex set of problems: to secure vast amounts of capital for providing energy services and improving standards of living; to improve the financial and institutional performance of the sector; and meet the local and global environmental requirements compatible with sustainable energy development.

The traditional strategy of relying almost exclusively on new energy supply capacities, with their preference for centralized energy production, and their neglect of technological diversification, appears economically and financially inviable and environmentally undesirable. In this context, the present energy situation and its perspectives has created a pressing need for identification of alternative energy technologies, energy demand management and a fundamental understanding of the ways in which energy, economy and environment interact with one another. Latin American countries require powerful new strategies to provide enhanced and increased energy services with substantially lower capital requirements and with greatly reduced local and global environmental impacts.

With the advances in the efficiency of both energy production technologies and end-use devices have come innovative strategies for captur-

Continued on next page

ing the benefits of these technologies. Recent studies have shown that a range of energy-efficient technologies, including appliances, lighting systems and components, industrial drive equipment, and efficient building materials and techniques allow far more energy services to be delivered per unit of investment than can be delivered from a new energy facility to less-efficient end-use devices. By adopting a comprehensive approach to all the options for providing energy services, Latin American countries can reduce or eliminate the need for energy investments, reduce reliance on oil as well as mitigate the environmental impacts of energy production and consumption.

Institutional Changes and the Environmental Dimension in the Planning Process

Significant changes are taking place in both the institutions and the planning approach in the energy sectors of Latin American countries in response to the new challenges. Some countries have already started introducing institutional arrangements that will allow their energy sectors to recover their financial viability so that they can invest to meet a rapidly growing demand, simultaneously improving their technical performance. The progressive introduction of market forces in a sector which has been considered until now a natural state monopoly is rapidly gaining wide consensus.

The incorporation of environmental aspects into the energy planning process also has consequences for the institutional side of energy sector. Energy-environmental policy issues are necessarily multisectoral in nature. Their implementation requires a whole system of rules and regulations by which competence, tasks and responsibilities are divided among the institutions involved.

The environment cannot be treated as a separate sector within the economy for the purpose of national policy formulation. Energy planning will therefore be developed more on a multisectoral basis rather than being confined to centralized groups representing the energy supply subsector alone. This means that energy planning is expected to adopt a more indicative character contrary to the mandatory form it has adopted until now. The role of governments will be focused on setting up the policy guidelines and the boundaries for energy development, while the implementation and management of the energy programmes will be transferred to private sector in varying degrees.

This new context implies some substantial changes in the approach to energy planning. The objective of providing energy products is being replaced by the provision of energy services, so that demand side resources are evaluated along with new supply options. Such an approach, known as Integrated Resource Planning, is gaining wide acceptance among energy planners as the most appropriate way to incorporate the benefits of energy efficiency improvements. On the other hand, the concern to reconciliate conflicting objectives (economic, environmental and social) points to a need for new concepts and methodologies, such as the multi-criteria assessment methods, to complement more traditional energy-planning methodologies.

The collaboration of the Centre with government departments, energy planning institutions, and OLADE aims at adapting and incorporating these new approaches into the planning activities of Latin American countries. Some examples of this collaboration are illustrated in this issue. ■

Limiting

by Emilio Lèbre

The main source of GHG emissions in Brazil is deforestation caused by the expansion of agricultural frontiers, mainly in the Amazon region. The corresponding CO_2 emissions are very hard to quantify due to the lack of reliable data concerning the exact surface of deforested land and the biomass densities of the different kinds of forests affected. Within the wide spectrum of figures found in the literature, one could mention the range of 290 to 410 Mt C (million tons of carbon) as a reasonable estimate of its order of magnitude (1).

Present CO_2 emissions due to energy consumption are considerably lower. Our estimates give about 73 Mt C/year in 1990 (2). In the long run, however, emissions from the energy sector are bound to increase and overtake CO_2 emissions from deforestation: a reference scenario for the year 2025 leads to 406 Mt C/year of emissions from fossil fuel consumption (3). Pressures stemming from demographic and economic growth needs could well increase the level of these emissions even further in the long term. Actually, under the assumptions taken in the construction of this scenario, the Brazilian population would increase from 146 million in 1990 to 233 million in 2025, which still falls below its projected long-term steady-state level. And the assumed 4.7% of average annual economic growth would lead to a GDP/capita of US$ 6,270 (measured in 1984 dollars) in 2025 which still lags behind present levels in industrialized countries.

As one should expect that in the long run Brazil will sooner or later reach appropriate levels of income and population, the crucial issue concerning CO_2 emissions remains the energy demand and supply patterns. Again one could fear even higher levels of emissions than in the reference case which assumes maintaining the same energy supply pattern of 1990. Indeed,

the Emission of Greenhouse Gases in Brazil

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this is a very low emission profile in regard not only to population (0.485 t C/year/capita) but also to economic activity (0.181 kg C/US$ of GDP in 1990). To put it on an international perspective, Brazilian CO_2 emissions per MWh of electricity generated are more than ten times less than present U.S. levels and in the car transportation sector CO_2 emissions per energy used are half of U.S. figures.

This can be explained by the very large share (60%) of renewables in the present Brazilian energy balance. Hydropower accounts for the overwhelming majority (more than 90%) of electricity generation. Ethanol from sugar cane secures more than half of the energy consumed by car transportation. Sugar cane bagasse supplies 6% of the overall Brazilian energy balance. Renewable firewood and forest wastes are estimated to provide up to 80% of domestic woodfuel consumption. Industry has become the larger consumer of primary wood (62% of its energy content) to meet 32% of its heat demand, mainly because of the important role of charcoal as a fuel and feedstock for pig iron manufacturing. Up to 20% of the woodfuel and up to 30% of the charcoal used in industry are estimated to be renewably produced.

On the other hand, given the huge amount of natural resources available in the country, the potential for renewable energy production is far from being tapped. An alternative scenario for the year 2025 shows the potential for halving energy sector CO_2 emissions, compared to the reference case. This would require a strategy relying mainly on the increase of renewable energy production (hydropower, ethanol and bagasse from sugar cane, afforestation programmes) and energy conservation.

However, short-term prospects point in exactly the opposite direction. It was during the seventies that renewables gained momentum to reduce skyrocketing foreign exchange expenditures caused by high international oil prices combined with large oil imports. Since the eighties, investment in renewables has been hampered by the lack of financial resources due to economic recession, high inflation rates and foreign debt, as well as the drop of oil prices and the reduction of

oil imports thanks to an increase of domestic production. Accordingly, the building of hydropower plants was nearly stopped, the Alcohol Plan was frozen and is now seriously threatened by extinction, while all the incentives to afforestation programmes were cut.

One can conclude that long-term prospects for limiting GHG emissions in Brazil will largely depend on the flow of organizational and financial resources, both domestic and from abroad, towards energy conservation and renewables, beyond the struggle against Amazon jungle clearing. A huge potential exists for GHG abatement at reasonable costs, and a number of opportunities for international cooperation towards this end can be identified.

To address these issues, a national team bringing together government bodies and research institutes, headed by the Energy Planning Programme of the Federal University of Rio de Janeiro, has been working since 1991 in cooperation with French, Asian and African institutions. This collaborative team has been associated with the UNEP Greenhouse Gas Abatement Costing project since its inception in 1991, and has now joined the project officially for Phase Two through funding from UNEP. ■

References

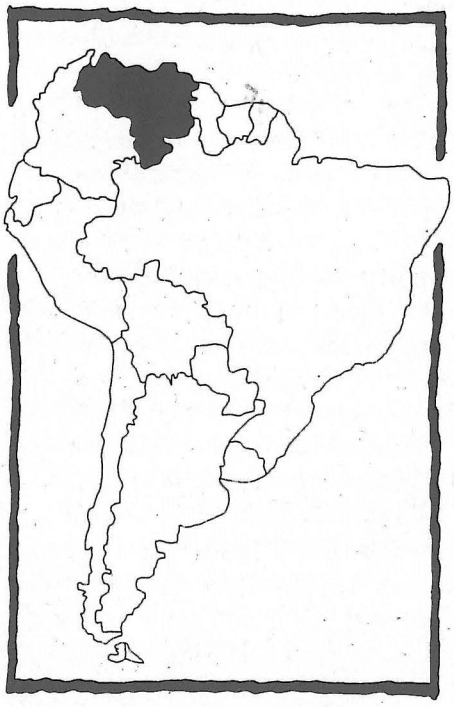
1. Reis, E. J. and Margulis, S. "Options for Slowing Amazon Jungle-Clearing", paper presented at the Conference on "Economic Policy Responses to Global Warming", Rome, October 5-7, 1990.

2. Pinguelli, L. P., La Rovere, E. L., Legey, L. F. et al. Emissiões de Dióxido de Carbono no Sistema Energético: Estimativa da Contribuiçao Brasileira para o Efeito Estufa e Comparações Internacionais, PPE/COPPE/UFRJ, Energy Planning Programme, Rio de Janeiro, February 1992.

3. La Rovere, E. L. La Mise en Valeur des Potentiels Énergétiques des Ressources Renouvables - Une Stratégie de Lutte contre l'Augmentation de l'Effet de Serre: le Cas du Brésil, Seminaire Modelisation Prospective, Critères de Décision et Négociation Internationale d'un Développement Durable: le Cas des Riques Climatiques, CIRED, Paris, October 1992.

Carbon Dioxide Emissions from the Energy System in Venezuela

by Luis Villanueva, Ministry of Energy and Mines, Caracas, Venezuela



Venezuela was the first Latin American country to introduce environmental legislation, having enacted an environmental law and created its Ministry of Environment and Natural Resource in 1977. More recently in 1992, Venezuela enacted a law which allows for penalties to be imposed on activities with adverse environmental impacts. There is strong support in the government in favour of Venezuela taking a lead role in treaties and actions to protect the global environment.

Attention has mainly been concentrated on two environmental issues: the increasing demand for land for industrial and social development, and leakage from the oil production industry. Although urban air pollution is becoming a serious problem in the country, the limitation of airborne emissions and air pollution have generally not been tackled specifically as yet. The recent focus on limitation of greenhouse gas emissions, however, provides the opportunity to analyze how emissions have evolved and to identify options for limiting their future growth. The reduction of GHG emissions, for example CO_2 from motor vehicles, would have a positive effect on local air pollution due to other exhaust gases.

Venezuela has now joined the UNEP Greenhouse Gas Abatement Costing Project through the direct participation of the Planning Department of the Ministry of Energy and Mines (MEM). Other ministries and the energy production and supply companies will also be involved through regular consultation. The activity complements MEM's existing work on the GHG emission inventory for Venezuela, and builds on earlier energy scenarios calculations in which MEM took active part.

Oil-Based Economy

The Venezuelan economy is based mainly on oil, and is consequently highly sensitive to fluctuations in the international oil market. Venezuela has diverse and abundant energy resources (oil, natural gas, coal and hydroelectric potential) and is a member of OPEC. Proven reserves of oil are 60 billion barrels and those for natural gas are about 3×10^{12} m^3. Most of the natural gas is associated gas. The oil industry is state-owned and is operated through Petroleos de Venezuela S.A. (PDVSA) which also owns refineries abroad, and even a gasoline distribution network in the U.S.

Following a government decision in the early 1970s, PDVSA reduced the flaring of gas by about 95%. In recent years, however, the amount of flared and vented gas has increased slightly as a consequence of the increase in crude oil production. Venezuela is still exploring the best economic use of its unflared gas: shipping of LNG to nearby countries is being considered, as is the conversion of a part of the urban vehicles fleet to compressed natural gas.

The major energy consuming sectors in the Venezuelan economy are industry (49%) and transport (37%). Surveys undertaken by the Ministry of Energy and Mines have assessed the fuel efficiency of the two sectors to be substantially lower than those in the industrialized world.

Within the framework of national economic policies, there was a practice of making the fuels available in the domestic market at their production cost, rather than at their opportunity cost (i.e. export price). This has led to inefficient use of energy in several sectors of the Venezuelan economy. The Venezuelan government is in the process of addressing this pervasive inefficiency of fuel use. It is committed to fuel price reforms to bring the domestic fuel prices in line with the FOB export prices. The price of gasoline was doubled during the last year to the present US¢ 9/litre. However, social problems arising from inflation

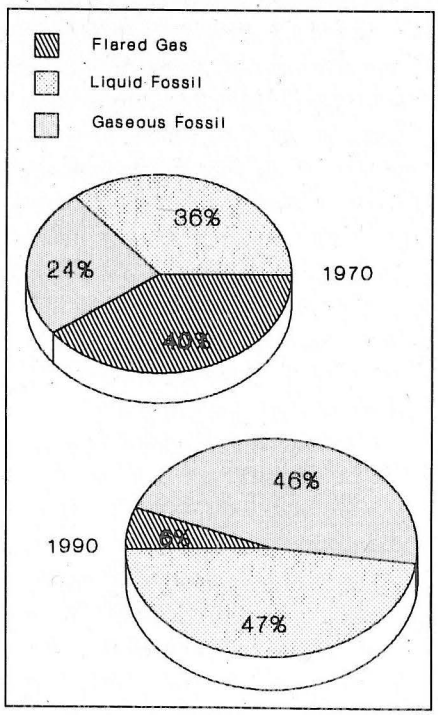


Figure 1. The change in CO_2 emissions from three main sources from 1970 to 1990.

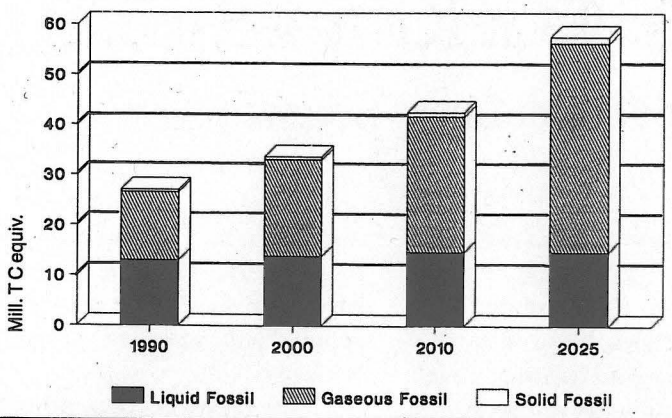


Figure 2. Projected CO_2 emissions for the low emissions case of "medium" (taking off) scenario broken down according to fuels.

and stagnation in the economy (partly resulting from a falling real price of oil in the international market), have brought the pace of this reform to a standstill.

Historical Development of CO_2 Emissions

The historical development of CO_2 emissions has been calculated using the methodology recommended by the OECD/IPCC Joint Work Programme on National Inventories of Greenhouse Gas Emissions. Owing to lack of information on the actual CO_2 emission factors from fuel combustion in the country, the recommended OECD/IPCC emission factors were used for the purpose of this study. Figure 1 shows how the contribution to total emissions from different sources changed between 1970 and 1990, in particular the decreasing fraction attributable to flaring.

Future Energy Scenarios and CO_2 Emissions

Future energy demand was projected using the STAIR (Services-Transport-Agriculture-Industrial-Residential demand) model, developed by the International Energy Studies Group of Lawrence Berkeley Laboratory (LBL) and applied previously in 1990 by the Ministry of Energy and Mines, within a project sponsored by the U.S. Environmental Protection Agency (EPA) in the framework of an IPCC/UNEP study. Three different scenarios for economic development were established, and each one of them was tested for two cases: with and without new emission-control policies (high and low CO_2 emissions cases). The horizon of the study was the year 2025, with reference results for the year 2010. All scenarios were based on common assumptions regarding international economic growth and structure. These include, for example, the assumption that OPEC will increase its market share leading to a stabilization of oil prices, and that the external debt of the country would not limit economic development.

Figure 2 shows the resulting CO_2 emissions for the "medium scenario" (the so-called "taking-off" scenario in the LBL study), in the low emission case. In this case the average annual population growth rate will drop to 2.2% in 2010, and to 1.6% in 2025; GNP growth rate will be 3.6% from 1990 to 2010, and 4.5% from 2010 to 2025.

These results provide a starting point for the work within the UNEP GHG Abatement Costing Project. The scenarios will be adapted to ensure compatibility with those in the other country studies, as defined in the project guidelines. The work will concentrate particularly on identifying the investment and operating costs associated with emission control options, and the macroeconomic effects which these are likely to have in Venezuela. A further important aspect to be considered is the effect on Venezuelan oil revenue, and hence the economy, of lower international oil demand and prices which may be expected to accompany worldwide CO_2 emission reductions on a significant scale. ■

SHORT MEETING REPORT

Post-UNCED Seminar on Environment and Development Policy Issues In Asia

The Tata Energy Research Institute, New Delhi, India organized a 3-day international seminar in October 1992 to examine the implications for Asia of the United Nations Conference on Environment and Development (UNCED). The seminar was jointly organized with the United Nations Development Programme (UNDP) and the International Development Research Centre (IDRC) of Canada.

Senior policy makers and researchers, mainly from Asian countries, and representatives of international organizations attended the seminar which had three main objectives:

- To present research papers on the policy implications of the rio Agreements (Climate Change, Biodiversity and the Rio Declaration), issues bearing on the agreements (such as technology transfer, incremental costs and institutional design) and approaches to devising actual policies and programmes in pursuance of Agenda 21.
- To discuss in working groups and make recommendations on the implications of the Rio Agreements and Agenda 21, the formulation of national/regional strategies, and the scope for regional cooperation and capacity building for sustainable development.
- The adoption of a "Compact for Sustainable Development in Asia" embodying the expecta-tions of cooperation and common perceptions in the implementation of the Rio Agreements and other post-UNCED issues. The Compact was signed by a number of eminent Asian researchers, politicians and other public figures.

The Centre was represented at the seminar by Gordon Mackenzie.

Counting the Cost of GHG Abatement

UNEP National Costing Project Enters Second Phase

Scientific studies conducted in recent years, particularly under the IPCC, have investigated the link between greenhouse gases and global climate change. A consensus has emerged, recommending that such emissions need to be reduced drastically worldwide if the risk of rapid climate change is to be reduced significantly. Most recently the Framework Convention on Climate Change [1], signed in Rio de Janeiro in June 1992, established that emissions of greenhouse gases should be limited or reduced through a coordinated international effort.

A number of studies have addressed the question of economic assessment of GHG abatement. Many have arrived at widely diverging results, from economic gains to sizeable costs which would have severe effects on a country. This disparity of results was one of the main reasons for initiating the UNEP project "National Greenhouse Gas Abatement Costing Studies" in the latter part of 1991, to clarify the economic issues involved in assessing the costs of limiting greenhouse gas emissions and to propose approaches for carrying out comparable costing studies.

The primary focus of the UNEP project is to examine how the impact of varying degrees of abatement on key cost indicators can be assessed. The methods should command broad consensus as providing reasonable indications of the costs involved in limiting emissions. They should also be practically realisable in relation to the available models, data and institutional capacities in the countries involved. The project has been reported in the previous two issues of C_2E_2 News.

Phase One completion

The first phase of the project was concluded in June 1992 with a workshop at Risø and the subsequent issue of the Phase One Report [2]. Phase One consisted of detailed studies of the underlying issues in estimating abatement costs, including analysis of modelling options and reviews of existing cost estimates, and a small set of national reviews. These country reviews aimed at establishing the status of analysis and data in the countries concerned, and illustrate in depth the practical issues raised in embarking upon abatement cost studies in widely diverse countries.

Four core country studies

The country case studies of Zimbabwe, India, the Netherlands, and Denmark in the first phase of the project have highlighted many of the important practical and theoretical problems associated with scenario construction and cost assessment. The two developing countries, India and Zimbabwe, differ in size, energy systems and experience with costing studies. Energy modelling and greenhouse gas studies are well established in India where a series of activities has led to improved economic modelling tools and expertise in abatement assessments.

The project is coordinated by the UNEP Centre, with assistance from the Tata Energy Research Institute of India, Caminus Energy Ltd of Cambridge, UK. Dr. Michael Grubb of London's Royal Institute of International Affairs is lead advisor and consultant to the project team. The national studies are carried out by country teams funded by national agencies, bilateral donors and UNEP.

Copies of the Phase One Report, the full Phase One Country Reviews for Denmark, India the Netherlands and Zimbabwe and the popular booklet "Counting the Cost" are available from the UNEP Centre.

In Zimbabwe, on the other hand, the present UNEP study marks the beginning of such exercises in the country, and indeed in the Southern African region.

The two developed countries, Denmark and the Netherlands, in spite of similar size, geographical location, and social and industrial structure, have chosen different approaches to GHG abatement costing. Thus even the small original core group of countries represents a spread of situations.

Aim of Phase Two

Phase Two aims to develop and test a methodological approach through a set of national case studies using common (or compatible) assumptions for parameters like international fuel prices, discount rates, emission factors, and general technological development. In addition every effort is being made to ensure that the structure of the analyses (e.g. time horizons and degrees of abatement considered) and the concepts of cost used are similar for all countries. This will allow maximum comparability between assessments.

An essential feature of the case studies is the combination of the results of bottom-up (engineering) models, used for detailed system modelling of GHG abatement scenarios, with short to medium-run macroeconomic models, in order to calculate the total macroeconomic effects of such strategies. This will involve improvement and utilization of the methodology of GHG-reduction cost curves.

More countries in Phase Two

Thanks to financial support from the Finnish, French, and Venezuelan Governments and additional support from UNEP, the initial four countries have now been joined for Phase Two by Brazil, Egypt, France, Senegal, Thailand and Venezuela. The extension of the project to ten countries, covering a wide range of development-

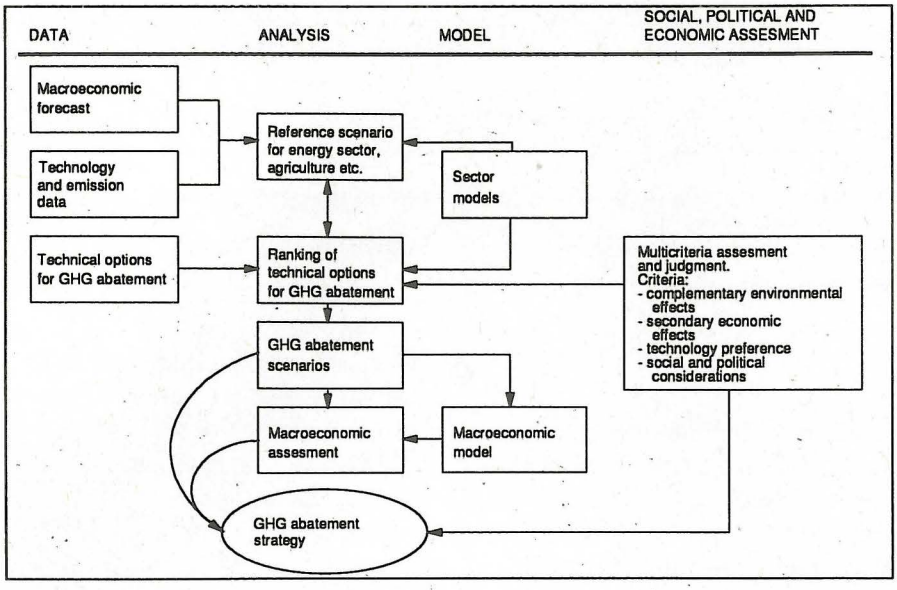


Figure 1. Structure of proposed abatement analyses procedure.

al and geographical settings, all carrying out comparable national studies of the cost of greenhouse gas limitation, will provide valuable information on the feasibility of a common approach.

A possible third phase already being discussed would extend the approach to an even wider group of countries, concentrating on the establishment and consolidation of local expertise in the assessment of such costs, as well as considering possibilities for intra-regional cooperation for cost-efficient GHG limitation.

Guidelines for a common approach

A number of central issues relating to the problem of GHG abatement costing are discussed in the Phase Two Guidelines. These issues range from the definition of the concept of cost itself, through proposed future fuel price assumptions, to recommendations for constructing scenarios.

The proposed approach for the national case studies is shown schematically in Figure 1. Comparability between the studies is being encouraged in all four areas, although it is accepted that national teams are likely to use local data sources and models, and the assessment will be country specific. It is particularly important, however, that the analysis procedure and the general assumptions are followed by all countries. Some effort is also being made to encourage the use of the same bottom-up energy model in as many countries as possible.

Scenario definition

The determination of abatement cost involves the comparison of an abatement scenario with a "non-abatement" reference situation. The definition of the scenario for the reference case, however, may present considerable difficulties. This is particulary evident in developing countries where economic and technological development may be expected to fluctuate and continue to be dependent on external funding to a greater or lesser degree for some time into the future. Reference scenarios for many developing countries cannot therefore be derived on the normal "business as usual" basis.

Reference scenarios for developing countries should assume no particular GHG abatement. This means, for example, that there should be no bias against the use of fossil fuels, at least for GHG abatement reasons. The reference scenario should normally assume a continued development of the energy system following general trends over the past decade. At the same time it must be assumed that modern efficient technology is installed, as capacity is replaced or extended.

International setting

To ensure comparability between the different national studies they must all be placed within the same international setting - i.e. the same future world. National scenarios therefore require a consistent global backdrop describing important factors such as economic growth, fuel prices and the general development of technologies.

A number of global scenarios have been prepared recently for use in other studies, and these provide convenient common reference points. The international scenarios proposed for the UNEP project are based on those of the World Energy Council [3], along with the project team's own fuel price projections for the reference and abatement situations.

The precise relation between global, regional and national scenarios is difficult to define in general, and therefore it is left to the judgement of the national teams in the UNEP project to decide on how the exogenous global scenario assumptions influence national growth patterns and energy system development, etc.

The combination of national reference and abatement scenarios with sets of global assumptions raises methodological questions which are difficult to resolve satisfactorily in the context of isolated national studies. For example, the extent to which national assessments should assume that other countries are also reducing emissions will affect the estimated national abatement cost.

Widespread CO_2 abatement is likely to depress the price of fossil fuels through reduced demand, while isolated abatement could seriously affect the industrial competitiveness of nations. For oil exporting countries such as new project participants Venezuela, the impact of global abatement with associated oil price changes will have an national economic impact irrespective of whether the country introduces abatement measures.

Continued on next page

Third workshop in New Delhi

The third project workshop will be hosted by the Tata Energy Research Institute in New Delhi, India from 22 to 25 February 1993. This final meeting will allow participants to discuss their progress in following the Phase Two Guidelines and to debate important issues related to the analysis, such as the definition of scenarios, forecasting technical and economic development, and integrating bottom-up and top- down approaches.

The second phase of the project is scheduled to be completed in June 1993. As a follow up to the project the Centre is planning a major international symposium being planned by the Centre. The symposium with the provisional title "National strategies for Limitation of Greenhouse Gas Emissions" is tentatively scheduled to take place in Denmark early in 1994. ■

References

1. UN (1992) *United Nations Framework Convention on Climate Change.* A/AC237/L14, 8 May, 1992.
2. UNEP (1992a) *UNEP Greenhouse Gas Abatement Costing Studies. Phase One Report.* UNEP Collaborating Centre on Energy and Environment, Risø National Laboratory, Denmark, August 1992.
3. WEC (1992) *Energy for Tomorrow's World - the Realities, the Real Options and the Agenda for Achievement (Draft Summary Global Report),* WEC Commission, World Energy Council, London, September 1992.

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SHORT MEETING REPORT

Workshop on Climate Change and Sustainable Development, Paris, 28 - 30 October 1992

The Centre International de Recherche sur l'Environnement et le Développement (CIRED) organized an international workshop on "Prospective Modelling, Decision Criteria and International Negotiation on Sustainable Development: the Case of Climate Change". The workshop, with the support of the Agence de l'Environnement et de la Maitrise de l'Energie of France, took place in Paris from 28 to 30 October 1992.

The first part of the workshop was centred on issues related to the long term modelling of the links between economics, technical progress and environment. It was recognized that uncertainties and scientific controversies related to the greenhouse effect represent a major challenge for modelling the impacts and establishing decision criteria. There were wide-ranging discussions on the macro-economic implications of limiting greenhouse gas emissions. The confrontation between bottom-up and top-down-approaches in the assessment of margins for "no regret" strategies in both developed and developing countries was one of the main topics of the debate. It was noted that the opposition between these two types of approaches is no longer meaningful. Top-down approaches are becoming more disaggregated and try to take into account the techno-economic potential of abatement strategies and bottom-up approaches try to incorporate economic considerations. The two approaches appear, therefore to be complementary rather than contradictory.

A number of specialists from OECD countries and developing countries attended the workshop. The Centre was represented by Arturo Villavicencio.

SHORT MEETING REPORT

International Workshops on GHG Limitation at IIASA

Two consecutive international workshops on related issues were held at the International Institute for Applied Systems Analysis, Laxenburg, Austria. The workshops were attended many of the leading researchers in the field and provided an ideal opportunity to discuss current activities in an international context, in particular the UNEP GHG Abatement Costing project was discussed in detail.

(i) International Workshop on Costs, Impacts and Possible Benefits of CO_2 Mitigation, 28-30 September 1992.
The first workshop addressed the economic issues related to the reduction of CO_2 emissions. After a general review of the economics of global warming various issues were discussed in detail, including the potential impacts of climate change, the specific costs of reducing CO_2 emissions, policy instruments, and modelling techniques. The discussions included a methodological and empirical discussion on the present state of international costing studies made by global models. In additions, examples of national GHG abatement costing studies in developing and industrialized countries were also presented. The discussion was closely related to the needs of IPCC and the ratification process for the climate convention.

(ii) Energy-Related Greenhouse Gases: Reduction and Removal, 1-2 October 1992.
The following workshop dealt primarily with energy technologies, scenarios and carbon removal technologies and the discussion was related to the needs of the IPPC subgroup on Energy and Industry.

The Centre was represented at both workshops by Kirsten Halsnæs.

Energy and Environment Studies in Zimbabwe

by R.S. Maya, Southern Centre for Energy and Environment, Harare, Zimbabwe

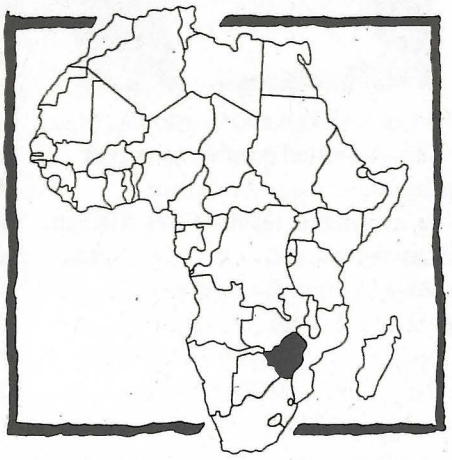
Zimbabwe is one of the three African countries taking part in the UNEP Greenhouse Gas Abatement Studies project, the other two being Senegal and Egypt. The Southern Centre for Energy and Environment has been commissioned by the Department of Energy in Harare to carry out the country study for Zimbabwe, in collaboration with the Energy Systems Group at Risø, Denmark. The study is supported by the Danish International Development Agency, Danida.

The Southern Centre for Energy and Environment (SCEE) is a non-profit research facility, run by Zimbabwean researchers, which provides research support to Government and assists Zimbabwean industries in defining options for sound energy end-use and environmental management. Current activities at SCEE, apart from the UNEP project, include the production of working documents for use in defining the national environmental programme in response to the Rio Earth Summit (UNCED) and collaboration with the Confederation of Zimbabwe Industries in defining simple and feasible early interventions for the improvement of environmental management in manufacturing plants.

Staff of SCEE also represent the Government of Zimbabwe in the IPCC Technical Expert Group on Methodologies for Estimating Net Greenhouse Gas Emissions.

Local environmental issues

In parallel to the work on global environmental issues, the Southern Centre is also active in the analysis of local environmental effects, particularly those associated with industry. In this regard, the SCEE has been engaged in discussions with local industrialists aimed at formulating methods for determining the incremental costs of achieving environmental benefits. Zimbabwean industries, on their own initiative, are now beginning to define environmental codes of conduct and have established an environmental sub-committee of which the Southern Centre is a member.



GHG emissions from Zimbabwe in 1991

Research work for Phase One of the UNEP Greenhouse Gas Abatement Costing Studies at the Southern Centre focused on producing an inventory of GHG emissions from the energy sector in Zimbabwe. Emissions from the use of biomass were not included, but one non-energy source of CO_2, the cement production industry, accounting for about 1% of anthropogenic emissions, was assessed. Results of the exercise showed that Zimbabwe emitted 16.9 million tonnes of CO_2 in 1991, a doubling since 1981. Coal utilization was by far the largest contributor in 1991 being responsible for 82% of total emissions. Estimated per capita emissions for Zimbabwe were estimated to be 1.71 tonnes and emissions per unit of GDP to be 3773 tonnes per Z$ million in 1991.

Reference and Abatement Scenarios

The Zimbabwe national team is now engaged in Phase Two of the costing study, and will determine the cost of reducing emissions up to 25% in the short term (2010) and up to 50% in the long term (2030). Both reduction figures are from baseline, i.e. from the level of emissions in the reference scenario, projected from the base year of 1990. The levels of methane and nitrous oxide emissions will be assessed as part of the study, but the percentage reduction figures will refer to CO_2 reductions as the principal offending gas.

Emission levels and emission reductions will be calculated for two economic development scenarios: (i) the reference case, "without abatement", following present economic trends and with reasonable fulfilment of national development objectives, and (ii) the "abatement" case including structural changes in the energy supply base and in end-use technology. It is assumed that such interventions will not compromise Zimbabwe's economic and social objectives, and also that GHG abatement occurs in the rest of the world so that Zimbabwe does not suffer the cost of unilateral action.

Abatement options on the energy supply side will remain constrained by the limited availability of hydropower. Although potential exists for expanding the hydropower generation capacity, the recurrence of drought conditions cannot be ruled out, and thus thermally based generation is necessary to maintain an adequate and reliable electricity supply. This means that coal remains the main option for electricity generation in the future. The limitation of the growth of CO_2 emissions will therefore be based mainly on efficiency improvements on the end-use side.

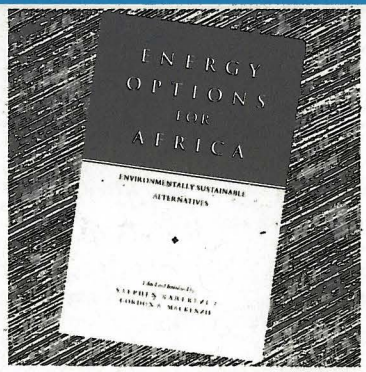
The Greenhouse Gas Abatement Costing activities at the Southern Centre represent the leading edge in this field of research in Zimbabwe and in the Southern African sub-region as a whole. In addition to the direct input to the UNEP project, providing the basis for a methodological framework, the work is also providing vital answers to national policy questions on how to respond to this global issue which contains many serious and potentially controversial issues for the country. ■

Energy Options for Africa

Environmentally Sustainable Alternatives

A group of African energy experts came together in Nairobi from 18 to 20 May 1992 to evolve "A New Environmentally Sound Energy Strategy for the Development of Africa" at a meeting organized jointly by African Energy Policy and Research Network (AFREPREN), the Foundation for Woodstove Dissemination (FWD), UNEP and the UNEP Collaborating Centre.

The proceedings of the meeting have now been published by Zed Books, London. The book, entitled "*Energy Options for Africa*", was edited by



Stephen Karekezi and Gordon A. Mackenzie. A limited number of copies are available from the Centre.

As an indirect result of this African initiative the Centre was asked by the Swedish Agency for Research Cooperation (SAREC) to take part in a formal evaluation of AFREPREN and its activities. SAREC helped establish AFREPREN in 1989 and has since been the main sponsor of the network activities. John Christensen is jointly responsible for the evaluation along with Dr. Mike McCall of Twente University in the Netherlands. A more detailed presentation of the results of the evaluation will be included in the next issue of C_2E_2 News.

The Centre was also invited to participate in a workshop hosted by the Stockholm Environment Institute and SAREC entitled "Renewable Energy Technologies in Southern and Eastern Africa" with the main objective of discussing which activities could best support a wider dissemination of renewable energy technologies in the region. The workshop held on 24 and 25 November included participants from a number of African countries, Asia and Europe.

A SECOND TWO-YEAR PERIOD FOR THE CENTRE

In October 1992 the Centre embarked on a further two-year period with continued and increased support from the three founding institutions, UNEP, Danida and Risø National Laboratory. The Centre was established in October 1990, with official opening early in 1991, and the first two years have been characterized by the initiation and expansion of a programme of activities within the overall mandate to promote the incorporation of environmental considerations in energy policy and planning, especially in developing countries. Two new staff members will join the Centre during the first half of 1993.

GUESTS AT THE CENTRE

Stephen Karekezi worked at the Centre as visiting scientist for the month of August 1992. Stephen is Executive Secretary of the Foundation for Woodstove Dissemination and Facilitator of AFREPREN based in Nairobi, Kenya. His main task during the stay was to coedit the book "Energy Options for Africa".

R.S. Maya was a guest at the Centre for the month of December 1992, working closely with Centre staff on the UNEP GHG Abatement Costing Project, and with other Risø staff on the country study for Zimbabwe. Dr Maya is director of the Southern Centre for Energy and Environment in Harare, Zimbabwe.

C_2E_2 News provides up-to-date information at regular intervals on the activities of the Centre, UNEP and related events and developments. Information on forthcoming conferences, reports, studies, etc. are welcome.

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