

# COMPARATIVE ASSESSMENT OF ENERGY SOURCES

## PROGRAMME OBJECTIVE

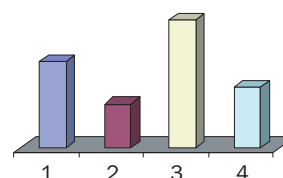
To facilitate national and international comparative assessments of full energy source-to-service chains with the aim of supporting sustainable energy development. To explore the role of nuclear power for sustainable energy system development, and to assist Member States in making informed policy decisions about their future energy development.

## OVERVIEW

The Agency's programme on comparative assessment of energy sources focused in 2000 on reviewing nuclear power's future role in increasingly competitive electricity markets, and its potential contributions to furthering sustainable energy development. To this end, several new methodological tools were developed to aid in informed decision making in Member States. These include a new modelling and analytical approach to electricity system operation and expansion planning specifically designed to reflect growing competition and heightened environmental concerns in the electricity sector; a simplified model for estimating and valuing external costs associated with electricity generation; development of a system of indicators of sustainable energy development; and the update of several other Agency energy–economy–environment analytical tools. A series of reports were also produced on the impact of competition on nuclear power, and the importance of nuclear power for environmental protection and as a means of greenhouse gas mitigation. Capacity building in Member States was also emphasized, through the dissemination of methodologies and through training and information seminars. Finally, the Agency increased its interactions with other international organizations dealing with similar issues, both within and outside the United Nations system.

Regular budget expenditure: \$2 492 653

Extrabudgetary programme expenditure  
(not included in chart): \$204 455



1. Energy Demand, Analysis, Supply Options and Indicators for Sustainable Energy Development: \$677 843
2. Health and Environmental Impacts and Risks of Energy Systems: \$341 812
3. Nuclear Energy in Sustainable Energy Strategies: \$1 003 279
4. Support to Member States: \$469 719

## **ENERGY DEMAND ANALYSIS, SUPPLY OPTIONS AND INDICATORS FOR SUSTAIN- ABLE ENERGY DEVELOPMENT**

Sound energy and electricity system analysis requires reliable data and information, appropriate tools and well defined analytical boundaries. Such analysis must also reflect current trends toward market liberalization, more stringent environmental constraints, the competitive allocation of scarce financial resources and rapidly changing technologies. To build and support the capacity of Member States to develop independent, sustainable energy development strategies, energy and environmental policies and investment decisions, the Agency provides a range of relevant data, information and analytical tools.

Despite the concerted emphasis worldwide on sustainable development, there remains no explicit comprehensive set of benchmarks for assessing progress, or needs, related to sustainable energy development, or to the role of nuclear power. The Agency's Indicators for Sustainable Energy Development (ISED) are intended to fill this gap. In 2000, the full set of 41 was field tested for applicability and data conformity in 15 countries. This has generated requests from several international organizations, including the International Energy Agency, UNESCO and the United Nations Economic Commission for Europe, to participate in the Agency's future work in this field. The full results of the project will be presented to the United Nations Commission on Sustainable Development for consideration during its ninth session (UNCSD-9), and to the Rio+10 meeting in 2002.

## **HEALTH AND ENVIRON- MENTAL IMPACTS AND RISKS OF ENERGY SYSTEMS**

A CRP completed in 2000 compiled data on wastes from non-nuclear fuel chains (mainly coal and oil), and developed a preferred international approach to comparing health and environmental effects from different fuel chain wastes. Specifically, at the CRP's third Research Co-ordination meeting, held in

November 2000, several risk comparison methods (between nuclear and non-nuclear fuel chains) were evaluated and a preferred method based on comparisons against national regulatory standards was identified.

## **NUCLEAR ENERGY IN SUSTAINABLE ENERGY STRATEGIES**

The development of the Agency's modelling tools over the past ten years reflects the evolution of electricity and energy markets worldwide. Early modelling work was tailored to centralized energy and electricity system planning and decision making, i.e. for national

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utilities with guaranteed markets and funding. More recently, the need is for decision aiding tools for choices among generation options under conditions of growing competition, a growing reliance on private capital markets, increased uncertainty and increasingly stringent environmental constraints.

The Agency therefore updated its established energy and electricity system models (WASP, FINPLAN, ENPEP and MAED) and introduced two new models, MESSAGE (a new electricity supply expansion model) and GTMAX, which simulates the operation of an electric system in a short-term electricity market. It also developed a simplified modelling package, B-GLAD, for estimating and valuing external costs associated with electricity generation. This software is designed to aid decision makers in weighing the health and environmental impacts of different generating technologies. The peer review and field test of B-GLAD is now in its final phase, and it will be ready for dissemination in 2001, at which time training will be made available to Member States.

To support its model development work, training and applications, the Agency introduced a Web based software package, *Business Collaborator* (BC), for most of its comparative assessment activities with Member States. BC establishes a ‘virtual office’ that participants can access in order to exchange and review

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documents and to engage in real-time ‘chat room’ conversations. The software has significantly reduced travel costs.

With regard to environmental analysis, including climate change mitigation, the Agency has concentrated on framing the argument for keeping the nuclear option open at various international negotiations on definitions, guidelines and rules associated with sustainable development. Nuclear power’s

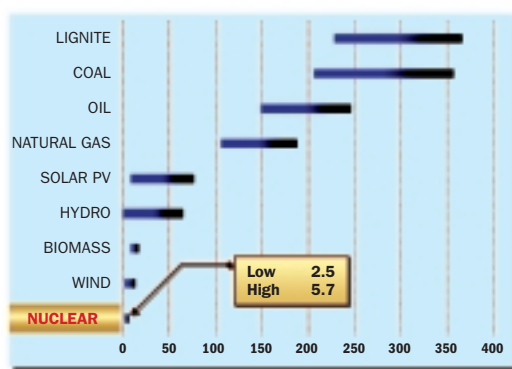


FIG. 1. Ranges of total GHG emissions from different electricity production chains, expressed in grams of carbon equivalent per kilowatt-hour of electricity generated. The ranges reflect differences in factors such as conversion efficiencies, local plant conditions, fuel transport requirements, the fuel mix assumed for electricity requirements related to plant construction and manufacturing equipment and the upstream components of the fuel cycle.

benefits in terms of mitigating greenhouse gas (GHG) emissions are undisputed (Fig. 1), and the Agency has taken an active role in climate change debates held by the United Nations Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC), providing background information and analyses of nuclear power’s potential contributions to GHG emission reductions. Resolution GC(43)/RES/14 from the 1999 General Conference requested that the Agency help developing Member States to explore the role of nuclear power in achieving sustainable development and in mitigating GHG emissions through the Clean Development Mechanism (CDM). In response, research was initiated with Member States to estimate the potential of nuclear power projects in non-Annex I countries (essentially the developing countries) to satisfy GHG reduction commitments in developed countries, as well as sustainable development needs, through the Kyoto Protocol’s CDM. In co-operation with five Member States, the Agency completed a series of case studies indicating that the CDM could indeed help advance nuclear development in Member States considering new construction, and that possible exclusions of nuclear power from the CDM would work against the interests of such nuclear development programmes.

Four of these case studies (for China, India, Pakistan and Viet Nam) were presented at the 2000 General Conference in September. In the case of new capacity, coal fired power generation was the least cost baseline option in each case, except for Indian sites that were more than 1200 km from the nearest coal mine. For such sites, nuclear power was the least cost option. With that exception, each case study compared its coal fired baseline to alternatives with lower GHG emissions. In all of the comparisons, nuclear power proved to be the least cost GHG mitigation option, with mitigation costs (based on levelized generating costs) ranging from \$26 to \$57 per tonne of carbon (t C), a range that is considerably lower than the estimated marginal mitigation costs for compliance with the Kyoto Protocol.

The Agency then presented all five case studies at the Sixth Conference of the Parties

(CoP-6) of the UNFCCC in November 2000. The fifth study, focusing on the Republic of Korea, also concluded that coal fired power would be the least cost baseline alternative, and that nuclear power would be the most cost effective mitigation option with a GHG mitigation cost slightly over \$4/t C. These presentations were especially relevant to the proposed exclusion of nuclear power from two of the flexibility mechanisms, CDM and Joint Implementation (JI). In a statement to the CoP-6 Plenary, the Agency also emphasized the low GHG emissions associated with nuclear power (see Fig. 1) and noted that the exclusion from flexibility mechanisms of any technology necessarily limits flexibility and thus, potentially, cost effectiveness. The presentation of the five case studies offered conference participants a detailed argument against the exclusion of nuclear power from the CDM and represented the only notable exploratory steps toward taking advantage of nuclear power's near-zero GHG emissions in the imminent markets for GHG reductions.

The next focal points of the debate on sustainable energy development are UNCSO-9 in April 2001, the continuation of CoP-6 in July 2001 and Rio+10 in 2002. The Agency has provided documents to UNCSO-9 and to the Committee on Energy and Natural Resource Development (CENRD) addressing nuclear power's future within the context of sustainable energy development. The Chair of CENRD asked the Agency to prepare a discussion paper on all current nuclear issues, including all applicable opinions and solutions. This involved a multi-stakeholder consultation process that solicited the full spectrum of opinions about the key facts and issues surrounding nuclear power. These were discussed and incorporated into the final discussion document. The Agency also contributed to the *World Energy Assessment*, organized jointly by the United Nations Department for Economic and Social Affairs, the United Nations Development Programme and the World Energy Council and published in September. This extensive study is intended as additional input to the UNCSO and provides the comprehensive factual background required to assess future sustainable energy development options.

A new CRP was started to quantify the actual contribution of nuclear power to date in mitigating air pollution, including GHGs. It also looks ahead to enhance mitigation assessment tools, develop methodological guidelines, and conduct national studies to better assess the potential role of different energy options, especially nuclear power, in sustainable energy strategies. All these contributions will be useful to Member States interested in designing and implementing sustainable development policies. Currently, the CRP includes national studies covering Bulgaria,

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China, Hungary, Pakistan, Romania, the Russian Federation and Slovakia. While all have a common goal of assessing nuclear power's role in reducing GHG emissions, each reflects country specific conditions regarding economic development, environmental regulations, international commitments to reduce GHGs, energy resource endowments, underlying technological capabilities, etc. Thus, in addition to conclusions about the role of nuclear power in different countries, these studies will, as a group, bring together valuable information on updated national GHG inventories, current and future policies on nuclear power development, and a variety of possible scenarios (and costs) of GHG reductions. Among other things, these will provide important additional factual and statistical information for future Agency contributions to the GHG mitigation debate.

## **SUPPORT TO MEMBER STATES**

The results of the various analyses and studies carried out by the Agency also serve as input for national workshops and training courses, and for working with individual

Member States to enhance their analytical capabilities in these areas. Support to Member States focuses on addressing such issues as: (i) the implications of global warming and the potential role of nuclear power in mitigation strategies; (ii) the development of sustainable energy strategies; and (iii) the trend toward greater competition and privatization within the electric power sector, and the implications for nuclear power.

The Agency completed a CRP on the DECADES modelling and database package in 2000. The purpose of this project was to enhance the capabilities of Member States, particularly developing countries, to perform comparative assessments of different energy options and strategies for electricity generation in conformity with the objectives of sustainable development. National case studies revealed that enforcement of environmen-

tal regulations has considerable implications on power system expansion in terms of investment requirements, operating costs and environmental burdens. A comparative analysis of alternative expansion options showed that the magnitude of these impacts is very much dependent on the strategies adopted to comply with the regulations. Some of the case studies conducted under the CRP showed the use of nuclear power to be part of the optimal strategy for future expansion of the electricity sector in a sustainable manner. The exchange of information and experience between national teams in the CRP also proved valuable in enhancing the Agency's energy planning tools to meet the evolving needs of electricity system planners in developing countries. The latest version of the DECADES Computer Tools was distributed to over 45 Member States, together with the requisite training in use of the package.