

CHAPTER V, ENERGY RESEARCH AND DEVELOPMENT: TOWARDS LONG-TERM AND STILL LONGER-TERM CONTRIBUTIONS

Section V.A., IEA Organisation of R & D

The formal mandate of the Committee on Energy Research and Technology (CERT) remains as described in Volume I of *The History*. This mandate has been elaborated upon, however, by two strategic documents.

The CERT decided in 1996 to develop a "Medium-Term Strategic Plan for Energy Research and Development", in parallel with the "Medium-Term Strategy" that the Governing Board was developing for the Agency as a whole for the period 1997-2000 (See the introduction to Chapter VII of the *Supplement to Volume I*). Toward this end, the CERT prepared a document setting out a mission statement, key strategies and provisions for CERT operations [IEA/GB(97)6], which was approved by the Governing Board at its February 1997 meeting [IEA/GB/C(97)1, Item 8]. According to this document, the mission of the CERT's Medium-Term Strategy would be "to maximize the contribution of energy research and technology development and deployment to the main objectives of the IEA, including energy security, global environmental sustainability and economic growth." The document then set out in more specific terms the role of the CERT with respect to this mission. Based on these key strategies, the CERT in early 1997 adopted its Medium-Term Strategic Plan for the period 1997-2000. Key themes were energy technology collaboration and deployment. Strategic directions were to: encourage cost-effective energy technology collaboration; produce high-quality energy technology policy analyses; promote the exchange of information between IEA Member countries; provide energy technology policy advice; cooperate with national governments, the OECD and other international organisations by providing advice on energy technology issues; and keep the Governing Board fully informed of the CERT's activities and progress.

Following extensive discussion at CERT meetings during 1999-2001, the CERT agreed a new "Strategic Plan" for its activities [IEA/CERT(97)3], submitting it to the June 2002 meeting of the Governing Board [IEA/GB(2002)20], which "noted the continuing significance of the objectives" contained therein [IEA/GB/C(2002)2, Item 5]. The stated purpose of the new Plan was to communicate to "CERT stakeholders" – its Working Parties and Expert Groups, the Agency's Implementing Agreement participants, IEA Member countries

and others – the Committee's mission and vision for delivering tangible results from investments in energy technology R&D. The expressed "vision" is "for the CERT to become the pre-eminent player in clean energy technologies supporting sustainable economic development, environmental protection and global energy security", and the stated mission, "to support the IEA's mission and goals by promoting the development and deployment of clean and advanced energy technologies through international networking, co-operation, collaboration, analysis and policy advice". The CERT endeavours to be "the locus for information sharing, networking and collaboration among energy technology researchers and policy makers around the world." Its "most important relationships are with its Working Parties". The Plan commits the CERT to develop measures to assess its own progress, including those:

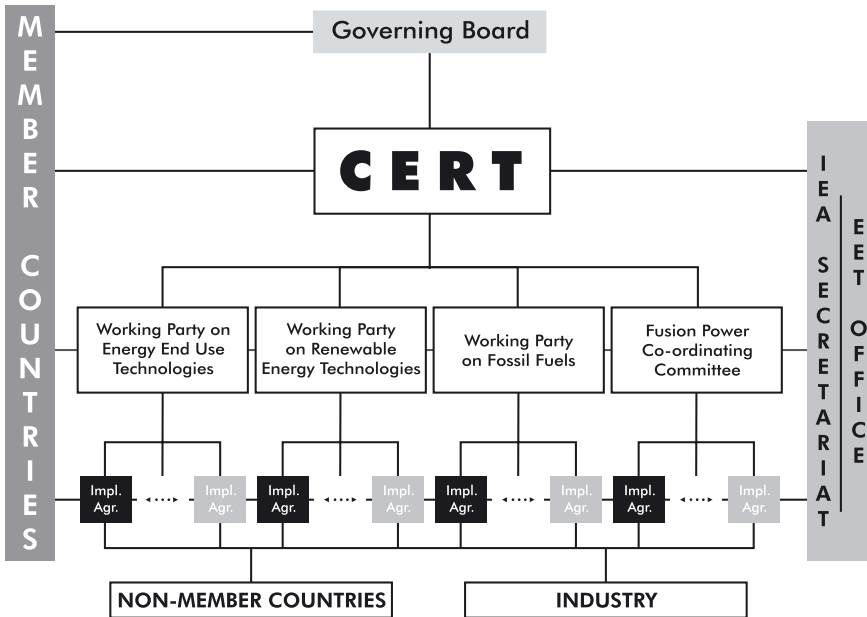
1. measuring progress against quantitative, results-oriented performance goals over time (such as a higher degree of recognition for research and publications);
2. measuring results obtained from activities under the Working Parties and Implementing Agreements by conducting multi-disciplinary reviews, cross-program reviews, and management reviews, in order to evaluate if they are properly focused; and
3. measuring the progress and results of projects.

Following presentation of the Strategic Plan to the Governing Board, the CERT decided that the Plan should be employed on a day-to-day basis in the Implementing Agreements sponsored by the Agency, as well as by the CERT and its Working Parties, and the CERT's Chairman dispatched a message so advising [IEA/CERT/M(2002)2, Item 3].

In practice, the CERT's success in attaining the goals of its Strategic Plan depends on a structure of relationships, interactions and transactions among the CERT, its four Working Parties, the Implementing Agreements sponsored by the IEA, the IEA Secretariat represented primarily by its Directorate for Energy Efficiency, Technology and R&D (EET), Member countries, non-Member countries, and industry. In 2002, the CERT designated CERT Liaison Officers to each of the Working Parties. This network of relationships is illustrated by the organigram overleaf.

The Mandates of the CERT's four Working Parties are reviewed periodically by the Committee, along with documentation concerning their respective strategies and implementation plans. The most recent approval of Working Party Mandates was in November 2003, when the CERT also endorsed those entities' strategic plans [IEA/CERT(2003)35].

Organigram of CERT Strategic Plan, April 2002



There have been cases of observership of the Agency's Working Parties by OECD countries that were IEA non-Member countries. In addition, Russia since 1995 has actually participated in the Fusion Power Co-ordinating Committee (Fusion Working Party).

As the result of a Hydrogen Workshop held in March 2003, the CERT has now created a Hydrogen Co-ordination Group.

In addition, the CERT makes use of Expert Groups. The CERT is supported directly by an Expert Group on R&D Evaluation, while two other Expert Groups, the Oil and Gas Expert Group and the Electric Power Expert Group, report through the Working Party on Fossil Fuels.

Creation of a Renewable Energy Unit within the EET Directorate, and some of the work of that Unit, are discussed in Section IV.D.5. above.

Section V.B., Research and Development Policies and Strategies

This section of Volume I of *The History*, at pages 255-256, describes the IEA/OECD publication, *Scoping Study: Energy and Environmental Technologies to Respond to Global Climate Change Concerns* (1994), and the High Level

Meeting convened in late 1994 to discuss it. A number of the suggestions made in that study led to activities in the Secretariat's Programme of Work, and some became the subject of IEA Implementing Agreements, or were added to existing Implementing Agreements [IEA/CERT(95)36]. Among the issues identified was how best to strengthen the Implementing Agreement mechanism, in order to make it more attractive to Member and non-Member countries as a vehicle for accelerating the rate of progress of technology development [IEA/CERT(95)35].

The Secretariat reported to the Governing Board at its February 1995 meeting, however, that the most significant result of the High Level Meeting was the progress made by Member countries in defining a "Climate Technology Initiative" (CTI) to support the actions on technology development and diffusion under the United Nations Framework Convention on Climate Change (UNFCCC) [Speaking Notes from records of Governing Board meeting in files of IEA Office of Legal Counsel]. At the First Session of the Conference of the Parties to the UNFCCC (COP-1) held in Berlin in April of that year, many of the IEA countries and the European Commission launched the CTI, an ambitious programme with objectives to deploy commercial and near-commercial climate-friendly technologies, and develop longer-term technological response options. Beginning in 1996, the IEA hosted the CTI on a temporary basis. (Subsequent developments with respect to the Climate Technology Initiative are discussed in Section IV.E. above).

Following the May 1995 Meeting of the IEA Governing Board at Ministerial Level, Ministers issued a Communiqué [IEA/GB(95)30/ANN] in which they identified specific means by which IEA countries could further their environmental, energy security and economic goals. The Ministers noted that the development of clean and efficient energy technologies has an important contribution to make, endorsed support for technological development and the removal of barriers to deployment in the marketplace, and supported expanded co-operation with key non-Member countries to encourage sustainable development with energy policy and investment regimes suitable for commercial ventures.

The IEA's "Medium-Term Strategy: 1997-2000" [IEA/GB(96)49/REV1/ANN1], which the Governing Board adopted in December 1996 [IEA/GB/C(96)5, Item 2], contained a section on "Energy Technology". The section observed that declining R&D budgets in most IEA countries lent added importance to technology policy co-operation under IEA aegis, and

noted that greater industry participation might need to be fostered. The following objectives were set for the IEA:

- Reinforce its efforts to promote energy technology co-operation, in particular through Implementing Agreements;
- Concentrate increasingly on promoting deployment of new and improved technologies and helping to overcome barriers to their application;
- Analyse the role of energy technologies in dealing with climate change;
- Address the issue of declining R&D expenditure and barriers to faster deployment of new and improved energy technologies;
- Encourage non-Member country participation in energy technology co-operation;
- Convene industry panels in appropriate technology fields to discuss government and industry roles and funding for energy technology and R&D in order to encourage greater co-operation;
- Seek to direct energy technology co-operation to areas lacking adequate attention.

When IEA Ministers met in May of 1997, they expected that the Third Session of the Conference of the Parties to the UNFCCC (COP-3), to be held in Kyoto the following December, would result in international commitments to emissions limitation and reduction objectives. Energy technology – with both the long-term aspect of R&D and the short-term challenge of deploying clean, low-carbon and efficient energy systems to the market, especially in developing countries – was seen as vital to solving global environmental problems, while maintaining economic growth and energy security.

The Communiqué from the Ministerial Meeting [IEA/GB/C(97)3/ANN] accordingly endorsed the IEA's "Statement on the Energy Dimension of Climate Change" (discussed in Section IV.E. above), which included, in its description of the main energy aspects of the climate change issue, a recognition that "enhanced use of best available, cost-effective technologies could help reduce energy requirements and associated emissions, but barriers to the adoption of available and cost-effective technologies will have to be overcome" [paragraph 5]. Discussing possible energy responses to climate change, Ministers agreed that it was essential that developed countries co-operate on improving energy efficiency worldwide, including enhancing the

commercialisation of climate-friendly technologies, encouraging long-term energy R&D and deploying energy technologies in developing countries. There was a need for longer-term R&D, undertaken co-operatively between governments and between industry and government. Reaffirming the Agency's Shared Goals and welcoming its Medium-Term Strategy, Ministers asked the IEA to "concentrate the Agency's collaborative technology efforts on development and deployment of new and improved technology, particularly those relevant to the Climate Technology Initiative" [paragraph 14]. Ministers also welcomed increased participation by IEA non-Member countries in the Agency's Implementing Agreements.

The Committee on Energy Research and Technology took the Ministerial request as a mandate to analyse further international energy technology R&D and policy trends, with a special emphasis on deployment of clean and efficient energy technologies. It decided to produce a paper on post-Kyoto technologies for the Agency's 1999 Governing Board Meeting at Ministerial Level, asking how much technology can achieve, under what conditions, and at what cost. This led to a Background Paper for the May Ministerial Meeting, "The Role of Technologies in Reducing Greenhouse Gas Emissions", which subsequently was published as an IEA report, *Energy Technology and Climate Change - A Call to Action* (2000).

When the Governing Board, in February 1999, reviewed the Medium-Term Strategy and "rolled it forward" for another four years, 1999-2002, with modifications [IEA/GB/C(99)1, Item 5], the Board made two noteworthy changes to the objectives it had set in 1997: it stipulated that the encouragement of non-Member country participation in IEA Implementing Agreements was appropriate "when there is a net benefit to participating Member countries", and it added this new task: "Assess the implications of lower energy prices for development and deployment of new and improved energy technologies" [IEA/GB(99)5/ANN1, paragraph 40].

In addition to the Background Paper that the CERT prepared for the IEA's 1999 Governing Board Meeting at Ministerial Level, that Committee put forward to the April Governing Board Meeting a proposed Ministerial document, entitled "The Technology Response to Climate Change - A Call for Action". The Governing Board agreed that, with certain revisions, the document would be made available to Ministers [IEA/GB/C(99)2, Item 4(d)].

In this document [IEA/GB(99)29], the CERT pointed out that governments can and should play a role in transforming, into opportunities, the current problems that face low-carbon technologies. Change can be encouraged through

procurement programmes, market simulation measures, voluntary agreements and information programmes. Such measures are unlikely to have sufficient impact, however, if not reinforced by price signals or other means of encouraging investments in low-carbon technologies. Governments should reverse the decline in long-term R&D investment and intensify technology deployment policies and actions. Collaboration through the IEA enhances value-for-money in R&D, deployment policies and the promotion of technology use in Member and non-Member countries. Fossil fuel subsidies should be removed and market incentives established to reduce carbon emissions.

The CERT's message found a response in the Communiqué from the May 1999 Ministerial Meeting [IEA/GB/C(99)3/ANN1]. Ministers acknowledged that lower oil prices produce economic benefits but cautioned that lower prices could slow the development of and investment in new, more efficient and cleaner energy technologies, including those based on renewable energy sources. They "restated the commitments made in the 1997 Kyoto Protocol" [paragraph 6], but also recognised the importance of controlling greenhouse gas emissions beyond the 2008-to-2012 fulfilment period set by the Protocol. Accordingly:

They **underlined** the vital role of long-term technology research and development in this context. They **affirmed** the importance of co-operative efforts under IEA Implementing Agreements in developing and deploying a new generation of sustainable energy technologies. Ministers **emphasised** the need to mobilise public and private resources to deploy environmentally sound technologies globally and to implement long-term emission reductions [Paragraph 8].

The Ministers affirmed the importance of co-operative efforts under IEA Implementing Agreements in developing and deploying a new generation of sustainable energy technologies. They asked the Secretariat to continue assessing the full range of energy issues and choices, including renewable energy and nuclear power, and the implications of any emerging market value for carbon, and to work with the energy industry to find long-term solutions to the challenges. Recognising the critical role that developing countries will play in the evolution of energy markets in the new century, they agreed that the IEA should widen and deepen its relations with major non-Member countries.

In translating the Ministers' messages into action, the CERT in 2000-2001 focused its discussions on the involvement of industry and non-Member countries in CERT-related activities, on lessons learned in energy technology

policy and on the role of long-term R&D. A CERT Note for the Agency's 2001 Ministerial Level Meeting of the Governing Board, "Support for Energy Technology – Imperative for the 'Three E's" [IEA/GB(2001)24], grew out of an October 2000 workshop on "Energy Technology Research, Development and Demonstration: Lessons for Twenty-First Century Partnerships"; a project on best practices in deployment of new energy technologies (published in 2003 as *Creating Markets for Energy Technology*); and an Informal Meeting of the Governing Board in April 2000 that discussed the deployment of cleaner energy technologies in non-Member countries.

The CERT's Note observed that energy R&D, which is crucial for the "Three E's", is becoming more short-term, and contended that it is the role of government to invest in and stimulate R&D over the long term. The old paradigm of government simply as a provider of research funds had to be replaced by a broader view of how governments can support energy research, development and demonstration (RD&D) and deployment. Governments needed, inter alia, to catalyse private sector RD&D by using "grand challenges" as frameworks for work with industry and academia; to increase collaboration in light of the global nature of the challenges; to help stimulate worldwide markets for available but not yet cost-effective or widely-used technologies; to create market conditions favourable for new technologies arising from long-term R&D; and to provide adequate in-house capability to support government's broader role in fostering energy technology RD&D and deployment.

The May 2001 IEA Ministerial Meeting discussed energy security and the place of energy in a sustainable future. Research and development featured prominently in the Communiqué from that meeting [IEA/GB/C(2001)3/ANN1], which reflected part of the CERT's conclusions. In all IEA countries, technological developments were seen to be improving prospects for greater energy efficiency, broader commercial application of cleaner fuel technologies, renewable energy and combined heat and power generation; the Ministers encouraged IEA Secretariat efforts to accelerate these improvements worldwide. They committed themselves, in their own countries and within the framework of the IEA, to support the development and transfer of energy technologies, and stated:

We recognise that energy technology research, development and demonstration... are essential to achieving energy security, environmental protection and economic growth. We accept the need for a government role in supporting long-term RD&D and encouraging the participation of industry. The IEA provides a unique forum and structure for collaboration to promote the availability of advanced technologies and reduce their cost.

Ministers supported the continuing diversification of energy systems – both by energy type and by source. While acknowledging that national circumstances and policies would determine the mix of fuels in each country, they stated their intention that renewable energy play an increasing role.

The Secretariat presented to the October 2002 meeting of the Governing Board a Note [IEA/GB(2002)34], "Technology Options: CO₂ Capture and Storage Technologies", informing the Board of IEA activity concerning the capture and storage of carbon dioxide from fossil fuel use. The Note explained that if costs can be brought sufficiently low, CO₂ capture and storage can become an acceptable component, alongside renewable energy, of a sustainable energy future; indeed, the Note asserted, such technology might be necessary to achieve deep reductions of CO₂ emissions worldwide in time to stabilise the concentration of greenhouse gases at acceptable levels. Assuming that systematic valuation of carbon is introduced and that there are substantial reductions in the cost of CO₂ capture and storage, the attractiveness of natural gas and coal will be enhanced, and as between them, coal's competitive position will be improved, while the hydrogen produced in the process of separating CO₂ from coal and natural gas could be used in transportation, if hydrogen were developed as a commercial fuel.

Industry participation in demonstration and dissemination of the appropriate technologies was seen as essential; however, few large companies presently are engaged in research and demonstration projects, and there is no clear financial incentive for them to do so. Therefore, if CO₂ capture and storage is to be added to the arsenal of climate-friendly technologies, the Note argued, governments will need actively to promote its development and facilitate industry's involvement, such as through financial and regulatory incentives, a long-term policy framework, and a stable policy environment.

The IEA Working Party on Fossil Fuels already had initiated a major project to foster the needed technologies, and had approved a "Zero Emissions Technologies Strategy for Fossil Fuels", which the CERT in June adopted as an activity in line with its own Strategic Plan. The Implementing Agreement for a Co-operative Programme on Technologies Relating to Greenhouse Gases Derived from Fossil Fuel Use and other IEA Implementing Agreements were active in this field, and the Coal Industry Advisory Board had launched its own programme on the subject. The Secretariat intended to facilitate the policy dialogue with all of the involved "stakeholders" to analyse and evaluate the long-term policy framework and technological achievements necessary to achieve commercial application of CO₂ capture and storage technologies.

In response, the Governing Board took a decision in which it "encouraged greater collaboration to support national and international R&D and demonstration projects, including projects undertaken by the relevant Implementing Agreements". It also asked the Secretariat to prepare the elements of a long-term policy framework to facilitate greater commercial application of CO₂ capture and storage technologies [IEA/GB/C(2002)3, Item 9].

A Secretariat Note to the 3 April 2003 meeting of the Governing Board [IEA/GB(2003)7/REV1] provided an assessment of the energy technology developments that could generate significant cuts in CO₂ emissions whilst also meeting security and economic goals in the energy sector. The contextual framework for the Note was that deep emissions reductions would come only by transforming the global energy system into one that relies on advanced, efficient, low-emissions technologies, which would have to be adopted progressively, but in light of long-term effects of decisions on capital stock that are being made near-term. The Note contended that many promising technologies are under development, and that what was needed was rapidly to make them competitive. Accomplishing this required action to spur investment, a link between basic sciences and applied R&D, and support of uptake of a technology by the market before that technology becomes competitive.

Annexed to the Note was a detailed review of individual technology options, which were being reviewed by a network of experts from IEA Member countries, the CERT and the Secretariat. Speaking of that annex, the Note said:

14. Numerous technology solutions offer substantial CO₂ - reductions potential, including renewable energies, fossil-fuel use with CO₂ capture and storage, nuclear fission, fission energy, hydrogen, biofuels, fuel cells and efficient energy end use. No single technology can meet this challenge by itself....
15. Energy technologies for end-use efficiency in the transport, industrial, and residential and commercial sectors are equally crucial.

Enhanced international collaboration was seen as vital to improve information and reduce costs in R&D, facilitate sharing of costs of large facilities and demonstration projects, and foster technology uptake so as to enhance "technology learning" and the cost reductions it brings.

In its decision, the Governing Board:

- (ii) confirmed that, without faster progress in technology development and adoption, deep cuts in energy sector greenhouse gas emissions and adequate long-term security cannot be achieved at reasonable cost;
- (iii) acknowledged the need for the following actions to facilitate faster progress in energy technology development:
 - devoting more public and private resources to cost effective applied energy technology R&D and demonstration;
 - increasing efforts to foster technology uptake by the market to enhance "technology learning";
 - increasing efforts to integrate basic science efforts and energy technology development needs; and
 - enhancing collaboration on energy technology R&D and demonstration, on fostering energy technology uptake, and, where appropriate, "directed" basic science efforts focused on energy technology challenges... [IEA/GB/C(2003)3, Item 7].

In the lead-up to the 28-29 April 2003 Meeting of the IEA Governing Board at Ministerial Level, the CERT concentrated its efforts on technologies for the long-term reduction of greenhouse gas emissions. Co-ordinating contributions from CERT and Working Party delegates and from Implementing Agreements sponsored by the Agency, the CERT prepared a draft report from which was drawn a Background Paper for Ministers, "Energy Technology: Facing the Climate Change" [IEA/GB(2003)7/REV2]. The Background Paper argued that the need had become urgent for IEA governments, individually and in concert, to speed the rate of technology innovation and adoption. In addition, the Secretariat together with the CERT, the Working Parties and the Implementing Agreement participants organised an "IEA Energy Technology Collaboration Fair", which took place at the Ministerial [See IEA/GB(2003)19].

Research and technology themes recur throughout the Communiqué from the Ministerial Level Meeting of the Governing Board [IEA/GB/C(2003)4/ANN1]. Ministers called for continuing development of policies and programmes, consistent with national priorities, to promote energy diversification, including increased support for energy RD&D and deployment; they indicated their particular interest in the acceleration of the commercial availability of cleaner technologies with low pollution and carbon emissions. More needed to be

done to reduce energy use per unit of output, and Ministers committed themselves to achieving greater efficiency both through national programmes and through international technology collaboration; they would pursue this by increasing incentives to efficiency in market and consumer behaviour, in particular in the transport sector, and for buildings and equipment. They also would seek to reduce energy intensity through R&D, technological innovation and international collaboration.

In light of the threats posed by increasing IEA country dependence on imported oil, the Ministers recognised the importance of working together, and with the private sector, to accelerate research and development in fuel efficiency and competitive alternative fuel sources and carriers; they noted, "in particular, our intent to further develop the technologies for a hydrogen future." They similarly called on the Secretariat to pursue technology development to help assure the security of natural gas supply. Finally, IEA Ministers called for the further development of technologies needed to meet the goal of sustainable development, and asked the Secretariat to lead a review of the focus of the Agency's R&D programme in strategic areas.

A Secretariat Note prepared for the October 2003 meeting of the Governing Board [IEA/GB(2003)25] provided information on the status of nuclear fusion generally, and specifically on the decision soon to be made by Canada, China, the European Union, Japan, the Republic of Korea, the Russian Federation and the United States, whether to invest \$4.2 billion in the International Thermonuclear Experimental Reactor (ITER) project. The CERT had discussed this subject in November 2002 and, recognising the significance of the ITER project as a crucial milestone in developing fusion power, it recommended bringing the matter forward for Governing Board attention.

An attached paper from the IEA Fusion Power Co-ordinating Committee reported that, despite uncertainties, current evaluations show that fusion electricity could be competitive in the future energy market. The purpose of the ITER project is to demonstrate that electrical power from thermonuclear fusion is scientifically and technically feasible. As ITER construction would take about ten years, and plans call for exploiting the reactor for ten to twenty years, a demonstration power plant only would be brought on after about 35 years, leading to the first commercial plant toward the middle of the century. The Secretariat's Note also contains information about several IEA Implementing Agreements whose activity is relevant to the development of nuclear fusion power.

One preoccupation of the CERT and of the IEA Secretariat in recent years has been with the modelling of energy technology developments and policy options. In 1997 a conference on "Energy Technology Availability" discussed assumptions about energy technologies that are made in energy models. In the aftermath of that conference, modelling activities became major tasks of the Secretariat. With the benefit of learning from experience of the Agency-sponsored Implementing Agreement on the "Energy Technology Systems Analysis Programme" (ETSAP), from modelling workshops, and from participation in the ACROPOLIS project (a collaborative IEA/European Commission effort on technology policy simulations for climate change mitigation), the Secretariat developed a new global energy technology database and model known as the "IEA Energy Technology Perspectives (ETP) Project". Based on the MARKAL energy systems modelling software maintained under the ETSAP Agreement, the ETP project's database includes detailed representation of energy technologies throughout the energy system and multiregional coverage, and is at the frontier of energy technology modelling. The ETP Project's purpose is to analyse the long-term impacts of technology policy on international energy markets and greenhouse gas emissions under different policy assumptions, and the database and model already have been used for the Alternative Policy Scenario of the 2002 *World Energy Outlook*, for analysis of how CO₂ capture and storage technologies would compete under different CO₂ incentives, and for analysis of several hydrogen economy scenarios.

The transport sector also has been a subject of special focus, in light of the facts that the sector is responsible for almost 60 per cent of oil consumption in the IEA countries (up from 36 per cent when the Agency was established in 1974), and is the chief sector propelling future growth in OECD oil demand. The IEA, therefore, together with the seven IEA-sponsored Implementing Agreements concerned with transport issues that are overseen by the End Use Working Party, has strived to improve the energy efficiency of the transport sector and to develop new means and technologies that will reduce oil dependency and greenhouse gas emissions. Recent publications in this area have included *Automotive Fuels for the Future: the search for alternatives* (1999), *Saving Oil and Reducing CO₂ Emissions in Transport: options and strategies* (2001) and *Bus Systems for the Future* (2002) (examining transport patterns in developing countries, where the growth in oil consumption soon will outstrip that of OECD countries). A Secretariat Note for the October 2003 meeting of the Governing Board [IEA/GB(2003)24], discussed in Section IV.B. above, comprehensively surveyed the opportunities for near- and long-term oil savings and emissions reductions in the transport sector.

Another activity designed to help carry out the CERT's objectives is the dissemination of available information. Many Implementing Agreements actively disseminate energy technology and policy information. The IEA Secretariat achieves such dissemination not only through the IEA's publications (See Section V.D. below), but also through use of the Internet. In 2002 the IEA launched its OPEN (On-Line Publication of Energy News) Energy Technology Bulletin. E-mailed periodically, the Bulletin seeks to generate broad cross-fertilisation of energy technology information and ideas. As of early 2003, more than 3000 subscribers were receiving the Bulletin. In addition, much of the wealth of specific energy technology information that is derived from activities under IEA Implementing Agreements can be accessed through those Agreements' respective websites.

The initiative on assessment of CO₂ capture and storage technologies, discussed above in this section, was the first of a series of technology and technology policy presentations based on results from the "IEA technology family" – the CERT, its Working Parties, IEA-sponsored Implementing Agreements, and the Secretariat's Office of Energy Efficiency, Technology and R&D. Presentations on transportation technologies and policies, fusion power and a hydrogen economy are expected in 2004.

Section V.C., System for International Collaboration on Energy R & D Projects

Following the 1997 Ministerial Meeting of the IEA Governing Board, whose Communiqué recognised the need to promote accelerated deployment of climate-friendly technology in non-Member countries, the CERT and the Committee on non-Member Countries both explored possible new pathways for technology co-operation with non-Member countries. IEA Implementing Agreements were considered unsuitable vehicles for the needed co-operation because the principal interest of key countries such as China, India and Russia was near-term deployment of existing technologies, in which the existing Implementing Agreements have no special expertise. The Secretariat informed the Governing Board [IEA/GB(97)50] that attention had focused on the idea of a different kind of "technology cooperation arrangement/agreement" (TCA) with each selected non-Member country, in which multilateral donor organisations and the private sector could participate, along with national governments. The CERT's Working Party on Fossil Fuels planned to take the lead by instituting a coal power plant pilot activity in China with one or more host utilities.

The Secretariat assured the Governing Board that the proposed technology co-operation would be developed only in areas where Member countries agreed that the Agency's involvement would add value to ongoing industry activities

or to bilateral or multilateral co-operation, and that it would be conducted in such a manner as to avoid any negative effect on the Agency's Budget or Implementing Agreements [See IEA/GB/C(97)5, Item 5(b)].

A combination of factors, including difficulties in acquiring and deploying the needed expertise and problems in making arrangements within China, led to delays in the pilot activity. In November 2002 the Working Party on Fossil Fuels decided to continue its efforts.

Section V.C.2., Project Formation and Management

As discussed in Section V.C.6. below, the Governing Board in February of 1996 requested the CERT to report back to the Governing Board with proposals for changes to the Agency's "Guiding Principles for Co-operation in the Field of Energy Research and Development", to improve the attractiveness of the Implementing Agreement mechanism to non-Member countries. The CERT's proposals [IEA/GB(96)51], which substantially rewrote the "Guiding Principles", were presented to and adopted at the December 1996 meeting of the Governing Board [IEA/GB/C(96)5, Item 6].

These amendments altered the basis for non-Member country participation in IEA Implementing Agreements by eliminating the adjectival reference to non-Member country participants as "Associate" Contracting Parties to those Agreements, and enlarging the rights that NMCs or their designated participants could enjoy under the Agreements. Specifically, they revoked the restrictions that prevented NMC participants in Implementing Agreements from voting on adoption of new tasks and Annual Programmes of Work under those Agreements, as well as the provisions that excluded them from voting on certain structural and policy questions (the admission of new Contracting Parties or Task participants, and the determination of intellectual property questions). In addition, NMC participants would be allowed to act as Operating Agent for an Implementing Agreement if the Agreement's Executive Committee chose them to play that role. The amendments retained, however, the stipulation that an NMC participant in an Implementing Agreement could not block an otherwise unanimous decision by Member country participants in a case where unanimity was required by the Implementing Agreement's participants, and also retained the prohibition against persons from NMC countries serving as Executive Committee Chairmen.

The amendments also modified the Governing Board approval process for participation by non-Member countries in IEA Implementing Agreements, to eliminate the need for repetitive Governing Board approval of a particular country's participation in different Implementing Agreements. Subsequent

applications by an NMC that had received a single Governing Board approval of its participation in an Implementing Agreement would be monitored by the CERT and the overall status of NMC involvement in Implementing Agreements would be reported annually to the Governing Board by the CERT.

An innovation made by the amendments was the creation of a new class of participants in Implementing Agreements to be known as "Sponsors". Article VIII of the amended "Guiding Principles" would allow, in exceptional cases, and subject to approval by the CERT, participation by entities of OECD Member countries that were not designated by the governments of those countries to become Contracting Parties to the Implementing Agreement. Such participation would be as Sponsors, in accordance with equitable terms and conditions adopted unanimously by the Contracting Parties.

At its April 2003 meeting the Governing Board accepted recommendations of the Secretariat for replacement of the "Guiding Principles" with a "Framework for International Energy Technology Co-operation", that unlike the "Guiding Principles" is intended to be binding on Implementing Agreement participants. Executive Committees of pre-existing Implementing Agreements have commenced making necessary amendments to their agreements to effect the binding nature of the "Framework" [See IEA/GB/C(2003)3, Item 8, and IEA/GB(2003)6/REV2]. The Secretariat's Note containing its recommendations explained that over the preceding 18 months, many CERT members, Working Parties and participants in Implementing Agreements had encouraged the Secretariat to review and revise the "Guiding Principles". The objectives of the revision were to:

- (a) permit broader participation by OECD non-Member countries;
- (b) permit broader participation by the private sector;
- (c) provide simple, common and binding rules for participation in Implementing Agreements and make known clearly the responsibilities of Implementing Agreement participants and the various IEA bodies, such as the CERT; and
- (d) to reduce the administrative burden, delay and any legal ambiguity for present and prospective participants in Implementing Agreements. [Paragraph 2].

The new "Framework" makes major changes in the provisions governing participation by NMCs or their designees in Implementing Agreements as Contracting Parties, and in those concerning NMC entities' participation in

Implementing Agreements as Sponsors, the aim of the changes being to broaden Implementing Agreement participation by OECD non-Member countries and by the private sector.

With respect to NMC participation as Contracting Parties, the "Framework" eliminates the remaining restrictions on NMCs or their designees mentioned above, specifically, the NMCs' previous inability to block otherwise unanimous decisions by Member country participants, and the prohibition on their representatives serving as Executive Committee Chairmen. The "Framework" does, however, stipulate that OECD non-Member country participants shall have no greater rights or benefits than OECD Member country participants. The "Framework" also delegates to the CERT the authority previously retained by the Governing Board to approve first-time participation in Implementing Agreements by OECD non-Member countries.

As concerns Sponsors, the "Framework" expands eligibility beyond the OECD universe, allowing Implementing Agreement participation in that capacity by entities of NMC countries without need for designation by those countries' governments, with the CERT retaining its approval authority for such participation. This was in recognition that industry today plays an increasingly important role in what formerly was the domain of government research, even as government funding of R&D has been declining.

In the period 1995-2003 the Governing Board approved the formation of the following new Implementing Agreements:

Implementing Agreement for a Co-operative Programme on Geothermal Energy Research and Technology [IEA/GB(96)37, Item 11(b)(iii)]

Implementing Agreement for a Co-operative Programme on Ocean Energy Systems [IEA/GB/C(2001)4/REV1, Item 10(d)(ii)]

Implementing Agreement for a Co-operative Programme on Spherical Tori [IEA/GB/C(2002)2, Item 9(c)(ii)]

Implementing Agreement for Climate Technology Initiative adopted by written procedure [IEA/GB/C(2003)5, Item 6(c)].

Further information about the IEA's "Framework" can be found in two recent Agency publications, *IEA Implementing Agreements: background and framework as of 2003* (2003) and *Implementing Agreement Highlights: 2002-2003 edition* (2003).

Section V.C.3., Financing and Facilities

The desire to maximise IEA non-Member country participation in IEA Implementing Agreements, and to use the Implementing Agreement framework as a mechanism for transferring climate-friendly technologies to non-Members, has been frustrated somewhat by funding limitations on the part both of those countries and of the Implementing Agreements' existing Contracting Parties. In December 1999, while considering a report from the CERT on its review of the IEA's Implementing Agreements (1995-1998), the Governing Board asked the CERT to provide specific suggestions on how to increase resources to fund outreach activities undertaken by Implementing Agreements. To prepare a response, the Secretariat invited CERT discussion on a proposal to establish within the Office of Energy Efficiency, Technology and R&D a new Unit, to co-ordinate existing efforts on deployment of technologies in non-Member countries, to ensure that this work was integrated with other work relating to deployment within IEA countries, and to initiate new efforts [IEA/CERT(2000)45]. The proposal was not brought forward to the Governing Board because it became clear that funding of the additional resources needed to implement it could not be expected.

Section V.C.4., Intellectual Property

The "General Guidelines Concerning Information and Intellectual Property in Implementing Agreements" were nullified by the Governing Board's April 2003 decision, discussed in Section V.C.3. above, to annul the "Guiding Principles on Co-operation for Research and Development in the Energy Sector", to which the "General Guidelines" were an annex. The Agency has not replaced the "General Guidelines", thus allowing greater latitude for variation from one Implementing Agreement to another in the intellectual property provisions.

Section V.C.5., Participation

As discussed above in the introductory section of this chapter, the "Guiding Principles" were annulled in April 2003, and replaced with a new "Framework". See that discussion for an explanation of the capacity in which non-Member countries now may participate in IEA Implementing Agreements.

In 2003 the Governing Board empowered the CERT to decide on first-time participation in IEA Implementing Agreements by the designees of non-OECD Member countries [IEA/GB/C(2003)3, Item 8]. As noted in Section V.C.1. of Volume I of *The History*, the Board already had delegated to the CERT the power to approve the participation of "Sponsors" in Implementing Agreements.

Participation by NMC entities in IEA Implementing Agreements has increased over the past decade, fostered by the Agency's liberalisation of the governing

provisions. At this writing the designees of eleven OECD non-Member countries are Contracting Parties to such Agreements (the number of Agreements participated in by each country is shown in parentheses): Algeria (1), Brazil (3), China (2), Croatia (1), Egypt (1), Israel (4), Lithuania (1), the Russian Federation (7), South Africa (2), Ukraine (1) and Venezuela (2). Three OECD Member countries that are not IEA Members also participate: Iceland, Mexico and Poland [IEA/GB(2003)6/REV2].

The following entities now participate as Sponsors in IEA Implementing Agreements:

Implementing Agreement for a Co-operative Programme on Technologies Relating to Greenhouse Gases Derived From Fossil Fuel Use

Sponsor	CERT Decision
RWE Aktiengesellschaft	IEA/CERT(94)29/ADD
The Electric Power Research Institute, Inc.	IEA/CERT(94)29/ADD
ExxonMobil Corporation	IEA/CERT(97)39; IEA/CERT/M(97)3
BP International Ltd.	IEA/CERT(97)39; IEA/CERT/M(97)3
Shell International BV	IEA/CERT(98)9; IEA/CERT/M(98)1
Chevron Texaco Corporation	IEA/CERT(2000)03; IEA/CERT/M(2000)1
EniTecnologie SpA	IEA/CERT/RD(2000)2; IEA/CERT/M(2000)2
Alstom Power Technology AG	IEA/CERT/RD(2001)3; IEA/CERT/M(2001)1
TOTAL SA	IEA/CERT(2002)9; IEA/CERT/M(2002)1

Implementing Agreement for a Programme of Research and Development on Energy Conservation through Energy Storage

Sponsor	CERT Decision
IF Technology b.v.*	IEA/CERT(2003)31; IEA/CERT/M(2003)3

Implementing Agreement for the IEA Clean Coal Centre

Sponsor	CERT Decision
Australian Coal Industry Consortium*	IEA/CERT(2003)32; IEA/CERT/M(2003)3
Coal Association of New Zealand*	IEA/CERT(2003)32; IEA/CERT/M(2003)3
Danish Power Group*	IEA/CERT(2003)32; IEA/CERT/M(2003)3

* These Sponsors were approved in 2003 but as of 31 December 2003 had not yet officially signed the Implementing Agreement.

The following table shows the overall status of participation in Implementing Agreements by non-OECD Member countries and their designees, and by Sponsors, as of 30 April 2003:

Energy Technology Area	Number of Implementing Agreements	Number of Countries Participating	Number of Contracting Parties	Number of Sponsors
Fossil Fuels	6	3	4	8
Renewables	9	9	11	0
Energy End-use: Transportation, Information Centres, Systems Analysis, Industry, Buildings	17	2	3	4
Fusion Power	8	3	6	0
Transfer of Technology	1	0	0	0
Totals	41	11	24	12

The participation of both OECD Member countries and non-Member countries in IEA Implementing Agreements is shown in tabular form in Annex 2 to the Agency's 2003 publication *Implementing Agreement Highlights*.

A report to the June 2003 meeting of the CERT [IEA/CERT(2003)24] showed that while the total number of Contracting Parties to IEA Implementing Agreements has continued to grow over the period 1990–2003, the rate of annual increase slowed in the latter half of that period.

Section V.C.6., Functions of the Implementing Agreement

In 1995, the third *Review of Energy Technology Collaboration Activities* was conducted, this one covering the period 1991–1994. The Secretariat's Note to the February 1996 meeting of the Governing Board [IEA/GB(96)5], while concluding that there were clear benefits of Implementing Agreement collaboration, and noting an increase in activities with an environmental focus, nevertheless cited some shortcomings: not all Agreements had made adequate progress in involving industry and end-users in their work and in disseminating the results of their work to industry; participation in some Agreements was weak; room remained for improved co-ordination between – or amalgamation of – Agreements; the review process itself needed streamlining; and the level of non-Member country participation was not as high as desired. The Governing Board observed that the efficiency and effectiveness of the Implementing Agreements must be improved, particularly

through enhanced co-ordination and transparency of the evaluations, and through amalgamation or termination of Agreements where synergies or cost savings could be achieved. It further requested the Committee on Energy Research and Technology to propose amendments to the "Guiding Principles for Co-operation in the Field of Energy Research and Development" to make the Implementing Agreement mechanism more attractive to non-Member countries. Those amendments are discussed in Section V.C.2. above.

A fourth review of IEA Implementing Agreements, for the period 1995-1998, was completed in 1999, and was the subject of a Note to the December 1999 Governing Board from the CERT [IEA/GB(99)59]. The review process involved obtaining detailed information on all Agreements, short evaluations, and the preparation of portfolio reviews by the Committee's Working Parties and the Fusion Power Co-ordinating Committee (Fusion Power Working Party), followed by consideration in the CERT.

The conclusions reached were similar to those from the previous review. The review reaffirmed the benefits of the collaboration, but said that from the strategic management standpoint, there needed to be prioritisation of subjects for Implementing Agreements, particularly in light of the critical issue of how such Agreements most effectively can address climate change issues. Also needed was stronger co-ordination within the governments of IEA Member countries, to assure that consistent messages about priorities were passed to national representatives on Implementing Agreement Executive Committees. The Note stated that the CERT will continue to encourage Working Parties and Implementing Agreements to develop mechanisms to encourage industry participation, and remarked that if outreach to non-Member countries by Implementing Agreements was to be induced, as desired by the Governing Board, additional funding would be required. The Governing Board endorsed the CERT's findings and asked the CERT to provide specific suggestions on how to increase resources to fund outreach activities undertaken by Implementing Agreements [IEA/GB/C(99)6, Item 7].

For the period 1999-2002, no integrated review of the Implementing Agreements was conducted; however, as discussed below, the extension process for individual Implementing Agreements was made more meaningful.

In 2001 the Governing Board delegated to the CERT the authority to approve extensions of the Agency's Implementing Agreements [IEA/GB/C(2001)1, Item 8]. This, together with the recommendation from the two reviews of Implementing Agreements that management of the technology co-operation programme be streamlined, led to the CERT's adoption of guidelines for End-

of-Term Reports for Implementing Agreements [IEA/CERT(2001)35] and of procedures and criteria for Implementing Agreement extension [IEA/CERT(2002)24]. The role of the Working Parties in supervising the Implementing Agreements was confirmed: they are tasked with making recommendations to the CERT on whether Implementing Agreements should be extended, based on a specified set of evaluation criteria.

The recent activities of the Agency's various Implementing Agreements are described in the 2003 publication, *Implementing Agreement Highlights*, which also gives information on their respective websites.

Section V.D., Country Reviews and Technology Reviews

The IEA Secretariat reported on "IEA Country Funding of Research and Development" at the October 1996 meeting of the Agency's Governing Board, expanding on initial conclusions that the Chairman of the Committee on Energy Research and Technology had presented at the Board's June meeting [IEA/GB(96)45]. The IEA long has collected national statistics on government spending for energy technology R&D; these are published in the Agency's annual *Energy Policies of IEA Countries*. Most governments do not collect detailed information on private sector energy technology R&D spending, however. To obtain a better understanding of that subject, IEA Member countries were asked to respond to several questions, and the Secretariat's Note summarised the data that was provided by the twelve countries that responded positively.

The Secretariat's Note advised that the data on total government investment showed the following trends:

- Over the past ten years, overall real levels of government investment in energy technology research and development seem to be declining in many countries. In some countries government support for energy R&D has declined very sharply.
- Since 1985, in real 1995 currencies, only energy conservation budgets have increased.
- Most energy R&D is conducted in only a few IEA Member countries: Canada, France, Germany, Italy, Japan, The Netherlands, Switzerland, the United Kingdom, and the United States. These nine countries account for about 96 per cent of total government energy technology R&D expenditures...

- overall government budgets relating to fossil and nuclear energy technologies have declined significantly in some countries, while recent support for renewable energy appears to be increasing....
- a shift in emphasis towards meeting shorter-term needs and away from support for longer-term technology options;
- in parallel with this trend, the tendency of increasing industrial competition and greater liberalisation in the utility industry to strongly encourage a shorter time perspective on private sector R&D.

These trends highlighted the need for greater collaboration, between national governments and between governments and the private sector, to foster longer-term energy technology R&D.

While high quality energy technology R&D information on private sector investments and priorities is difficult to come by, the Note concluded that, in general, longer term energy technology R&D investment by the private sector appears to be declining, partly, it was believed, under the influence of increasing worldwide market competition. These factors were cited:

- Current energy prices provide limited incentive for longer term energy R&D by private firms....
- It appears that the structure of energy technology R&D by private companies is undergoing change. Large corporations have been shifting the majority of their R&D resources away from central corporate laboratories (long believed to be the home of longer term industrial R&D) and into business unit laboratories (which are believed to be the locus of shorter term, product R&D)....
- The restructuring of the natural gas and electric utility industries in IEA Member countries may at least initially reduce the ability of these industries to fund longer term, pre-competitive energy R&D....
- Many analysts believe (in spite of the absence of substantiating data) that industry may be changing the composition of its energy R&D portfolio and shifting resources away from supply/production technologies and toward energy end-use technologies....

- Private sector firms performing energy R&D appear to be using co-operative mechanisms to offset some of the decline in overall industrial energy R&D funding and to ensure a proportion of projects continuing longer term R&D....

In discussing the Secretariat's Note, Governing Board delegates emphasised the potential benefit of analytical work on data that already is available, and discouraged the imposition of new data collection burdens. The Board asked the CERT to examine trends in government and private sector energy technology R&D and report back to the Governing Board in 1997 [IEA/GB/C((96)4, Item 7].

The CERT reported back on this subject at the December 1997 meeting of the Governing Board [IEA/GB(97)53]. Its findings were similar to the previous year's, but carried a tone of greater urgency:

- The continued erosion of energy science and technology budgets... has put at risk our ability to provide advanced technological solutions to climate change concerns....
- The trend toward shorter-term R&D is... affecting some government R&D budgets as governments... seek to partner more closely with industry....
- ...Ministers should be very cautious in their assumptions about the timely future availability of new, advanced, climate-friendly technologies... to meet their shared goals..., and... to meet possible future targets for reduction of greenhouse gas emissions from the energy sector....

Governments therefore should protect longer-term energy technology R&D, share information, and support R&D partnerships within and among countries.

The Governing Board, at its December 1997 meeting, agreed that the CERT's findings warranted serious consideration, and asked the CERT to provide in 1998 a more detailed report on the qualitative effects of recent changes in energy technology R&D expenditures, along with recommendations on how those effects should be addressed. [IEA/GB/C(97)5, Item 10].

The General Report ("Overview") within the Agency's 2002 edition of its annual publication, *Energy Policies of IEA Countries*, advises that government energy R&D budgets in IEA countries declined an average 1.7 per cent per annum in the 1990s, although they increased slightly after 1997; the most drastic decline was in coal research, while R&D budgets for energy conservation, renewables, power and storage increased. Recent trends in Member countries were described as follows:

Stronger awareness of sustainable development is the most important recent trend. However, in many instances the role of technology developments that enhance energy security also comes in for emphasis, so that technologies in efficiency, renewables, fuel cell, hydrogen, CO₂ sequestration and clean coal are becoming important. Enhancement of industrial competitiveness is being considered by a number of countries.

Other recent trends include understanding the importance of innovation, involvement of industries, universities, research institutes, and international co-operation [Page 96].

The most recent Questionnaire employed in the annual review process is Document IEA/SLT/CERT(2003)2, used for the 2003-2004 reviews. This document contained new questions, with respect to "overall [R&D] policy objectives", about the criteria and strategy in selecting energy research programmes (including the balance among long-term, medium-term and short-term objectives); the linkage between basic science and energy technology development; the methodology used to evaluate the performance of energy R&D programmes; and the results of that evaluation.

Apart from "survey" studies such as *Energy Policies of IEA Countries*, global analyses like that done on energy technology R&D spending in 1996, and input to the Agency's *World Energy Outlook*, the CERT's portfolio of specific energy technology and policy reviews is a broad one, indicative of the concept that there is no "single bullet" – no single technology – to achieve a sustainable energy economy. Support is given to a continuing diversity of energy systems, by both energy type and energy source, and with regard to country-dependency on a particular mix of fuels. For example, publications during 2002-2003 have dealt with a variety of subjects such as bus systems, nuclear reactor development, emissions technologies for fossil fuels, renewable energy, fusion power, international energy technology collaboration, and the creation of markets for energy technology.

The Agency's 2003 publication, *Creating Markets for Energy Technologies*, posits that market forces alone will not enable clean energy technologies to become the pillars of a sustainable energy system, and examines the design and implementation of policies that encourage the use of cleaner and more efficient energy technologies. The publication contains studies of 22 cases of successful government support programmes for the creation or expansion of markets for clean energy technologies, collectively representing an investment of more than 20 billion Euros. The 22 cases are

examined from the research, development and deployment perspective, to more fully understand the nature of the innovation and learning process; from the perspective of market barriers, to better deal with market failures; and from the market transformation perspective. The key messages to policy makers are to: (1) invest in niche markets and learning in order to improve technology cost and performance; (2) remove or reduce barriers to market development that are based on instances of market failure; and (3) use market transformation techniques that address shareholders' concerns in adopting new technologies and help to overcome market inertia that can unduly prolong the use of less effective technologies.

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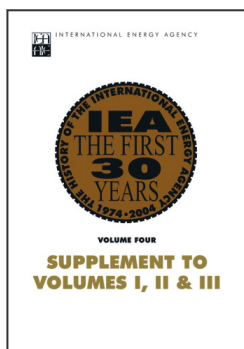
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