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Gordon Thompson  
Robert Goble  
F Scott Bush

**Design of an Information System on  
Technologies that can Limit  
Greenhouse Gas Emissions**

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CENTER FOR TECHNOLOGY, ENVIRONMENT AND DEVELOPMENT  
Clark University, Worcester, Massachusetts

*in association with:*

INFORMATION UNIT ON CLIMATE CHANGE  
United Nations Environment Programme, Geneva

*For further information, please contact:*

Edward R Williams  
US Department of Energy, PE-63  
Room 4G-036, 1000 Independence Avenue, Southwest  
Washington, DC 20585, USA  
phone: (202) 586-2061 fax: (202) 586-2062

W Bradford Ashton  
Battelle Pacific Northwest Laboratories  
901 D Street, Southwest, Suite 900, Washington, DC 20024, USA  
phone: (202) 646-5240 fax: (202) 646-5233

F Scott Bush  
Center for Strategic and International Studies  
1800 K Street, Northwest, Suite 400  
Washington, DC 20006, USA  
phone: (202) 775-3295 fax: (202) 775-3199

Gordon Thompson  
Institute for Resource and Security Studies  
27 Ellsworth Avenue, Cambridge, MA 02139, USA  
phone: (617) 491-5177 fax: (617) 491-6904  
Email: [info@irss-usa.org](mailto:info@irss-usa.org) Web: [www.irss-usa.org](http://www.irss-usa.org)

Robert Goble  
Center for Technology, Environment, and Development  
Clark University, Worcester, MA 01610, USA  
phone: (508) 751-4622 fax: (508) 751-4600

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*Disclaimer*

The conclusions presented here received broad endorsement by workshop attendees. They do not represent definitive statements or policy commitments by the attendees or their institutions, by the workshop organizers, by the UN Environment Programme, by the US Department of Energy, or by Battelle Pacific Northwest Laboratories.

## **1. Introduction**

This report summarizes a workshop whose broad purpose was to improve the collection and dissemination of information on technologies that can limit greenhouse gas emissions. Within that broad purpose, the workshop focused on the design of a technology data base currently being developed for the Intergovernmental Panel on Climate Change (IPCC). The workshop, sponsored by the US Department of Energy, was held at the Center for Strategic and International Studies in Washington, DC, on 18-19 February 1992. It was attended by technical, scientific and information management experts from a variety of countries and institutions.

The remainder of this report begins with a description of the context for the workshop. It then sets out the purposes of the workshop, describes the workshop process, and summarizes the discussions that took place. Those discussions were held partly in plenary sessions and partly in three working groups that focussed on the following three issue areas: information use; information supply; and institutional issues. The report closes with a set of conclusions that received broad endorsement by attendees.

## **2. The Context for the Workshop**

The concept of sustainable development enjoys growing acceptance around the world. Governments, business leaders and citizens increasingly agree that human needs can and should be met without destroying our natural resource base. The implications of this new awareness are not fully understood, but it is clear that the technologies and practices that sustain our economies will change. Some of those changes might be substantial and rapid.

One goal of sustainable development is to ensure that human-induced emissions of greenhouse gases do not adversely affect global or regional climates. There is no international consensus about the global or national limits to be set on those emissions, but there is broad interest in identifying and assessing technologies and other measures that can limit emissions. Thus, there is a need for the systematic collection and dissemination of information about such technologies and measures. In fact, it is widely accepted that there is a need to improve the worldwide exchange of information on measures that can contribute to all facets of sustainable development.

A variety of technology information projects have been launched in response to these needs. The projects variously aim to collect, process, disseminate or facilitate the exchange of information on technologies or other measures that can contribute to sustainable development, often with attention to limiting greenhouse gas emissions. The projects are at varying stages of development and have national, regional or international scope. There has been, until now, little communication between these projects and the workshop provided a forum for such communication. Appendix A lists some of the projects.

The need for improved exchange of technology information has been recognized by the IPCC. This is an international expert body, sponsored by the World Meteorological Organization and the UN Environment Programme, whose function is to advise policymakers and negotiators on scientific and technical matters related to human-induced climate change. It has three working groups, of which Working Group III, chaired by the United States, is devoted to identifying and evaluating strategies that respond to the threat of climate change. Within IPCC Working Group III is the Energy and Industry Subgroup, co-chaired by China and Japan. Its function is to assess the

potential roles, within response strategies, of technologies and other measures in the energy and industrial sectors.

The Energy and Industry Subgroup has taken note of the many publications providing information on technologies that can limit greenhouse gas emissions. However, much of that information cannot be directly related or adjusted to new conditions because the data in each study were collected in different formats or were based on different assumptions. It has become clear that consistent data in a readily exchangeable standard form are essential for climate change studies, particularly for international or comparative studies whose results will be reviewed and shared by many users. In addition, although more efficient and less polluting technologies than those currently used may be available for public or private sector application, many countries lack sufficient resources to adapt or investigate such technologies on their own. This can lead to limited analysis of available options, use of data of questionable quality, and poorly informed investment decisions.

In light of these problems, the Energy and Industry Subgroup agreed in August 1991 to develop a Technology Characterization Inventory (TCI). The TCI is to be an information system that contains data on the characteristics of energy-related technologies and provides guidance on how these technologies might be adapted for use in specific locales. Initial development of the TCI is being coordinated by the US Department of Energy, assisted by Battelle Pacific Northwest Laboratories. Technology data, review comments and technical consultation are being provided by a number of IPCC nations and participating organizations. Other nations and organizations have been invited to join the effort. An initial version of the TCI was presented to the IPCC by the United States delegation at the February 1992 IPCC meeting.

### **3. Purposes of the Workshop**

As mentioned above, the workshop had the broad purpose of improving the collection and dissemination of information on technologies that can limit greenhouse gas emissions. The workshop also had a more specific but compatible purpose, namely to provide advice on the design of the TCI. Since the TCI is a pioneering internationally oriented effort devoted to information exchange in this area, its development will strongly influence the development of other information systems.

The effort to develop the TCI and other information systems related to greenhouse gases will involve a search for international consensus on standards and procedures that allow effective exchange of information in this area. Analogous standards and procedures are needed to allow exchange of information on sustainable development measures more generally. Thus, the workshop also represented a step toward that larger end.

The workshop organizers, namely the Center for Strategic and International Studies, the Institute for Resource and Security Studies, and Clark University's Center for Technology, Environment and Development, were asked by the US Department of Energy and Battelle Pacific Northwest Laboratories to solicit advice on the design of the TCI from potential users and contributors of information, and from representatives of other technology information projects. The workshop was organized in response to that request, with important assistance from the UN Environment Programme's Information Unit on Climate Change.

#### **4. The Workshop Process**

Potential attendees were identified by the workshop organizers, commencing in October 1991. Invitations to the workshop were issued in mid-January 1992. Invitees were told that they could nominate a colleague to attend in their stead, and several did so. The attendees, listed in Appendix B, represented a broad cross-section of potential users and contributors of information. Attendees were also notable for their considerable technical expertise and their effective participation in the workshop. The discussion was held in English, a foreign language for many participants.

An agenda was provided to attendees one week before the workshop (see Appendix C). That agenda was followed with minor alterations. At the same time, attendees were sent a list of questions and some potential responses to those questions, with instructions that these questions and potential responses were intended to stimulate discussion, not to end it (see Appendix D). At the workshop itself, participants generally were not reluctant to pose questions of their own or to offer their own perspectives and opinions. Several participants submitted written comments and suggestions after the workshop.

The agenda allowed discussion to occur partly in plenary session and partly in three working groups, whose themes were: (i) making information useful for diverse purposes and users; (ii) collecting, processing and disseminating information; and (iii) institutional issues affecting information systems. In the afternoon of the first day, the working groups were asked to address short-term (February-June 1992) considerations, while they addressed longer-term considerations on the morning of the second day.

A presentation on the TCI was made by a representative of Battelle Pacific Northwest Laboratories, and a demonstration of a computerized version of the initial TCI was subsequently given by another Battelle representative. A presentation was also made by a representative of the Information Unit on Climate Change.

During the workshop, short presentations were made by participants who are involved with other, related technology information projects (see Appendix A for a list of such projects). These short presentations featured representatives of: (i) the Industry Cooperative for Ozone Layer Protection; (ii) the German government's IKARUS project; (iii) the US Environmental Protection Agency's Air and Energy Engineering Research Laboratory; (iv) the International Energy Agency's Technology Information Exchange System; (v) the International Energy Agency's Energy Technology Systems Analysis Programme; and (vi) the Institute of Energy Saving Problems, Kiev, Ukraine. At a dinner in the evening of the first day, a presentation was also made by the head of the World Bank's Global Environment Facility.

## **5. Workshop Discussion**

This summary of the workshop discussion is intended to convey a sense of its scope and range, together with an impression of the issues that were raised and the perspectives that were brought to bear on them. Broadly endorsed conclusions are presented in the following section. Another intent here is to illustrate those conclusions through specific examples of the issues and concerns raised by workshop participants.

### *General Observations on the TCI and other Technology Information Systems*

There was consensus that the TCI addresses a real need. Analysts and policy people from the developing world and from eastern Europe stated strongly their desire for more and better information on technologies for sustainable development and greenhouse mitigation. Their countries need this information to guide the formulation of domestically or internationally oriented policies on energy and environmental issues and to help shape plans for investment and development. They see the TCI as potentially important in two ways: as a direct source of information; and as an example to stimulate and guide the development of other information systems.

International information systems, such as the TCI, are seen by this community as only one component of the planning tools needed. Such systems can provide generic information about technology characteristics and can also offer a channel for acquiring more detailed information from the international community. However, sophisticated local processing of this information, coupled with knowledge about local and regional conditions, is needed for the effective formulation of policies and development strategies. The participants stressed that strong analytic capabilities are found throughout the world, but that individuals and organizations in the developing world and eastern Europe are often limited in their access to current sources of information and to the meetings and communications technologies that allow information exchange.

Much of this discussion occurred in the context of characterizing the appropriate target audience for the TCI. For the reasons indicated above, most participants believed that the direct users of information systems such as the TCI will be local and regional analysts who can apply the information either to practical implementation of greenhouse gas mitigation efforts or to policy formulation. Encouraging and strengthening local and regional analytic centers and linking them together in networks should be considered central to information system development.

Relatively short-term local and regional planning efforts were perhaps uppermost in the minds of developing world and eastern European participants, but they and others also saw a major role for information systems in the international policy arena. It was variously argued that: (i) nations negotiating about greenhouse policy need better information on the implications of control policies; (ii) information about technical capabilities could add specificity and realism to current policy debates; and (iii) good information represents an essential element of contingency planning for global warming.

Although broadly agreeing that the TCI and related efforts offer a great potential benefit, participants raised concerns. The dangers of over-promising were stressed by several people. In their view, it is important to be clear about what an information system contains and what it does not, about how it can be used, and about the other resources needed for evaluating technologies in a particular context. One participant

argued that "parsimony" should be one of the criteria for determining the scope of data requirements. A concern was expressed that the selection of technologies for inclusion, or the ways in which their characteristics are presented, might deprive potentially promising technologies of their due attention. For example, emerging technologies such as photovoltaic cells might not be listed or might appear to be unattractive because their potential for cost and performance improvement is not shown.

Likewise, there was a concern that a focus on individual technologies might obscure opportunities for limiting greenhouse emissions through system changes. For example, there is successful experience in Brazil with dedicated bus lanes. This system-level option might be a more cost-effective way of reducing greenhouse gas emissions than, for example, introducing more fuel-efficient bus engines. Another example is provided by Indian development of a compression process for making durable mud bricks. This option reduces the demand for fuel-wood in brick manufacture, thus reducing net greenhouse gas emissions and providing other environmental benefits.

Many participants voiced a concern that user needs and user capabilities would not be adequately taken into account in the design of the TCI. The workshop itself was viewed as a positive initial effort to address this problem, but extensive follow-up efforts were regarded as critical. In this context, several participants pointed out that local conditions will strongly influence decisions as to which technologies are of interest. For example, the infrastructure and resources needed to support a given technology are available to considerably differing degrees in particular locations. Capital and operating costs, and many other factors relevant to choosing technologies, are often strongly site-dependent or country-dependent.

Quality of information was viewed by most workshop participants as a crucial concern. Participants expect that most direct users of information systems will be members of the analytic community, who place high value upon the reliability of sources and the timeliness, consistency, and comparability of items of information. Such users also need a living information system, one that will be kept up to date and that will have internal and external quality checks.

As mentioned above, the workshop provided a forum for communication among representatives of several technology information projects. Additional projects, although not represented, were discussed. Some of these projects, like the TCI, aim to collect, process and disseminate information. Others are devoted to a clearing-house role, facilitating the exchange of information. Participants felt that the TCI could serve important functions not addressed by existing projects. More importantly, there was a clear consensus that the development of many dispersed, independent information systems is both a likely trend and a desirable one. Such development would yield a variety of benefits associated with healthy competition, and would permit the growth of regional or specialist information systems that provide information needed primarily by particular groups of users.

There is a danger that information systems will be overly duplicative and, more seriously, that they will be incompatible. Such an outcome would waste resources and would limit the systems' usefulness. Recognizing the danger, participants agreed that there is too little communication among existing information projects and a current lack of planning for communication among the potentially much larger group of future projects. They also saw a need for the development of international conventions or standards on information categories, procedures for recording and exchanging information, quality control, and other matters.

*Choices of Technologies and Sources of Information*

There was a clear consensus that the list of technologies now being characterized by the TCI team, while it includes many technologies of interest to the developing world and eastern Europe, is insufficiently attuned to the range of needs in those regions. One problem is that the present list does not adequately reflect relatively simple technologies -- such as the compression manufacture of mud bricks -- that can yield substantial benefits in the developing world. Another problem is that the list does not always target the technology elements most relevant to informed decision-making. For example, it now includes ethanol-fueled vehicles but would more usefully include a range of the technologies involved in the production, handling and use of ethanol as a fuel. With that change in emphasis, the TCI would be more useful to a decision-maker contemplating the merit of an ethanol fuel strategy. To fully serve that function, the TCI would provide a wide range of information pertinent to strategy choice, such as the requirements for producing ethanol and the opportunities for local manufacture of ethanol-related technologies.

Most participants felt that broader outreach is needed to generate a more useful list. Indeed, the meeting elicited several reasons why international technology information systems such as the TCI should draw information from a variety of sources, especially from the developing world and eastern Europe. Reliance upon a wider array of sources would help to ensure that information systems address the technologies of greatest relevance to users and characterize those technologies in a manner that accounts for a range of user perspectives. Broad involvement of local information providers would also assist in the dissemination of information. Partnerships could develop, whereby local entities not only provide information but participate in its processing and dissemination. In this context, several workshop participants indicated that, in the short term, they might be able to contribute pilot technology characterizations that would help to guide the further development of the TCI.

A source of information that was viewed as critical is the growing set of projects that are conceived, in whole or in part, as demonstrations of measures that can limit greenhouse gas emissions. The World Bank's Global Environment Facility will support a variety of such projects. Others can be identified. If the world community is to gain the full benefit from this information source, it is vital that projects incorporate adequate monitoring and that the results of that monitoring are widely disseminated through international information systems such as the TCI.

Although there was broad agreement on the need for diversifying sources of information, it came with warnings from a number of participants about difficulties that might be generated. Multiplicity of sources can make it more difficult to maintain control over the quality of information. There will inevitably be less uniformity in format. Information may come with a slant attached to political or regional interests. Over the long term, the question of how to obtain information from dispersed sources will be a major issue in the development of information systems and in defining relationships among those systems.

Despite a generally expressed desire for the ultimate characterization of a large list of technologies, many participants warned against proceeding with too many technology characterizations now. Numerous content and data handling questions need resolution and it was widely felt that these issues are best explored through in-depth characterizations of a few technologies. A number of people suggested that a potentially important role of the TCI will be to serve as an example that can guide other technology characterization efforts, but it was generally felt that further development of the TCI is needed if it is to fulfil this role.

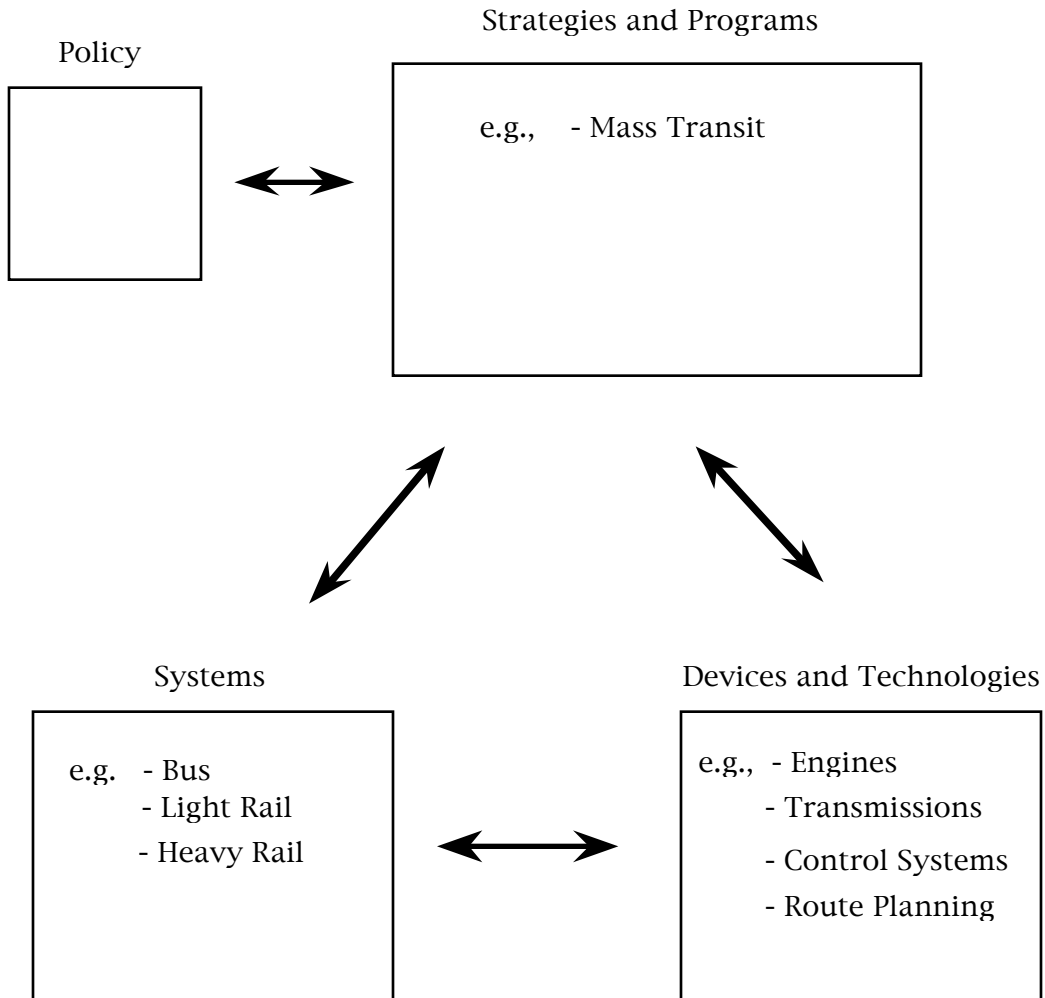
*Content of a Technology Characterization*

A great deal of discussion was devoted to the scope and organization of information within a technology characterization. A concern was expressed that the present TCI is simply a compendium of information on specific, discrete devices, with limited information on potential applications of those devices. Another concern was that the TCI's present focus on devices tends to exclude consideration of system modifications. The above-mentioned example of dedicated bus lanes in Brazil illustrates the potential importance of such modifications. These concerns arose within a general perspective that technologies must be viewed as elements of systems, while systems must themselves be viewed as elements of strategies and programs.

Figure 1 illustrates this perspective. In this case, the strategy or program under consideration is mass transit, typically a public-sector activity. Policymakers are closely concerned with issues at this level, which have to do with matters such as the scale and geographic scope of the program, its financing, etc. At the next level down -- the systems level -- mass transit options include bus, light rail, heavy rail, etc. Policymakers may be involved in choices about such systems, but middle-ranking officials typically play an important role as well. At the level of devices and technologies, the focus of the present TCI, there are many technologies that can contribute to mass transit systems. Examples shown here include discrete devices (engines, transmissions), "soft" technology (route planning), and combined soft/hard technology (control systems). Policymakers rarely play any direct role in technology choice at this level, but such choice is powerfully influenced by decisions made at the systems and program levels.

There will be numerous relationships among technologies, systems and strategies. As an example, a nation or region's fuel and electricity strategies will affect the choice of motive power for mass transit vehicles. That choice may lead to a preference for one systems option (e.g., bus) over another (e.g., light rail). Land-use, labor, fuel, electricity and other strategies will determine the extent of application of the chosen systems option. Determining these relationships quantitatively is beyond the scope of an information system, but a qualitative assessment is within that scope if relational database techniques are used. Moreover, incorporating an assessment of the relationships into an information system could be immensely valuable. Establishing qualitative relationships in a particular context is relatively straightforward but demands a considerable amount of highly skilled labor. With a computerized, relational database, that work only needs to be done once. Thereafter, users can readily identify the relationships and use other tools, such as planning models, to quantitatively explore their implications.

**Figure 1**  
**The Information Management Problem**



(This problem demands the use of a relational database.)

Technologies may be components of other technologies, or otherwise have important relationships to them. It will often be important to capture these relationships. An example discussed at the workshop concerned valves for the control of flows of hot water or steam used to heat buildings. The introduction of such valves and their associated control systems, or the improvement of existing arrangements, offers a near-term, cost-effective way to improve energy efficiency in many eastern European settings. It could be that, while the digital control systems need to be imported, the valves themselves could be locally manufactured. Such a possibility would make the technology much more attractive in countries where hard currency is scarce. An information system should, therefore, contain information about the valves and about the control systems, together with descriptions about the ways in which they might be used together.

The categories to be used in an information system generated much discussion and many suggestions. A broad range of both qualitative and quantitative information was considered necessary to fully characterize a technology. Figure 2 summarizes the categories that many participants considered to be necessary, with examples of some sub-categories. The broad categories are: quantitative and qualitative characteristics; material and non-material prerequisites and implementation requirements; present and potential applications and relationships; and development status. The present TCI contains some of this information, under different categories. It lacks important items of information, such as the applications and relationships of technologies.

The handling of quantitative information, particularly information pertaining to costs, was a serious concern to many participants, and a number of approaches were suggested. One possibility discussed but not generally favored was to subsume the technology information system within an economic model. Many participants pointed out that there could be substantial site-specific or country-specific variations in fuel prices, capital and labor costs, taxes, subsidies, etc. The generally accepted resolution to this problem was that, wherever possible, users should be able to calculate derived quantities such as costs, environmental impacts, etc., using local information. For this purpose, information systems should incorporate calculating modules that prompt the user to provide the needed local information, yielding site-specific or country-specific estimates of derived quantities.

Quality of information continued to generate discussion in this context. Participants regarded quality control partly as an issue of process, a matter discussed below, but also as a matter of content. Most held it important to fully document the sources of information and to provide a path for obtaining more detail. They called for characterization of the uncertainties in data and for indicators of its timeliness. Those indicators should include dates on which data were compiled, identification of trends in rapidly changing data (e.g., cost estimates for emerging technologies such as photovoltaic cells), and a general indicator of the "perishability" (likelihood of revision) of data.

Figure 2

**Desired Content of an Information System  
on Devices/Technologies**

CHARACTERISTICS: (Quantitative and Qualitative)	e.g.,	<ul style="list-style-type: none"><li>- Performance</li><li>- Cost (capital, operating, maintenance):<ul style="list-style-type: none"><li>• From experience (site-dependent)</li><li>• Projected (assumption-dependent)</li></ul></li><li>- Environmental characteristics</li><li>- Social impacts</li></ul>
PREREQUISITES AND IMPLEMENTATION REQUIREMENTS: (Material and Non-Material)	e.g.,	<ul style="list-style-type: none"><li>- Infrastructure</li><li>- Resource base(including human)</li><li>- Enabling devices/technologies</li><li>- Constraints</li><li>- Opportunities</li><li>- Potential scale of application</li></ul>
APPLICATIONS AND RELATIONSHIPS: (Present and Potential)	e.g.,	<ul style="list-style-type: none"><li>- Contributions to strategies and programs</li><li>- Contributions to systems</li><li>- Contributions to or from other devices/technologies</li><li>- Combinations with other devices/technologies</li></ul>
STATUS:	e.g.,	<ul style="list-style-type: none"><li>- Commercially available</li><li>- Field testing</li><li>- Proof of concept</li></ul>

(All information should be fully documented and traceable to its ultimate source.)

There was debate about how to incorporate information on market penetration by technologies. This can be a difficult parameter to characterize. While participants could not agree on a format for addressing market penetration, a clear desire was expressed for information that indicates the degree of maturity of each technology. Information systems should discuss how extensively a technology is now used, where it is used, the contexts for its use, and its apparent future prospects.

*Development of Information Systems*

The processes accompanying the development and use of a technology information system were considered to be as important as their content. Participants repeatedly stressed the importance of ongoing dialogue with users and periodic updating, adaptation, and revision of the information system. They also believed that international information systems can be effectively used only through strong local and regional organizations. Such organizations would also be important sources of information, and links with them would facilitate the development and the ultimate usability of an international information system. As noted above, some of the participants indicated that their organizations might be able to contribute pilot technology characterizations in the near future.

A related concern is the need for coordination that arises if an international information system is linked to a number of local and regional organizations and to other international systems. Participants differed in their opinions about the degree of uniformity that information systems should aspire to. However, it was generally felt that an international effort to obtain consensus among information system managers will be essential. Conventions and standards will be needed to assure the comparability of data and the feasibility of information exchange. Agreement will be needed on review processes for maintaining information quality. Participants believed that there should be, at a minimum, agreement on a set of qualitative categories for technology characterization and on conventions for the definition and presentation of quantitative properties.

Participants repeatedly stressed that the problems in information system development are not all foreseeable. The general view was that development should proceed in stages, with continuing feedback and evaluation. At each stage, the evaluation would determine if the current objectives are feasible, would identify unforeseen obstacles or advances, and would assess progress including the effectiveness of outreach. Many participants felt that the TCI could set an example for other information systems, but only if it is continuously updated and improved.

A number of technical and procedural questions about outreach were raised. Some people felt that it would be desirable for the TCI to be translated into other languages (the standard United Nations languages were mentioned). However, most participants felt that, in the TCI's present state of development, efforts at translation would be premature and unnecessary, given that most of the user community could cope effectively with an English language effort. There was more debate about the extent to which information systems should be computerized, and at what level of technological sophistication. Participants from the developing world had the conflicting concerns that, on the one hand, too much reliance on sophisticated computers and telecommunication channels will render information systems inaccessible in their countries while, on the other hand, not using current information processing technology will leave their countries behind in the international exchange of information. This conflict was not resolved, but a consensus did emerge that managers of information systems should strive for flexibility in system outputs to cover a range of user capabilities and that the provision of up-to-date information capabilities should be a priority for development efforts around the world.

*Institutional Issues*

Participants proposed a variety of international channels through which TCI outreach could be achieved. Beyond the IPCC itself, these include the UN Conference on Environment and Development, the UN Environment Programme's Information Unit on Climate Change, and a variety of non-governmental channels. Participants were concerned that outreach should involve the private industrial sector, which is potentially important as a consumer and supplier of information. A variety of suggestions were made for formalizing outreach efforts. One suggestion was to create an international journal. Another was to establish an international TCI advisory committee.

While governments will play an important role in developing information systems and in using the information they provide, participants generally felt that the players in this arena should not be confined to government organizations. In particular, the process of establishing consensus on information categories and on standards or conventions for information exchange should be largely divorced from the policy concerns of governments. A substantial role for non-government organizations seems indicated here. Also, sensitive issues should be addressed by allowing options, rather than by striving for standardization at all costs. Some participants noted that there will be a number of practical difficulties in international exchange of information, such as the handling of intellectual property rights. That issue was not resolved at the workshop.

The long-term financing of information system development provoked considerable discussion. There was a general acceptance of the concept that users should pay according to their ability, but no particular funding mechanism was singled out. Instead, the discussion touched upon a variety of potential mechanisms including private information markets and potential support from developed nations. It was generally thought that support would be forthcoming if information exchange is perceived as effectively contributing to sustainable development.

## **6. Conclusions**

As mentioned above, these are conclusions that received broad endorsement from workshop attendees, but do not represent formal commitments by them or their institutions. The conclusions are derived from notes taken by the workshop organizers.

### *The Need for Technology Information*

1. Sustainable development requires the collection, exchange and rapid dissemination of credible, useful information on relevant technologies and implementing measures; improvements are required in the processes by which information on sustainable development measures, including technologies that can limit greenhouse gas emissions, is now exchanged.
2. The TCI represents an important step toward meeting the need for improved information exchange; it is a pioneering internationally oriented effort devoted to the exchange of information on technologies that can limit greenhouse gas emissions.
3. The purpose of information exchange is to facilitate environmentally, economically and socially appropriate actions by a variety of organizations in many settings; this implies that the information should reflect practical experience with

proven technologies across their range of application, promising but unproven technologies, and the full spectrum of factors relevant to well-informed decision-making.

*Dispersed Information Systems*

4. The likely trend in development of technology information systems is toward dispersed, independent systems; this trend is desirable because it promotes healthy competition and allows the growth of regional or specialist information systems that provide information needed primarily by particular groups of users.

5. Although individual information systems will inevitably acquire unique features, it is important that information exchange among systems be possible; this will require the development of international conventions or standards on information categories, definitions of terms, etc.

*Roles of the TCI*

6. In choosing technologies to be characterized in the TCI, its managers should select technologies that have wide, generic application or that are targeted to serve particular high-priority applications (such as improving the efficiency of energy use in certain countries); also, the technologies selected should not be limited to devices but should include methodologies, forms of organization, decision aids, etc.

7. The TCI could, in addition to being directly useful in information exchange, serve as a model that would guide the developers of other information systems; this implies that the TCI managers should test new information management techniques, should actively communicate with information users and other information system developers, and should seek consensus on conventions or standards for information exchange.

*Information needed by Users*

8. Although some users may be satisfied with information on discrete technologies, many will require information that relates technologies to their potential applications in systems, strategies or programs, and many will require information on the components of a technology; these requirements imply that the TCI and other technology information systems should develop as relational databases (see Figure 1).

9. At the level of devices and technologies, users will require information that encompasses (see Figure 2) quantitative and qualitative characteristics, prerequisites and implementation requirements, present and potential applications and relationships, and development status.

10. Users should be able to calculate costs and other derived quantities using a combination of site-specific or country-specific data (e.g., local fuel costs) and information supplied by the TCI or another information system; such systems should include calculating modules that facilitate calculation by users of derived quantities for each technology.

11. Some technologies of interest to users will be proven, others will be promising but unproven, and others will be proven only in certain contexts; information systems should encompass each of these types, providing the experience base for proven

technologies and the potential, depending upon assumptions, for promising but unproven technologies.

12. Qualitative characteristics, such as social impacts (e.g., employment implications), should appear as standardized categories in all information systems, although individual systems will emphasize or interpret these characteristics in differing ways; more generally, there should be a broad range of standardized information categories that are used to differing extents in individual information systems.

*Information Acquisition and Processing*

13. Information system managers should encourage and facilitate the monitoring and reporting of technology characteristics for a broad range of past, ongoing and planned projects including those administered by users or funded by development agencies; potential information sources include projects funded by the World Bank and its Global Environment Facility, records held by the United Nations Development Programme, etc.

14. Information systems should continuously acquire fresh data and update their information files accordingly; information in those files should be accompanied by indicators of trends.

15. Controlling the quality of information and estimating the uncertainties in data should be important concerns of information system managers; means of quality control and uncertainty estimation will include systematic peer review of information inputs, studies comparing inputs from different sources, personal accountability for inputs, and a capability for users to trace information to its ultimate source.

*Information Dissemination*

16. Computers will be essential tools within the information systems envisioned here, and users will need computers to gain the full benefit from those systems; however, paper output should be made available to users with insufficient access to computing resources.

17. Users will often employ technology information as an input to decision aids of varying complexity, such as planning models; information categories and data protocols employed in information systems should be designed to facilitate such use.

18. Dissemination could occur through channels such those provided by the United Nations Environment Programme, through information franchises such as those proposed by Volunteers in Technical Assistance, through governments and non-governmental organizations, through commercial channels, etc.

*Development of the TCI*

19. To meet the needs identified here, and to fulfil its potential as a leading technology information system, the TCI requires adaptation and further development; during that process the TCI managers should expand their outreach to information users and sources, and to developers of other information systems.

20. Adaptation and further development of the TCI will involve the incorporation of additional information and the adoption of a relational database structure; during this

process the TCI managers should concentrate their efforts on a limited set of technologies.

21. Selection of technologies, systems and strategies to be characterized in a further developed TCI should occur in consultation with potential information users and with developers of other information systems; in this context, recall the above-stated need for the TCI to focus on technologies that have generic application or that are targeted to particular high-priority applications.

22. Opportunities exist for the near-term further development of the TCI, including: (i) drawing upon developing country and eastern European institutions for sample characterizations of technologies pertinent to their local settings; (ii) pilot development of a relational structure for a few technology characterizations; and (iii) pilot creation of one or more calculating modules that require user inputs, e.g., modules that calculate operating costs and air emissions for a fuel-burning technology, given the appropriate information about locally available fuels.

*Development of other Information Systems*

23. The initiation of new efforts to develop technology information systems, drawing upon the example provided by the TCI, is desirable; those efforts could be initiated through the submission, to the IPCC and other forums, of information packages on selected technologies.

24. Managers of regional, national or specialist information systems could facilitate access by their users to the services provided by international information systems such as the TCI; these managers would also play an important role in helping to establish international conventions or standards for data exchange.

*Institutional Issues*

25. A further developed TCI, and other information systems as they become available, should be tested and refined by means of their presentation to, and use by, selected groups of potential users; such testing should involve a broad cross-section of potential users in several countries, including representatives from the public sector, business, industry, and non-governmental organizations.

26. International consensus is needed on conventions or standards for data exchange, on open access to information systems, and on the protection of intellectual property rights; establishment of this consensus will require consultation with governments and international agencies but will most effectively occur in the non-government sector.

27. Information markets may support a large part of international information exchange, but information should also be available at reduced cost to those with a limited ability to pay; support from the private sector and developed country governments is likely to be forthcoming if information systems are viewed as effectively contributing to sustainable development.

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**Appendix A**

**Related Information Systems**

(Systems known to the organizers at the  
time of the workshop)

International Cleaner Production Information Clearinghouse (ICPIC)  
Industry and Environment Office  
UN Environment Programme, Paris

Centre for the Analysis and Dissemination of Demonstrated Energy  
Technologies (CADDETT)  
International Energy Agency (OECD), Paris

OZONET  
Industry Cooperative for Ozone Layer Protection, Washington, DC

CO2 Technology Data Bank  
International Institute for Applied Systems Analysis  
Laxenburg, Austria

Instruments for Energy-Related Greenhouse Gas Emission Reduction Strategies  
(IKARUS)  
German Federal Ministry for Research and Technology, Bonn

Technology Information Exchange System (TIES)  
International Energy Agency (OECD), Paris

Energy Efficiency 2000 Project  
UN Economic Commission for Europe, Geneva

Energy Technology Systems Analysis Programme (ETSAP)  
International Energy Agency (OECD), Paris

Technology Database Management System (GloTech)  
Air and Energy Engineering Research Laboratory  
US Environmental Protection Agency

Institute of Energy Saving Problems  
Kiev, Ukraine

Volunteers in Technical Assistance  
Arlington, Virginia, USA

## Appendix B

### List of Attendees

Michael Adler  
U.S. Environmental Protection Agency

W. Brad Ashton  
Battelle Pacific Northwest Labs

Richard Baron  
Battelle Pacific Northwest Labs

Igor Bashmakov  
Energy Research Institute  
Moscow, Russia

Lee Beck  
U.S. Environmental Protection Agency

F. Scott Bush  
Center for Strategic and Int'l Studies

Jasmin Callosa  
Haribon Foundation  
San Juan, Philippines

David Eicke  
Battelle Pacific Northwest Labs

Arthur Fitzgerald  
Northern Telecom Ltd.

Kenneth Friedman  
U.S. Department of Energy

Martin Getzendanner  
U.N. Environment Programme

Robert Goble  
Clark University

Douglas Hill  
Netherlands Energy Research  
Foundation

Carl Hocevar  
U.S. Agency for International  
Development

Harold Jaffee  
U.S. Department of Energy

Todd Johnson  
The World Bank

Eric Larson  
Princeton University

Jason Mark  
National Renewable Energy  
Laboratory

Jaroslav Marousek  
SEVEN - The Energy Efficiency  
Center  
Prague, Czechoslovakia

Hirohiko Nishikubo  
Embassy of Japan

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Slawomir M. Pasierb  
Polish Foundation for Energy  
Efficiency  
Katowice, Poland

George C. Varughese  
Development Alternatives  
New Delhi, India

Frank Pinto  
U.N. Development Programme

David L. Waggoner  
U.S. Agency for International  
Development

Alan Poole  
National Institute for Energy  
Efficiency  
Rio de Janeiro, Brazil

Ed Watts  
U.S. Department of Energy

Nikolaj V. Raptsov  
Institute of Energy Saving Problems  
Kiev, Ukraine

K.H. Weber  
Fachinformationszentrum  
Karlsruhe, Germany

Kathleen Rees  
U.S. Department of Energy

Eliza Wojtaszek  
Battelle Pacific Northwest Labs

Paolo F. Ricci  
International Energy Agency (OECD)  
Paris, France

Dadi Zhou  
Energy Research Institute  
Beijing, China

Harvey Sachs  
Center for Global Change  
University of Maryland

Xie Shaoxiong  
Ministry of Energy  
Beijing, China

Richard D. Stern  
U.S. Environmental Protection Agency

Shaw Thacher  
Volunteers in Technical Assistance

Gordon Thompson  
Institute for Resource & Security Studies

## Appendix C

### Workshop Agenda

#### Tuesday, 18 February 1992

- 8:30 AM - Continental Breakfast
- 9:00 AM - Introduction:
  - o Purpose of the workshop
  - o Getting acquainted
  - o The IPCC process
- Current status of the TCI and its potential development
- UNEP Information Unit on Climate Change; initiatives and plans
- Roundtable discussion; participant perspectives on:
  - o Data users and their needs
  - o Other data system and institutional initiatives in climate change/energy/sustainability
- 1:00 PM - Lunch at CSIS; presentations on other information systems
- 2:00 PM - Demonstration of computerized version of the TCI followed by Q & A with Battelle
- Work group objectives; general discussion
- Break into 3 work groups. Afternoon topic is short-term (February - June 1992) development of the TCI for the IPCC and UNCED process. The groups are:
  - WG#1 Making the data useful for diverse purposes and users.
  - WG#2 Collecting, processing, and disseminating data
  - WG#3 Institutional issues affecting data systems
- 7:00 PM - Reception/dinner; after-dinner speech by Kenneth Newcombe, coordinator, Global Environment Facility, the World Bank

#### Wednesday, 19 February

- 8:30 AM - Continental Breakfast
- 9:00 AM - Plenary
- 9:30 AM - Work groups continue. Morning topic is development and use of the TCI and other data systems after UNCED.
- 1:00 PM - Lunch at CSIS; continuing discussion
- 2:00 PM - The three workgroups assemble their reports on short and long-term recommendations
- Work group reports; general discussion
- Wrap up; where do we go from here?
- 4:00 PM - Conclusion

## Appendix D

### Proposed Discussion Points

(These points were supplied to participants one week prior to the workshop)

To focus discussion we have proposed some questions (numbered Q1, etc.). Participants are urged to modify these and to add further questions to be answered at the workshop. We have also identified some potential responses (numbered PR1, etc.) to the proposed questions. These responses are intended to stimulate discussion, not to end it! The discussion will occur in three work groups as identified in the program. Short-term (February - June 1992) and longer-term considerations will be addressed in consecutive sessions of the work groups. The proposed questions are categorized accordingly.

#### SHORT-TERM CONSIDERATIONS

##### Working Group #1 (making data useful)

- Q1 Who might use the TCI?
- PR1
- o Three user levels: project implementation, planning, policy
  - o Within user levels: analysts in government, industry, regulatory agencies, academia, finance
  - o In the near-term, the principal users will be a small group of analysts in developing and former centrally planned economy (CPE) countries.
- Q2 What are the critical user issues for TCI development? (and how do they depend on the particular interests of the user?)
- PR2
- o User friendliness and format (especially hard copy vs computer realizations)
  - o Promotion, dissemination, and access
  - o Content: e.g. technology selection, information categories, site-specific information, data variability, etc.
  - o Compatibility with other information systems or with planning and policy tools
- Q3 What additional information is needed?
- PR3
- o Resource implications of technologies
  - o Potential scale of application - market penetration
  - o Interrelation of technologies

##### Working group #2 (collecting and supplying data)

- Q4 What data sources should be used?
- PR4
- o Current use of US data, as interpreted by US national laboratories is adequate.

- o More attention should be given to practical experience in many different contexts.
- Q5 How might quality control be exercised?
- PR5
  - o More attention to primary sources
  - o Data labelled with an uncertainty index
- Q6 Should information in the TCI be re-organized?
- PR6
  - o Present organization by stages in the energy system is adequate
  - o Define qualitative terms.
  - o Employ formulae for cost and performance parameters.

Working Group#3 (institutional issues)

- Q7 What outreach efforts should be made?
- PR7
  - o Presentations at UNCED Preparatory Committee meeting and in Rio, via NGO fora
  - o Expansion of the TCI for 1 or 2 selected technologies, to illustrate possible TCI development

LONGER-TERM CONSIDERATIONS

Working Group #1 (making data useful)

- Q8 What are the critical user issues for ongoing data base development?
- PR8
  - o Access via global information networks
  - o Data organized at several levels of aggregation
  - o Incorporation of calculating capabilities to account for site-specific factors
  - o Compatibility with related data bases and decision aids
  - o Relation to policy and investment decisions
  - o Extension to sustainability measures generally

Working Group #2 (collecting and supplying data)

- Q9 Where might data come from?
- PR9
  - o Users should both consume and supply data.
  - o Development finance should support project monitoring
  - o Governmental commitments to sustainability could involve facilitation of data collection and exchange
- Q10 How might quality control be exercised?
- PR10
  - o Hierarchy of data aggregation should preserve raw data, with individual attribution.

- o Aggregated data should incorporate standardized indices of variability and quality.
  - o Independent review of data
  - o Base of practical experience to be identified
- Q11 To what extent should data systems be automated?
- PR11
- o Person-to-person access should be facilitated.
  - o Automation would allow continuous updating.
- Q12 Should data input be selective?
- PR12
- o Present information technology, with hierarchical aggregation of data, would allow extensive data collection.
- Q13 How can qualitative factors be incorporated?
- PR13
- o These factors are important.
  - o Standardized international definitions are required but regional and local adaptation will be necessary.
  - o Social science participation is needed.

Working Group #3 (institutional issues)

- Q14 Should data systems be centralized?
- PR14
- o International standards would allow data to be exchanged among many systems.
  - o Decentralized, competing, data systems could reduce costs, improve data quality, and better meet a variety of user needs.
  - o Some large data centers will be needed.
- Q15 How might data exchange be governed?
- PR15
- o International standards and open-access agreements would obviate any need for central control.
- Q16 How might data systems be financed?
- PR16
- o Developed country commitments to global sustainability could involve subsidy of data systems.
  - o Information markets could support a large part of international data exchange.
  - o Cost to users should reflect ability to pay.
- Q17 How can international standards be achieved?
- PR17
- o Standards must be based on consensus.
  - o Consensus development should occur outside government.

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