

INDICATORS FOR SUSTAINABLE ENERGY DEVELOPMENT TOOLS FOR TRACKING PROGRESS

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The concept of Sustainable Development emerged with the publication of the Brundtland Report "Our Common Future" in 1987 by the World Commission on Environment and Development. It received further impetus and became the focus of world attention with the adoption of Agenda 21, the Rio Declaration on Environment and Development, by the United Nations Conference on Environment and Development (UNCED, popularly known as the Earth Summit) held in Rio de Janeiro, Brazil, in June 1992.

While there is still no universally accepted definition of sustainable development, the Brundtland Report defined it to mean "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

Agenda 21 adopted by the Earth Summit addresses the pressing problems of today and also aims at preparing the world for the challenges of the 21st century. In its 40 chapters, it provides a comprehensive plan of action for organizations of the United Nations System, governments, and major groups in every area in which humans affect the environment. All important issues that have significant bearing on one or more of the four key dimensions of sustainability, namely the

social, economic, environmental and institutional aspects, are covered. (*See box, page 15.*) The responsibility to ensure effective follow-up of UNCED and to monitor and report on implementation of the Earth Summit agreements at the local, national, regional and international levels rests with the Commission on Sustainable Development (CSD), which was created by the United Nations in December 1992.

The final chapter of Agenda 21 specifically requests countries and organizations to develop "indicators" of sustainable development that can be used to track and assess progress. This article surveys major initiatives toward this end, and highlights work being done by the IAEA in cooperation with partner organizations to develop a set of indicators for sustainable energy development.

ENERGY & SUSTAINABLE DEVELOPMENT

Energy plays a crucial role in our society: it is an essential input for social development and economic growth. Not only is energy a provider of basic needs and services in our everyday lives -- heating, cooling, cooking, lighting, transportation, etc. -- but it is also a production factor of prime importance in virtually all sectors of the industry.

At the same time, energy production and use are responsible for major environmental degradation at all levels -- local, regional and global. For example, combustion of fossil fuels and fuelwood leads to indoor and outdoor air pollution by particulates and oxides of sulfur and nitrogen; hydropower often causes severe environmental damage due to the submergence of large areas of land; and global climate change associated with the increasing concentration of greenhouse gases in the atmosphere has become a major worldwide concern today. Natural resource depletion, accumulation of wastes, including radioactive wastes, deforestation, water pollution and land disturbance are some more examples of energy-related environmental concerns.

There are also large disparities in the level of energy consumption not only among different countries but also among the rich and poor groups in the same country. It

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is noteworthy that nearly 1.6 billion people still have no access to electricity or other forms of commercial energy and that the richest 20% of the world's population use 55% of primary energy, while the poorest 20% use only 5%.

With the demand for energy increasing worldwide, the sustainability of the supply capacity of the earth's finite fossil fuel resources is questionable. While this may be a long-term global concern, the security of supply and continued uninterrupted availability of imported energy is an immediate concern for countries short of indigenous energy sources, particularly those which are heavily dependent on oil and gas imports.

Thus the provision of adequate energy services at affordable costs and in a secure and environmentally benign manner is an essential element of sustainable development. In reviewing the programme for Agenda 21, the 19th Special Session of the UN General Assembly held in 1997 (Earth Summit + 5) specifically recognized the need for a movement towards sustainable production, distribution and use of energy. In establishing the CSD's multi-year Work Programme, the Special Session decided that the sectoral theme of the CSD's 9th session in April 2001 (CSD-9) will be atmosphere/energy; the session will also focus on energy and transport issues.

More recently, as part of its global assessment, the World Energy Council has called for policy actions toward meeting goals for energy accessibility,

ENERGY & AGENDA 21

The importance of energy for sustainable development is fully recognized by Agenda 21. In this connection Chapter 9 of the Agenda clearly states:

"Energy is essential to economic and social development and improved quality of life. Much of the world's energy, however, is currently produced and consumed in ways that could not be sustained if technology were to remain constant and if overall quantities were to increase substantially. The need to control atmospheric emissions of greenhouse and other gases and substances will increasingly need to be based on efficiency in energy production, transmission, distribution and consumption, and on growing reliance on environmentally sound energy systems, particularly new and renewable sources of energy. All energy sources will need to be used in ways that respect the atmosphere, human health, and the environment as a whole."

Energy -- and the development of indicators for sustainable development -- are among 36 issues identified in Agenda 21. The Agenda 21 issues are agriculture; atmosphere; biodiversity; biotechnology; capacity-building; consumption and production patterns; demographics; desertification and drought; education and awareness; energy; finance; forests; freshwater; health; human settlements; indicators; industry; information; integrated decision-making; international law; institutional arrangements; land management; major groups; mountains; oceans and seas; poverty; science; small islands; sustainable tourism; technology; toxic chemicals; trade and environment; transport; waste (hazardous); waste (radioactive); and waste (solid).

availability, and acceptability.
(See related article, page 2.)

DEVELOPMENT OF INDICATORS

Indicators of Sustainable Development. Although the objectives of sustainable development are very broad, a set of quantifiable parameters (indicators) is needed to measure and monitor changes and progress towards the achievement of objectives. Accordingly, ever since the publication of the Brundtland Report, various international and national organizations have been trying to develop indicators for one or more aspects of sustainable development.

Some pioneering work has been done by the Organization for Economic Co-operation and Development (OECD). Over the last 10 years, the OECD has developed several sectoral sets of environmental indicators, including those related to transport, energy, and agriculture, and a set of indicators derived from environmental resource accounting. From this work, a core set of around 50 environmental indicators has been defined.

Another OECD initiative is the development of a conceptual framework, called the "pressure-state-response" (PSR) model, for categorizing the nature of different

environmental indicators. In this model, which is based on causality links, the indicators for environmental pressures describe “direct” and “indirect” pressures from human activities exerted on the environment, including natural resources; those for environmental conditions (“state”) relate to the quality of the environment and the quality and quantity of natural resources; and those for societal responses show the extent to which society responds to environmental concerns through individual and collective actions and reactions, intended to:

- (1) mitigate, adapt to or prevent human-induced negative effects on the environment;
- (2) halt or reverse environmental damage already inflicted; and
- (3) preserve and conserve nature and natural resources.

The effort to develop indicators received a major boost following the adoption of Agenda 21. Chapter 40 of Agenda 21 specifically asks countries and international governmental and non-governmental organizations to develop the concept of Indicators of Sustainable Development (ISD). In 1995 the CSD established a five-year Work Programme on Indicators of Sustainable Development (WPISD) to assist decision-makers at the national level. It was decided that, besides dealing with the environmental issues, the ISD need to cover the social, economic and institutional issues as well, since each represents a distinct critical dimension of sustainable development. Working in collaboration with a large

number of governments and organizations, the CSD in 1996 developed a preliminary working list of 134 ISD covering the various chapters of Agenda 21.

The WPISD does not consider the indicators included in its working list as providing a comprehensive set. It intends to use them, after necessary refinements, only as a core set to which other indicators, or sets of indicators covering particular aspects of sustainable development, may be added. The CSD working list is currently undergoing voluntary testing at the national level in 22 countries from various world regions. The CSD aims to have an agreed set of core indicators available for all countries to use by the year 2001.

In order to elucidate the nature of different indicators, the CSD adopted the OECD's framework and extended it further by replacing the concept of “pressure” with “driving force”. In this DSR (driving force-state-response) framework, “driving force” indicators encompass human activities, processes and patterns that impact positively or negatively on sustainable development; “state” indicators refer to the state of sustainable development; and “response” indicators highlight policy options and other responses to changes in the “state” of sustainable development.

Later, in 1998, the Division of Sustainable Development of the United Nations Department of Economic and Social Affairs (DSD/DESA) identified a set of 43 key indicators and a provisional core set of 17 indicators for

measuring changes in consumption and production patterns (IMCCPP). They covered all “key resources” -- energy, materials, water, and land -- and “consumption clusters” -- mobility, consumer goods and services, buildings and housekeeping, food, and recreation.

Following their testing by national governments and international organizations, the indicators in the provisional core set of IMCCPP are intended for inclusion in the revised CSD list of ISD.

Among other related activities, the work on environmental indicators currently being pursued by the Statistical Office of the European Union (EUROSTAT) and the European Environment Agency (EEA) of the European Commission deserves special mention. These organizations also adapted and extended the OECD approach into a new model called the Driving Force-Pressure-State-Impact-Response (DPSIR) model. The indicators dealing with driving forces, pressure and response are being developed by EUROSTAT, while those covering State and Impact are being handled by the EEA. Recently, EUROSTAT has come up with a set of 60 pressure indicators comprising six indicators for each of the ten main themes (air pollution; climate change; loss of biodiversity; marine environment and coastal zones; ozone layer depletion; resource depletion; dispersion of toxic substances; urban environmental problems; waste; water pollution and water resources) identified in the Fifth Environmental Action Plan of the European Union (EU). It

also intends to look into the possibility of aggregating these 60 indicators into 10 indices, one for each policy field, allowing a better comparison with economic indices such as Gross Domestic Product. The DPSIR model has been adopted by most EU member states as the most appropriate way to structure environmental information.

Sustainable development indicators tuned to specific national situations are being, or have been, developed by a number of countries, such as UK, USA, Canada, France, Netherlands, and the Nordic countries. By and large, all these efforts make use of the PSR and DPSIR approaches in identifying and categorizing various appropriate indicators.

An effort is also being made by some organizations, including the World Bank and the Scientific Committee on Problems of the Environment established by the International Council of Scientific Unions, to develop aggregated indicators or a small number of indices of sustainable development by identifying and assessing the linkages among the various social, economical, environmental, and institutional elements of sustainable development. The process involves the use of more or less complex mathematical formulae in order to combine several indicators into a single index by assigning appropriate weight to each indicator in proportion to its relative importance.

Two examples of such indicators are the “genuine saving” indicator (defined as the true rate of saving in a

nation after due account is taken of the depletion of natural resources and the damages caused by pollution) and the “wealth of nation” indicator (an aggregated approach that represents the stock of produced assets, natural capital and human resources, the last including raw labour, human capital and social capital).

Although the aggregation approach could be very helpful in reducing the number of indicators, it has a serious drawback in that the weightings used for aggregating different individual indicators reflect subjective preferences, which is a problem of political choice. Hence, in some cases, this can give rise to results without real meaning.

INDICATORS FOR SUSTAINABLE ENERGY DEVELOPMENT

Little work has been done so far to develop indicators for sustainable energy development (ISED). However, several energy-related indicators do appear within the initiatives of various international and national organizations. Among them, by far the most detailed coverage of energy-related indicators is found in the OECD work on environmental indicators, particularly that on sectoral energy-environment indicators. The later were developed to promote the integration of environmental concerns into energy policy making in the OECD countries. Using an adjusted PSR model, these indicators have been classified into three themes: (i) energy sector trends of environmental significance,

(ii) their interactions with the environment and natural resources, and (iii) related economic and policy considerations.

In separate work, the International Energy Agency (IEA) of the OECD has developed some indicators dealing with the energy use and efficiency in various economic sectors and linked them to carbon emissions with the help of a model called Model of Energy/Emissions Indicators. Although the WPISD working list of ISD does not deal explicitly with the energy issues, it too includes several energy-related indicators that were identified in relation to specific chapters of Agenda 21.

Some indicators specifically referring to the energy sector have been identified by DSD/DESA as a part of its work on “changing production and consumption patterns” (Chapter 4 of Agenda 21). Different energy-related indicators, generally dealing with environmental issues, also appear in the work of EUROSTAT, EEA and various national projects.

A set of seven indicators covering environmental issues related to radioactive waste management (Chapter 22, Agenda 21) also has been developed by the IAEA. The IAEA further is developing full and core sets of ISED in cooperation with international organizations and Member States. (*See box, page 18.*)

So far, then, most work on indicators concerns only the environmental dimension of sustainability, and even that is scattered. A comprehensive treatment of the energy sector

INDICATORS FOR SUSTAINABLE ENERGY DEVELOPMENT: IAEA INITIATIVES

A project on "Indicators for Sustainable Energy Development (ISED)" was introduced by the IAEA as a part of its work programme on Comparative Assessment of Energy Sources for the biennium 1999-2000. It is being pursued by the Planning and Economic Studies Section of the Department of Nuclear Energy. The envisaged tasks are to: (1) identify the main components of sustainable energy development and derive a consistent set of appropriate indicators, keeping in view the indicators for Agenda 21, (2) establish relationship of ISED with those of the Agenda 21, and (3) review the Agency's databases and tools to determine the modifications required to apply the ISED.

The first two tasks are being pursued with the help of experts from various international organizations and Member States. In this connection two expert group meetings were held, one in May 1999 and the other in November 1999. The following nine topics were identified as the key issues that need to be addressed in connection with sustainable energy development: social development; economic development; environmental congeniality and waste management; resource depletion; adequate provision of energy and disparities; energy efficiency; energy security; energy supply options; and energy pricing.

Initially a preliminary list of about 100 ISED was developed to cover these key issues. A new conceptual framework model specifically tuned to the energy sector was developed, drawing upon work by other organizations in the environmental area. The model is based on the "cause, symptom, and solution" approach and incorporates all the four dimensions of sustainable development -- social, economic, environmental and institutional.

For each dimension of sustainability the model helps to arrange the identified indicators so as to show their linkages with each other by categorizing them as the driving force, state, and response action

indicators. The indicators identified for the institutional dimension are classified only as corrective policy measures or response actions, as determined by the state indicators of the other three sustainability dimensions.

Within the framework of this conceptual model, two provisional lists of ISED -- a full list and a core list -- have been prepared. They cover indicators for the following energy related themes and sub-themes under the economic, social and environmental dimensions of sustainable energy development:

Economic dimension: Economic activity levels; End-use energy intensities of selected sectors and different manufacturing industries; energy supply efficiency; energy security; and energy pricing.

Social dimension: Energy accessibility and disparities.

Environmental dimension: Air pollution (urban air quality; global climate change concern); water pollution; wastes; land use; accident risks; energy resources depletion; and deforestation.

The provisional full set comprises 28 driving force indicators, 13 state indicators and 29 response action indicators. The provisional core list of ISED was presented at the International Workshop on CSD Indicators of Sustainable Development held in Barbados in December 1999.

While the effort to improve upon the provisional full and core lists of ISED will continue for some time, it is planned to subject them to country testing on a limited scale. This is planned with the help of national teams engaged in formulating their sustainable energy strategies in collaboration with the IAEA. It is hoped that this work will help the Agency, on the one hand, in making useful contribution to the CSD work on energy-related issues and, on the other, in modifying its own databases and methodological tools so as to make them more responsive to sustainable energy development issues.

encompassing all the four dimensions of sustainability is still lacking.

The need to derive a comprehensive set of indicators for sustainable energy development is gaining greater attention. It was underscored in

the work programme adopted by the UN Special Session in 1997, and in the decision that energy issues will be a main theme at the 9th session of the CSD in April 2001.

These are welcome developments. Through its

range of activities, the IAEA is playing a leading role in international efforts to establish useful sets of indicators that will help governments to track and assess progress along the challenging path of sustainable energy development. □