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Indicators for Sustainable Energy Development: A Collaborative Project

(Contribution submitted by the International Atomic Energy Agency)

1. Since 1999 the International Atomic Energy Agency (IAEA) has been engaged in a cooperative project with the International Energy Agency (IEA) and other international research organizations to formulate a set of comprehensive indicators for sustainable energy development (ISED). The project was initiated to fill the need for a comprehensive framework effort that incorporates energy parameters into the overall assessment of sustainable development as set out in Agenda 21.

2. The IAEA and the IEA consider that this project would be enhanced by future participation of the United Nations Economic Commission for Europe (UNECE) and its Committee on Sustainable Energy (CSE), both in terms of geographical coverage and in terms of added value to the overall statistical and analytical effort. At the same time, the UNECE/CSE could also benefit from such participation in terms of fulfilling its current research priorities in the field of energy.

Energy in the Context of Sustainable Development

3. Agenda 21 was adopted by the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil in 1992. The theme of this document is sustainable development as a focus for addressing the pressing problems of today and preparing the world for the challenges of the coming decades. Because the objectives of sustainable development are very broad, governments and policy makers need a set of quantifiable parameters (indicators) to measure and monitor important changes and significant progress towards the

achievement of these objectives. This was recognised by Agenda 21, which specifically (Chapter 40) asks countries and international governmental and non-governmental organisations to develop the concept of Indicators of Sustainable Development (ISD).

4. Agenda 21 covers all issues that have significant bearing on one or more of the three key dimensions of sustainability, namely social, economic and environmental. One of these significant issues is energy. The provision of adequate and affordable energy services, in a secure and environmentally benign manner, and in conformity with social and economic developmental needs, is an essential element of sustainable development.

5. Energy is an essential input for social development and economic growth. It provides basic needs and services such as heating, cooling, cooking, lighting, and transportation and is a critical production factor in virtually all sectors of industry. Globally, the demand for energy is increasing in consonance with socio-economic development. At the same time, the production and use of energy can cause environmental degradation - local, regional and global. Moreover, there are large disparities in the level of energy consumption, not only among different countries, but also among the rich and poor in the same country. While the sustainability of the supply capacity of the earth's fossil fuel resources is not an issue for the foreseeable future, the security of supply and continued uninterrupted availability of energy is an immediate concern, especially for countries short of indigenous energy sources.

6. The importance of energy for sustainable development and the need for a set of indicators specifically relating to this has been a concern since the publication of the *Brundtland Report*, "*Our Common Future*" in 1987 (WCED 1987). The need was re-emphasised in 1992 with the publication of Agenda 21, and most recently underscored at the 9th session of the UN Commission on Sustainable Development (CSD) in April 2001. To date, however, none of the efforts to develop indicators under the aegis of Agenda 21 [1] specifically incorporates indicators for sustainable energy development (ISED). A comprehensive treatment of the energy sector encompassing all three dimensions of sustainability is still needed.

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[1] Starting in 1995 the United Nations Work Programme on Indicators of Sustainable Development (WPISD) produced a core set of ISD covering the environmental, social, economic and institutional dimensions of sustainable development, including several energy related indicators. (UN, 1996; DSD, 2000, DSD 2001a) It also devised the Driving Force/State/Response (DSR) framework now widely applied for indicators (UN, 1996). Several energy-related indicators have also been developed as part of the Organisation for Economic Cooperation and Development (OECD) (OECD, 1993/1998/1999/2000) and EUROSTAT (EC, 1999a/1999b; EEA, 1999) work on environmental indicators. Supplementing these efforts is the work of the International Energy Agency (IEA) of the OECD on disaggregated indicators of energy use and efficiency in various economic sectors and the corresponding carbon emissions (IEA, 1997a/1997b; Schipper et.al. 2000; Unander and Schipper, 2000), and of the French Environment and Energy Control Agency (ADEME) on Energy Efficiency Indicators (ADEME, 1998/1999) as well. And a few indicators specifically referring to the energy sector were identified by the Division of Sustainable Development of the United Nations Department of Economic and Social Affairs (DSD/DESA) (DSD, 1998).

Development of ISED

7. To address this need, IAEA in 1999 initiated a project to develop "Indicators for Sustainable Energy Development" (ISED), in close cooperation with the UN Committee on Sustainable Energy (CSE) and the United Nations Work Programme on Indicators of Sustainable Development (WPISD), various international organizations (notably the IEA, the United Nations Department of Economic and Social Affairs (UN-DESA), the European Commission (EC), the Nuclear Energy Agency (NEA/OECD), the United Nations Educational, Cultural and Scientific Organisation (UNESCO), and some Member States of the IAEA.

8. The premise of the ISED project is that data on economic, environmental and energy sector changes are useful to policy makers only if they are available in a coherent form that presents an understandable picture of actual and anticipated conditions. Raw data - a shoebox full of numbers -- unaggregated, unorganised and uninterpreted - are, from a policy perspective, quite useless. The goal of this project, then, was to derive a set of energy-related indicators that could present energy, economic, environmental and social data to policy makers in a coherent and consistent form, showing their inter-linkages, and capable of being used for making comparisons, trend analyses and internal policy assessments as required. Such indicators would permit interested parties to gauge their own progress in terms of sustainable energy development, and to chart their own social and political course for reaching higher levels of economic and environmental achievement. The ISED project thus focuses on ultimately providing Member States with a useful analytical and decision aiding tool aimed expressly at highlighting previously unexamined aspects of Agenda 21. The project has two main phases – Creating a Framework and Practical Applications.

Phase 1 –Creating a Framework

9. The first phase aimed at supplementing the general indicators of sustainable development (ISD) being developed by WPISD. This effort, largely completed, is described in detail in the attachment, "*Indicators for Sustainable Energy Development*," prepared for and presented at the 9th session of the UN Committee on Sustainable Development in April 2001.(See also http://www.iaea.org/worldatom/Programmes/Energy/pess/csd9/isedindicatorspaper.pdf).
The main features of Phase 1 were to:

- identify the main issues and parameters relevant to sustainable energy development;
- define cause-and-effect inter-relationships (*Driving Forces* and *States*) among important energy-related parameters, and link these with a set of potentially appropriate policies (*Response Actions*) for improving the sustainability of energy sector development; and
- using the WPISD framework, structure a set of appropriate indicators for measuring changes in energy-sector related parameters, and for monitoring progress in achieving sustainable energy development.

10. Phase 1 of the ISED project identified 16 main topics to be addressed in connection with sustainable energy development under the three dimensions of sustainability as defined in Agenda 21. These are categorised below.

Social dimension	Economic dimension	Environmental dimension
Energy disparities Energy affordability and accessibility	Economic activity levels Energy production, supply and consumption Energy pricing, taxation and subsidies End-use energy intensities Energy supply efficiency Energy security	Global climate change Air pollution Water pollution Wastes Energy resource depletion Land use Accident risks Deforestation

11. To define the interrelationships between these parameters, the ways in which they can change and the policies that can affect them, the ISED project ultimately distilled a set of 41 indicators. Of these 41 indicators, 23 are considered core indicators, which means they are relatively specific to energy (so energy consumption per capita is a core indicator while population growth is not), and within that core subset, still essential for conveying a concise yet relatively complete picture of energy developments. This full set of indicators is based in part on the results of systematic informal testing by groups of energy system analysts in 15 countries: Argentina, Bulgaria, China, Croatia, Cuba, Germany, Netherlands, Indonesia, Lithuania, Mexico, Pakistan, Russian Federation, Slovakia, Turkey and the USA. The 41 ISED indicators are shown and categorised in Table 1, with the core indicators shown in bold. In keeping with the accepted WPISD framework, the 41 ISED indicators can be divided into *Driving Force* indicators (those parameters such as population growth and GDP that affect energy use and availability), and *State* indicators (those such as consumption, production and import levels that define the status of energy use or availability). Details are provided in the attachment.

Table 1: List of ISED: Economic and Social Dimensions (Core ISED in bold font)

Driving Force			State
Indirect	**Indirect within energy sector**	**Direct**	
Economic Dimension			
1. Population: total/urban ⊕ ♥ 2. GDP per capita ⊕ ♥ **3. End-use energy prices with and without tax/subsidy ♦ ♥ ♠: for households, industry, automotive fuels** 4. Shares of sectors in GDP value added ⊕ ♥: manufacturing, transportation, agriculture, commercial & public services 5. Distance travelled per capita ⊕ ♦ ♥ ♠: total, by urban public transport 6. Freight transport activity ♦ ♥ : total, by transport mode 7. Floor area per capita ⊕ 8. Manufacturing value added by selected energy intensive industries ⊕	**9. Energy intensity Å ♦ ♠: manufacturing, transportation, agriculture, commercial & public services, residential sector** 10. Final energy intensity of selected energy intensive products ♦ ♠ **11. Energy mix Å ♦ ♠ : final energy consumption, electricity generation by fuels types, primary energy supply** **12. Energy supply efficiency ♠: ratio of TFC to TPES, fossil fuel efficiency for electricity generation, losses in gas transportation and electricity transmission , percentage of CHP in electricity generation, oil refining efficiency** 13. Status of deployment of pollution abatement technologies: extent of use, average performance	**14. Energy use per unit of GDP Å ♦ ♥ ♠ : total primary energy, primary conventional energy, electricity** **15. Expenditure on energy sector: total investments, environmental control Å , hydrocarbon exploration and development, RD&D Å, net energy import expenses**	**16. Energy consumption per capita ⊕ ♦ ♥ ♠ : total primary energy, automotive fuel, CRW, electricity** **17. Indigenous energy production ♥ ♠: total primary energy, shares of fuel types and CRW, electricity** **18. Net energy import dependence ♠: total primary energy, total conventional energy, fossil fuels by type, electricity**
Social Dimension			
ENERGY ACCESSIBILITY AND AFFORDABILITY 19. Income inequality **Å**	20. Ratio of daily disposable income/private consumption per capita of 20% poorest households to the prices of electricity and major household fuels	**21. Fraction of disposable income/ private consumption per capita spent on fuel and electricity by:** • **average population ♦** • **group of 20% poorest population**	**22. Fraction of households:** • **heavily dependent on non-commercial energy** • **without electricity**

⊕ **marks ISED which correspond to ISD in the UN-CSD Working list/Core list;**

♦ **marks ISED which correspond to ISD in the DSD/DESA Provisional list for Chapter 4 of Agenda 21;**

♥ **marks ISED which correspond to OECD Core Set of Environmental Indicators and related Socio-economic Indicators;**

♠ **marks ISED which correspond to EC list of Environmental Indicators and Indicators for Integrating Environmental Considerations into energy Policies**

Table 1 (cont'd): List of ISED: Environmental Dimension (Core ISED in bold font)

Driving Force		State
Indirect	**Direct**	
Environmental Dimension		
The relevant indicators are covered in the subsets of Driving Force and State indicators of the Economic and Social dimensions	AIR POLLUTION: **23. Quantities of air pollutant emissions ⊕ ♦ ♥ ♠ : SO_2, NO_x, particulates, CO, VOC** **26. Quantities of greenhouse gas emissions ⊕ ♦ ♥ ♠ : total, from electricity generation, from transportation** 27. Radionuclides in atmospheric radioactive discharges ♠ WATER POLLUTION: 28. Discharges into water basins ♥ : waste/storm water, radionuclides, oil into coastal waters ⊕ [a] WASTE: **29. Generation of solid waste ⊕ ♦ ♥ ♠** **31. Generation of radioactive waste from nuclear power fuel cycle chain ⊕ ♥** LAND **33. Land area taken up by energy facilities/infrastructure Å** ACCIDENT RISKS ENERGY RESOURCES DEPLETION **35. Fraction of technically exploitable capability of hydropower currently in use** **36. Proven recoverable fossil fuel reserves ⊕** 38. Proven uranium reserves ⊕ DEFORESTATION **40. Intensity of use of forest resources as fuel-wood Å**	**24. Ambient concentration of pollutants in urban areas ⊕ ♥: SO_2, NO_x, CO, suspended particulates, ozone** 25. Land area where acidification exceeds critical load **30. Accumulated quantity of solid wastes to be managed** **32. Accumulated quantity of radioactive wastes awaiting disposal** **34. Fatalities due to accidents with breakdown by fuel chain** 37. Life time of proven fossil fuel reserves ⊕ 39. Life time of proven uranium reserves ⊕ 41. Rate of deforestation ⊕ ♦ ♥ ♠

12. Indicators are primarily important as a guide for policy making and for measuring progress in policy implementation. Unique to this ISED project is the additional step that identifies for each of the *Driving Force* indicators, possible *Response Actions* (specifically targeted policy interventions) that can affect the direction of progress as defined by the indicators. Thus, policymakers can consider where taxation, technology requirements, pricing policies or tighter environmental standards, for example, might be expected to significantly further the goals of sustainable energy development. These *Response Actions*, and the indicators they target, are shown in Table 2. The *Response Actions* targeting indicators 1-15 correspond primarily to the economic dimensions of sustainable development, and those targeting indicators 29-41 correspond primarily to the environmental dimension. The last four *Response Actions*, which are broadly stated and for which there are no clearly identified targeted *Driving Force* indicators, relate mainly to the institutional dimension. The last column of the table lists indicators other than the most directly targeted indicator, that are also likely to be positively affected by any particular *Response Action*. We recognise that there will often be other indicators on the list that are negatively affected by a given response action – for example, expensive improvements in safety or environmental protection may depress some of the economic indicators. Like all human endeavours, sustainable development involves tradeoffs. Indicators can help to identify some of these. Figure 2 provides a graphic illustration of the flows, impacts and linkages between these various indicators.

Table 2: *Response Actions* with Targeted and Positively Affected ISED

Targeted indicator	*Response Action*	Positively Affected Indicators
3: End-use energy prices with and without tax/subsidy	**Introduce taxes on polluting fuels**	**5-7,9,10,14-16,18,23-30**
	Include externalities in full cost of energy	**5-7,9,10, 13-16, 18, 23-39**
	Eliminate energy subsidies except for the poor population	**5-7,9,10,14-18,23-34,36-39**
	Provide energy subsidies to the poor population	**20-22, 40, 41**
4, 8: Shares of sectors and sub-sectors in GDP value added	**Optimise economic activity levels through reducing shares of energy intensive sectors/manufacturing industries**	**8,9,14-18,23-34,36-39**
5: Distance travelled per capita by transport mode	**Increase share of public transport in passenger travel**	**9,15-18,23-26,28,36,37**
	Increase share of electrically driven public vehicles in passenger travel	**24**
9, 10: Energy intensity of economic sectors and selected energy intensive products	**Decrease energy intensities through end-use energy efficiency improvement**	**14-18, 21-34, 36-41**
11: Energy mix	**Diversify energy supply**	**15, 18**
	Increase share of renewables in fuel mix	**15, 18, 20-32, 34-41**
	Increase share of natural gas in fuel mix	**12, 15, 23-34**
	Increase share of nuclear in fuel mix	**23-26, 28-30, 34, 36, 37**
12: Energy supply efficiency	**Increase efficiency of energy supply, in particular for electricity generation**	**14-18, 23-39**
	Increase fraction of electricity supplied by CHP plants	**14-18,23-26,28-30,33,36,37**
13: Status of deployment of pollution abatement technologies	**Improve performance of pollution abatement technologies**	**23-25**
	Extend use of pollution abatement technologies	**23-25**

Table 2 (cont'd): Response Actions with Targeted and Positively Affected ISED

Targeted Indicator	*Response Action*	Positively Affected Indicators
15: Expenditure on energy sector	**Increase expenditure on hydrocarbon exploration and development**	**17, 18, 36, 37**
	Increase expenditure on radioactive waste management	**31-33**
	Increase expenditure on waste management	**29-33**
	Increase expenditure on air pollution abatement	**13, 23-25**
	Increase RD&D expenditure for energy technology	**9,10,12-14,16-18,21-41**
29: Generation of solid waste	**Decrease amounts of waste through recycling and reuse**	**30, 33, 36, 37**
31: Generation of radioactive waste from nuclear power fuel cycle chain	**Decrease amounts of radioactive waste through its recycling, treatment and conditioning**	**32, 38, 39**
33. Land area taken up by energy facilities and infrastructure	**Extend protected area as a percent of total land area**	**40, 41**
40. Intensity of use forest resources as fuelwood	**Extend managed forest area**	**41**
	Develop National Sustainable Development strategy	**1, 5-10, 12-41**
	Ratify and implement global agreements	**23, 26**
	Strengthen environmental regulations	**13, 23-32**
	Strengthen safety regulations	**28, 34**

13. The International Energy Agency (IEA) has been engaged in analysing indicators of energy use and efficiency in its Member countries since 1995, linking these indicators to human and economic activities and to carbon emissions. [2] A notable feature of the IEA approach is that the sectoral intensities of energy use and CO_2 emissions are analysed at a very disaggregated level, making evident the link between energy, human and economic activities and the link between energy and CO_2 emissions. The IEA approach also shows how economic and technical driving factors, like energy prices, economic growth and new technologies, shape energy use, and therefore determine CO_2 emissions. The IEA has also developed a "Model of Energy/Emissions Indicators," which portrays the links between the general economy and the demand for specific energy services, the energy system required to supply these services, and the resulting emissions.

14. The IEA also maintains extensive energy-related data bases and comprehensive energy statistics for its Member States as well as for a large number of non-Member States. The IEA performs detailed and regular analysis of these statistics and provides periodic assessments of energy sector trends and issues. Incorporating into this statistical system the information derived from the ISED will permit the IEA over time to discern and study trends in sustainable energy development and to provide analysis on the effectiveness of efforts in this sector.

Phase 2 - Practical Applications

15. The second phase of the project, now underway, is being undertaken jointly by the IAEA, the IEA and by a number of their Member States. Both agencies have a strong interest in further developing and applying the ISED in consonance with Agenda 21. Phase 2 focuses on demonstrating the practical applicability and utility of ISED in a variety of analytical and policy making cases. The goal of this phase is ultimately to demonstrate the use of ISED as an integral part of data collection and analysis for parties interested in charting the course of their sustainable development efforts. Phase 2 will ultimately include:

- making necessary modifications to the relevant IAEA and IEA databases and analytical tools so as to make them more suitable for collecting and using ISED data, and to make them more responsive to sustainable energy development issues;
- incorporating ISED data into on-going statistical analysis, to develop trends related to sustainable energy development; and
- structuring assistance to Member States in the use of ISED analysis in formulating their energy strategies in conformity with the objectives of sustainable development.

16. An interesting aspect of this second, more long term phase of the project, will encompass data collection and data base construction of indicators in a few select countries by relevant institutions that already have a strong statistical foundation and some experience with constructing indicators. A mix of OECD countries, developing countries and countries under the Energy Charter will participate in this initial demonstration project of how well the ISED indicators fit with national statistics, how easy it is to derive them, and what special problems might be encountered, particularly in assuring comparability of different national data. The

[2] IEA, 1997a/1997b; Schipper et al, 2000, Unander and Scshipper, 2000, Unander and Schipper, 2000

work will comprise a more formal elaboration of the informal testing already done in a number of IAEA Member States, subject to a coherent set of guidelines, definitions, and methodology. The results of this initial demonstration will be incorporated into the statistical and analytical structures of both the IEA and the IAEA, and additional countries can be invited to join the project after the initial demonstration phase.

ISED and the UNECE

17. The UNECE and its Committee on Sustainable Energy (CSE) are currently pursuing a comprehensive working programme with the three-fold aim of: promoting development; implementing strategies and policies to facilitate the transition to a more sustainable energy future; and developing a regional perspective of global events related to energy sustainability. The CSE has identified the following five energy policy issues facing the ECE region, as particularly important to address when elaborating long-term sustainable energy policies:

- Energy availability and security of supply
- Energy intensity and efficiency
- Energy pricing, subsidization and internalization of externalities
- Cleaner fossil fuels, new and renewable energy, and research & development
- Market opening, liberalization and economic efficiency.

Of these issues, the CSE has decided to focus on two: (1) energy intensity and efficiency; and (2) pricing, subsidization and internalization of externalities.

18. In this context, the ISED could be useful for structuring data collection and analyses addressing these specific target issues. Use of the ISED, already being integrated into on-going statistical analyses and data bases, could offer the CSE and ECE Member States a ready-made framework for anticipated studies. Using previously tested and systematically constructed methods can reduce the need for difficult time- and resource-consuming model development efforts. In the long run, the full set of 41 ISED indicators would be relevant to the work of the CSE, but given the current more sharply focussed priorities of the ECE, a smaller subset of indicators might be of greater interest – at least for demonstration purposes - in the short run. A
sample sub-set of indicators most directly relevant to current ECE concerns is shown in Box 1.

19. How these selected indicators – energy prices, energy use, energy intensity, energy efficiency, energy mix and energy security – might apply specifically to the five CSE priority areas, is sketched out in Table 3. The table suggests how these indicators might be used to inform ECE policy deliberations, by providing the *Response Actions* from the ISED list that correspond to the indicators selected. The relevant *Response Actions* include taxation, other mechanisms to internalise external costs, the elimination of subsidies, industrial and transport sector restructuring, energy efficiency improvements, and shifts in energy supply mix. It should be noted that the full list of ISED does not include any indicator directly structured to assess progress in market liberalization: in the ISED scheme, market liberalisation would be considered not as a quantifiable indicator but rather as a *Response Action* targeted to the selected indicators.

Box 1: Possible Subset of ISED Related to Monitoring Key ECE Energy Concerns

1. End-use energy prices with and without tax/subsidy for: households, industry, and automotive fuels

2. Energy use per unit of GDP: ?total primary energy, electricity

3. Energy intensity of economic sectors: manufacturing, transportation, agriculture, commercial and public services, residential sector

4. Energy intensity of selected energy intensive products

5. Energy supply efficiency: fossil fuel efficiency for electricity generation, losses in gas transportation and electricity transmission, percentage of CHP in electricity generation, oil-refining efficiency

6. Energy mix: primary energy supply, final energy consumption, and electricity generation by fuels types

7. Net energy import dependence: total primary energy, fossil fuels by type, electricity

20. For purposes of this discussion, Table 3 goes one step beyond the ISED structure to illustrate how the generic *Response Actions* might be translated into specific, detailed policy measures and actions whose implementation by the Committee and the ECE might choose to contemplate and whose impact and implementation might be further analysed using the ISED. The information derived from combinations of indicators should help policy makers to target their policies more accurately, and assess their policy options more comprehensively.

Table 3: Sample Subset of ISED Relevant to ECE Priority Energy Policy Concerns

ECE Energy Policy Concerns	Corresponding Indicators from Full List of ISED	ISED *Response Action* on Targeted Indicator	Possible ECE Policy measures and Actions on Target Indicator
Energy Pricing, subsidization and internalization of externalities	3: End-use energy prices with and without tax/subsidy: for households, industry, automotive fuels	Introduce taxes on polluting fuels; Include externalities in full cost of energy Eliminate energy subsidies except for the poor population	Internalize negative environmental externalities; Remove biases favouring the production and use of polluting fuels; Refocus the tax system to favour sustainable development objectives; Use to greater extent economic instruments, including fiscal measures; Gradually remove subsidies; Provide transfer payments rather than subsidies; Raise energy prices in transitional countries to economic or international market levels Enhance coordination on energy taxation policies among the ECE countries
Energy intensity and efficiency	14. Energy use per unit of GDP: total primary energy, electricity 9: Energy intensity of economic sectors: manufacturing, transportation, agriculture, commercial & public services, residential sector 10: Energy intensity of selected energy intensive products	Optimise economic activity levels through reducing shares of energy intensive sectors/manufacturing industries Increase share of public transport in passenger travel Decrease energy intensities through end-use energy efficiency improvement	Switch to less energy intensive industries, processes and services; Integrate energy efficiency in sectoral policies; Implement legal and regulatory frameworks and enabling environment favouring energy conservation and efficiency; Further strengthen the legal and regulatory environment, favouring market formation activities and private investment Improve material intensities across sectors;

	12: Energy supply efficiency: fossil fuel efficiency for electricity generation, losses in gas transportation and electricity transmission, percentage of CHP in electricity generation, oil refining efficiency	Increase efficiency of energy supply, in particular for electricity generation; Increase fraction of electricity supplied by CHP plants	Implement advanced, environmentally-sound technologies with lower specific fuel consumption; Open up and liberalize energy markets
Energy availability and security of supply	11: Energy mix: primary energy supply, final energy consumption, and electricity generation by fuels types 18: Net energy import dependence: total primary energy, fossil fuels by type, and electricity	Diversify energy supply; Adjust fuel mix	Enhance the diversity and variety of the energy mix available to consumers; Improve the maintenance and upkeep of existing energy infrastructure; Eliminate constrains hampering modernization and investment in new facilities in countries with transitional economies
Cleaner fossil fuels, new and renewable energy	11: Energy mix: primary energy supply, final energy, electricity generation by fuels types	Increase share of natural gas in fuel mix; Increase share of renewables in fuel mix; Increase share of nuclear in fuel mix	Switch to more environmentally benign fossil fuels, such as natural gas; Increase reliance on renewable energy resources Switch to nuclear power and away from fossil fuels;

21. The IAEA and the IEA have begun to compile historical data on ISED for various countries as a first step in highlighting the utility of the ISED for policy analysis at the national level. This effort builds on the data bases of the IEA and OECD and, wherever possible, on data available from other international organisations, such as the UN Statistical Office, the World Bank, EC, WEC, and UNEP.

22. Indicator-based analysis is not a new policy making tool. What is new about the ISED is the focus on the energy sector in the specific context of sustainable development, tying energy trends and policies specifically to economic, environmental and social concerns in a systematic and consistent fashion, and the linking of indicator information to specific policy responses.

Future Work

23. The ISED have been developed as a result of a cooperative effort among various international organisations and national experts and provide a relatively comprehensive set of indicators for sustainable energy development. As the statistical base for the ISED grows, continued and broad-based multi-agency collaboration is highly desirable. One potential area for expanded participation in the ISED project lies of course with the individual country teams interested in the collection of data and the construction of the indicators. A second area lies with international organisations interested in incorporating such indicator-based data as part of their on-going data bases and using them to analyse trends in energy sector development.

24. A third area lies in capacity building. Having time series with consistent, verifiable and creditable data is crucial if the ISED are to be useful as analytical tools. The impact of a certain implemented *Response Action* may be misjudged if the indicator that the *Response Action* is meant to affect is based on poor, inappropriate or inconsistent data. Scarce resources for data collection may result in a lack of disaggregated data or data that are not consistent with internationally accepted practices. Given the importance of consistent and good quality data, a priority area for future work on ISED is to involve more countries in capacity building activities. Several countries have already expressed a need for advice and support in establishing improved systems to collect and report data in a manner consonant with the use of the ISED.

25. As a companion effort to the continued enhancement of trend and policy analysis based on ISED, the two Agencies will therefore develop a methodological package to facilitate the dissemination and use of ISED for interested parties. Ultimately training workshops can be organised including participants from statistical offices and from institutions within each country that would be the most relevant users of the ISED and associated data. Such workshops could be held on a country-by-country basis or with groups of countries. The training would focus on methodological issues and collection procedures relevant for the data required to establish ISED, while ensuring compliance with international standards for energy related statistics, and the use of indicators as policy tools.

26. Finally, we must not lose sight of the forest for the trees. That is, we must ask what patterns of indicator values and trends would indicate that we are on, or closer to, a sustainable development path, and what values and trends would indicate the opposite? There are no easy answers because of the tradeoffs mentioned earlier. Aggressively preserving resources, for

example, may serve the objectives of the second half of the *Brundtland* definition of sustainable development – preserving the ability of future generations to meet their own needs – but will get low marks overall if it is done at the expense of the first half of the *Brundtland* definition – meeting the needs of the present, particularly today's poor. Even without the prospect of easy answers, however, it will be important to explore, analyse and discuss the conclusions that should be drawn from the trends revealed by ISED. Participation by the Committee on Sustainable Energy in any or all of these efforts would be most welcome.

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Figure 1 is a simplified illustration of the interrelations between these various sustainability dimensions of the energy system. For example, the environmental *State* associated with the energy system results from the impact of *Driving Forces* originating from the economic and social dimensions of the energy system. The social *State* of the energy system is, in turn, influenced by certain *Driving Forces* originating from the economic dimension of the energy system. The institutional dimension is an addition of ISED to the three Agenda 21 dimensions relates to the potential for *Response Actions*. Institutional responses can affect all three other dimensions - social, economic and environmental – through corrective policy *Response Actions* affecting the sustainability of the whole energy system.

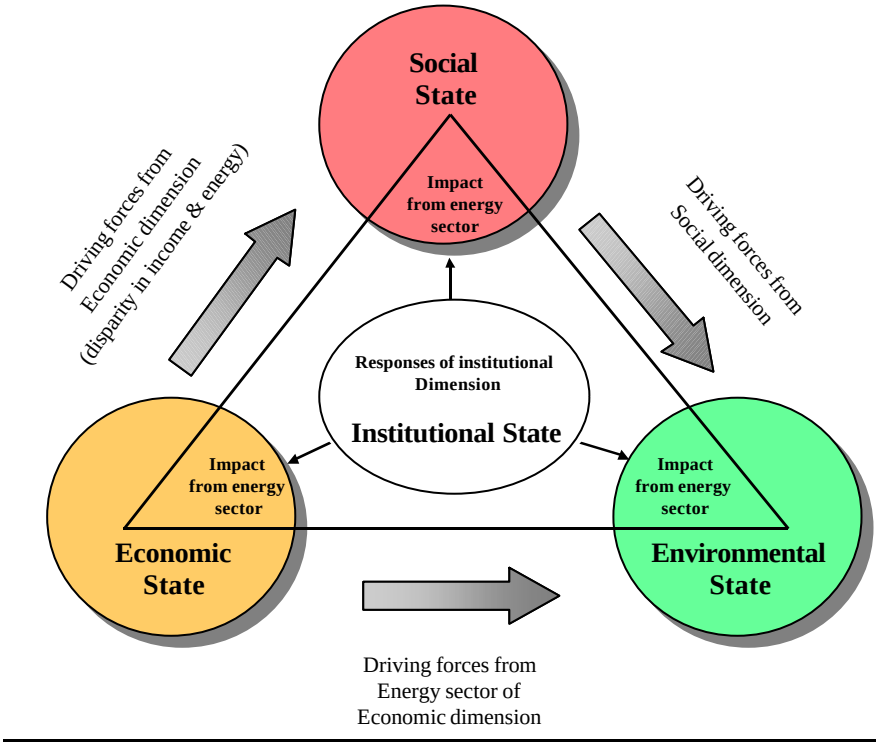

Figure 1: Interrelations between sustainability dimensions of the energy sector.

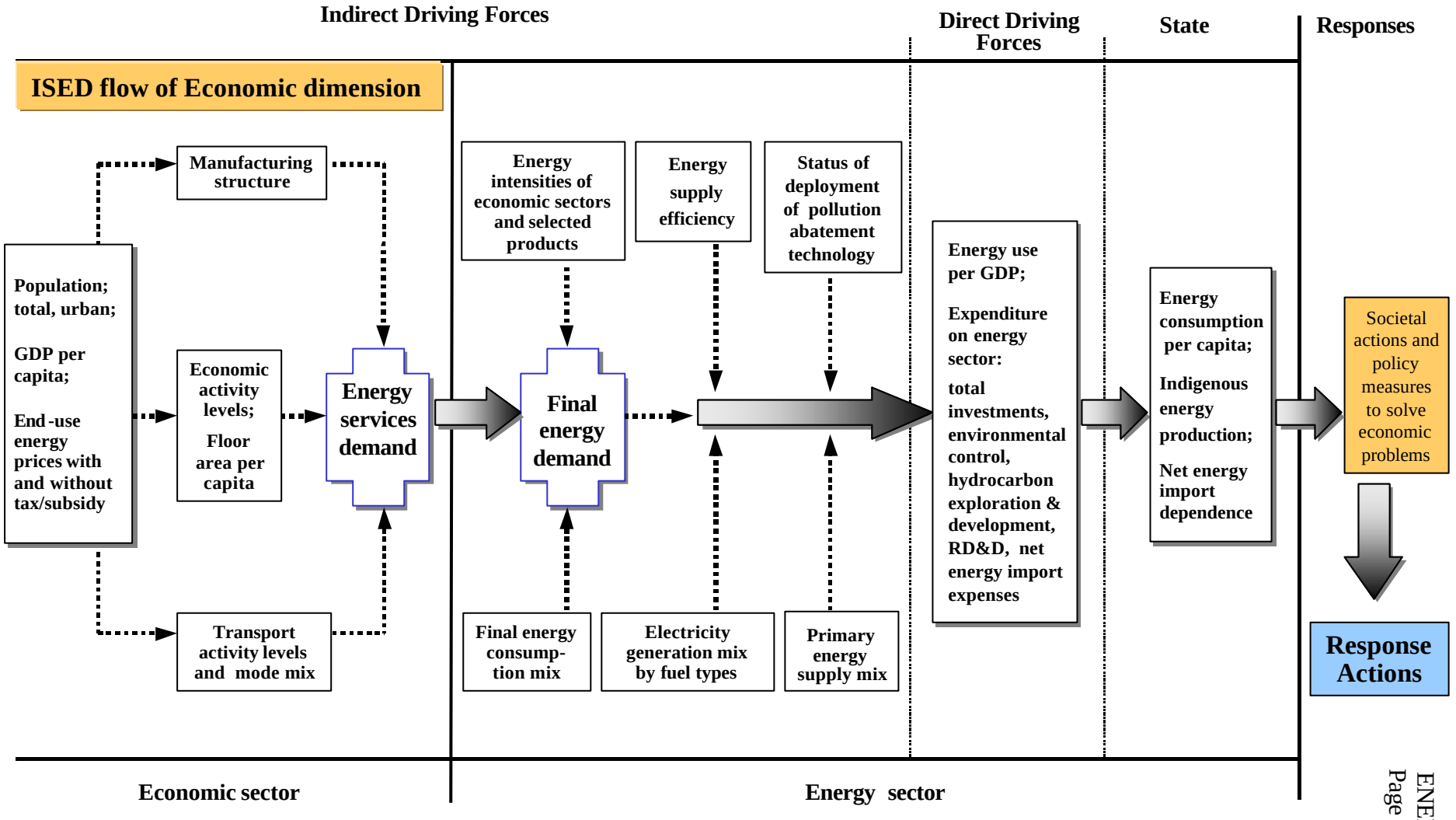

Figure 2: Flows, impacts and linkages between the various indicators