Issues Paper Session 4.2:

SOCIETAL ISSUES IN TRANSITIONING TOWARDS SUSTAINABLE SYSTEMS

Theme No. 1: "Developed Economies"

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THE SCOPE OF "THE PROBLEM"

Previous speakers have defined for us their interpretation of the terms "sustainability" or "sustainable development." A working definition of these concepts is a necessary starting point when considering the alternate transition paths industrialized / developed and emerging / developing regions might take. Each of the thirteen papers synthesized in this overview had their own implicit vision of what a sustainable economy, and therefore a sustainable energy infrastructure, might be. Some focused on the nearer-term technological aspects, while others focused on the broader economic and social challenges of sustainability. The primary topic of this session is "societal issues," which for our discussion focuses not only on the societal concerns and goals related to "sustainable development" but the social, institutional and economic means of identifying and implementing more sustainable supplies and uses of energy.

In their collective description of the key issues regarding a sustainable future, *economics*, *environment and resource use*, and *social values* were uniformly cited, with population and inter-regional as well as inter-generational economic and equity issues playing important supporting roles. (1,8,9,10) Arai and Suzuki (1) and McCarthy (8) each focused on the issues of disparity and equity in current and future energy use and economic prosperity. Arai and Suzuki looked at the differences in energy use per capita between industrialized and developing economies and suggested a staged transition to a $1 + \alpha$ kW / capita benchmark for global energy consumption. McCarthy focused on rural-urban and inter-regional migration based upon current quality of life disparities, and the immediate need to address these issues when developing appropriate "pathways" to sustainability. Failure to do so might lead to inadvertent population shifts, likely to confound even the best crafted sustainability-related infrastructure improvements. Table One illustrates the fundamental schism between various economies when it comes to the essential infrastructures–water, food, energy, mobility, that rural and urban communities offer their citizenry. In this highly generalized representation, where neighboring regions have widely different standards of living, migration, if not political instability, is likely to occur. These disparities cannot be overlooked.

Table One: Regional Availability of Robust Public Services

	Urban	Rural
Industrialized	•	•
Emerging	•	
Developing		

(• Indicates "adequate" public works.)

Recognition of these north / south and rural / urban disparities, as well as such disparities on a more local level are a key element when considering appropriate transition paths. Therefore it is necessary to bridge the global / regional / local aspects of sustainability in combination with the economic / environmental / social imperatives of sustainable development. These discussions remind us that the geographic as well as temporal aspects of sustainable development are critical when devising policies which promote the rational use of energy and other resources.

Environmental factors are clearly the topic that sets discussion of sustainable development apart from economic development discussions of the past. Differing perspectives of environmental threats are a major stumbling block in international negotiations regarding such issues as climate change and free trade. Table Two illustrates how environmental issues related to air, water and land-use map to the geographic scope which so commonly differentiates north vs. south environmental concerns. While industrialized nations are not unconcerned about local environmental threats, they are the overwhelming environmental issue for developing countries.

Table Two: Geographic Scope of Select Environmental Threats

	Air	Water	Soil / Vegetation
Global	*Climate Change*	*Fisheries, Coral Reefs*	*Biodiverity*
Regional	*Acid Deposition*	*Rivers, Agriculture*	*Agriculture, Waste*
Local	*Smog, Particulates*	*Irrigation, Sanitation*	*Soil, Groundwater*

As our knowledge of the environment improves, the divisions between the rows and columns in Table Two become less well defined. We may find yet that the local manifestations of such global environmental issues as climate change are also the most destructive. As the renowned Massachusetts politician Thomas P. “Tip” O’Neill Jr. once stated, “All politics is local.” Ultimately, all economic and health and environmental impacts are local as well. This presents significant institutional as well as technological challenges to putting in place the means to develop and deploy sustainable systems. Bisconti and Richards (2) discuss how democratization has begun to involve the public more directly in these types of discussions, and some of the techniques by which such complex issues can be reasonably incorporated into public debate.

THE SCOPE OF “THE SOLUTION”

Most students of long-term economic and infrastructure development recognize that most of the major environmental and socio-economic problems faced by society are comprised of the following three aspects:

a) *Complex Problems*
   – with local, regional and global economic, social and environmental consequences,
b) *Dispersed Solutions*
   – requiring a broad range of technological and policy responses by people *everywhere*, and
c) *Finite Resources*
   – that is to say, there isn’t the sufficient time, talent or money to do everything at once.

The scope and complexity of the issues raised as the key drivers of sustainable development are matched by the breadth of any required “solution.” These three factors impose a large burden on society as a whole to develop the ability to understand and integrate complex issues, problems and combined goals; identify and develop the tools and techniques necessary to address them; and finally to implement these efforts in a timely and effective manner. Market mechanisms may play a key role in coordinating some of these activities, but not exclusively so.

Most of the papers allocated to this reviewer focused on the policy aspects of technology development, deployment and use. They also discussed the technical, institutional and social requirements for making good, long-term decisions–both as policy-makers and as users of energy. The various dimensions of this; economic policy, R&D policy, technology innovation, and policies to promote more rational use of electricity, transportation, and end-use efficiency are discussed below in the context of both developed and developing countries. It is clear from these papers that "business as usual," even in approximate form, is inadequate to address the scope and complexity of truly sustainable energy use. Some argue that the KYOTO PROTOCOL is just the first step in the long march to a sustainable future. What types of innovations might be required cost-effectively meet the Kyoto targets? What policies and institutions will be needed to achieve substantial and sustained reductions in emissions, and likely overall resource use on local, regional and global scales? The following sections describe some of the elements of this paradigm shift.

SCOPING OUT TRANSITION PATHS

The ability to understand the dimensions of combined problems such as climate change, the need for clean water and sewage in rapidly growing mega-cities, and improved standards-of-living on an equitable basis is a huge task. Furthermore, there are many types of "transition paths"– geographic, technological, and socio-economic. Here we will focus on technological transition paths and the economic and other policy instruments which assist their development. When we consider transition paths to a "sustainable energy infrastructure," coordinated *"infrastructure management"* on the provision and use of energy plays an important role, whether it be in the electric sector, in transportation, or the buildings in which people live and work.

From an energy infrastructure point of view, the disparities between developed and developing nations begin with the relative size and performance of their respective infrastructures, and the talent and resources available to maintain and improve them. Of course how an infrastructure–energy or otherwise–is likely to change over the near and medium-term is as important as its current state of operation, especially when looking for opportunities to introduce more sustainable practices. Rapidly growing economies present better opportunities for the deployment and use of more sustainable technologies and practices since only the incremental cost, and not the total replacement cost of technologies need be considered. Table Three classifies basic energy infrastructures into four types, Mature/Industrialized, Re-industrializing, Emerging/Industrialized and Developing, based upon their relative size, age and rate of growth. This classification begins to reflect the real differences among various developed and

Table Three: Infrastructure Types and Age/Growth Characteristics

Infrastructure Type	Infrastructure Growth	Existing Infrastructure Size	Existing Infrastructure Age	Example(s)
Mature/Industrialized	Slow	Large	Moderate/Aged	OECD
Re-Industrializing	Slow/Moderate	Large/Medium	Aged/Moderate	FSU, E. Europe
Emerging/Industrializing	Rapid	Small/Medium	Moderate/New	China, India
Developing	Slow to Rapid	Small	Aged/Moderate	Africa

developing countries when it comes to continuous improvement of their energy infrastructures.

While the development of fuels, transportation and electric power infrastructures can be pursued in parallel, synergies among them must be recognized and integrated into the transition path. For example, roughly seventy percent of China's rail system is devoted to coal transportation, a one-way flow of cargo from the coal-bearing North Central regions of the country to the rapidly growing Eastern provinces. Boutarfa, Abdoun and Bounar (3) address similar issues for the MAGHREB nations of North Africa, putting forward a combined natural gas and power generation scenario to address the region's growing electricity needs.

Gas and oil pipelines, and the long-term fuel needs of the transportation, industrial, commercial and residential cannot be overlooked. However, as Reichel and Semrau (9) point out, all infrastructure improvements require relatively high levels of capital investment, and therefore the issue of finance cannot be divorced from the discussion of infrastructure growth. Coordinated development of these energy infrastructures is also important. Among emerging economies, the economic impacts of intermittent electricity outages–increasing manufacturing downtime, and clogged transportation networks–delaying the delivery of products, can have significant economic and competitiveness impacts. In the transportation sector, Figueroa, Davidson and Mackenzie (6) note that passenger and freight transport are "essential for national development," and recommend that problems associated with rapid growth in transport, changing vehicular fleets and altered transportation patterns, be combated with an array of integrated transport planning and operations, inter-modal public transport, safety standards and regulations, and fees to modify the acquisition and use of private vehicles.

With the liberalization of so many capital-intensive energy industries around the globe, how will the incremental cost of more sustainable infrastructure investments be viewed by financial markets, especially when greater rates of return can be expected from the telecommunications, entertainment and other industries? Cánovas and Gonzalvez [5] discuss how government agencies in Spain have stepped in to promote the development of more sustainable renewable energy projects. Notable in the approach of IDAE is not only financial support via third-party financing or co-ownership, but the technical expertise provided in project development, construction and operation. Access to expertise is a primary component of the E7 group of electric utilities as described by Schlenker and Strassburg. [10]

Access to more “attuned” financial resources is only one aspect of the problem in implementing more sustainable uses of energy. As governments rush to divest their basic energy industries, they erode their leverage over the amount and types of technologies which may be introduced. Industry coordination and balance, another term for “infrastructure management,” may be irretrievably lost unless other policies are implemented to direct private investments.

Large capital projects are not the only area where the incremental cost of more efficient technologies are being “overlooked.” Streicher and Fitch [11] review the microeconomic factors which have deterred individual consumers from selecting more efficient and lower “life-cycle cost” appliances. This “efficiency gap” is the result of both market “failures” and market “barriers,” ranging from fuel cost subsidization and a poor understanding of related risk and environmental factors, to higher transaction costs, lack of adequate finance, and ultimately uninformed buyers and sellers of energy technologies. This ultimately returns us to the second major point by Bisconti and Richards, [2] that underneath increased public involvement in energy and environmental decision-making is the need for a much better informed general populous.

FOSTERING TECHNOLOGICAL INNOVATION AND INTEGRATION

While the politician’s mantra may be “all politics is local,” the real estate professional’s adage is “location, location, location.” When it comes to developing sustainable energy infrastructures, “integration, integration, integration” may be the moniker of the future. While the today’s most efficient power plants have reached the 60% efficiency level, cogeneration options such as combined heat and power (CHP) can use 90% of available energy. With the development of fuel cells and microturbine systems, CHP may ultimately reach the small consumer, just as heat-pump systems do today. Today, this energy-integration is being extended to include indoor-air quality, improved comfort, and price-responsive building controls by top-of-the line energy service companies. This type of integration will continue to grow as computer controls increase in sophistication, and decrease in price. Integration “outside of the fence,” as with district heating and cooling loops in urban centers, is also on the increase. Mangan and Groberg (7) offer a glimpse of the future with their discussion of “By-product Synergies,” extending the integration not only beyond-the-fence of individual facilities, but beyond energy products and services as well. Their checklist of By-product Synergy barriers and principles goes well beyond the technical issues of integration, to encompass the regulatory, legal, economic and informational aspects as well.

Even with the integration of all these factors; sustainability criteria, coordinated infrastructure development, increased public participation, reduced market barriers, and enhanced technological integration, society is still faced with the fact that a sustainable energy future cannot be achieved with today’s best technologies. Market pull and technology push may slowly improve technological performance, but substantial basic research and development in energy systems will still be required. This is troublesome, for–as Virdis, Friedman and Woodruff (13) note–both government and industry investment in energy R&D has been declining. Liberalization of energy industries worldwide have accelerated this trend, as past monopoly electric utilities are replaced by more “bottom-line” oriented companies. Recommended solutions include increased government support for “basic” research, coupled with government-industry partnerships in select research areas, as well as loosened restrictions on industry collaboration. Tax incentives for R&D, as well as directed taxes on energy to foster technology development are also discussed.

Accelerated technology development, deployment and use will likely be necessary if politicians and government officials require emissions reductions too soon. Turnover in capital stock, particularly energy infrastructure components, generally occurs slowly, and increased energy prices due to resource depletion cannot be expected to be a driver. Bruneau (4) discusses the history of energy substitutions over the past several centuries, noting that it has always been technological innovation, and not a pervasive shortage of wood, coal, or petroleum products, which has lead to the introduction of new energy sources. Therefore promotion of innovation, including fundamental R&D, will likely be the foremost driver of technological change.

With the advent of competition in the energy industries, technology development and deployment takes on a new meaning. Movement away from centralized management and coordination, to profit-oriented specialists along the energy "supply-chain" implies that these entities will better manage their operating procedures, and hopefully improve or redefine the "value" of their products and services. In this vein, innovation and integration begin to merge as concepts.

EFFICIENCY IMPROVEMENTS ALONG "THE SUPPLY-CHAIN"

While "energy efficiency" has long been the goal of technology developers, "operational efficiency" via advanced monitoring and control technologies allows technical performance margins to be followed more closely, allowing existing pieces of the infrastructure, power lines or rail corridors–for example, to serve a greater number of people. In this way they also serve as "economic efficiency" improvements. Areas where the "supply-chain optimization" of a competitive market may further increase energy and operational efficiency is in "space" and "time." In developed nations, roughly five to ten percent of all electricity generated at central stations is lost via its transmission and distribution. (It can be much, much higher for select developing nation infrastructures.) Generation sited at or close to customer sites–such as cogeneration, CHP, and photovoltaics–avoid these losses. Improved end-use efficiency of course does this as well.

These "spatial" efficiency improvements can be supplemented with time-of-use or "real-time" price signals. Smart controls–for peak load electricity use, or smart vehicle operators–via congestion sensitive toll roads, reduce or shift usage of the infrastructure thereby eliminating the need to overbuild it for extreme peaks. Ultimately, select non-energy or passive-energy substitutes for some current energy uses will be developed. Common examples include electronic conveyance of documents and products such as software substituting for overnight delivery trucks, video conferencing reducing the need for long-distance travel, and integrated building design incorporating daylighting, natural ventilation, and passive heating and cooling. Recognizing that "efficiency improvements" come in a wide variety of shapes and forms is another way to discuss the broad-based and pervasive "integration" that will be the most likely characteristic of a sustainable energy infrastructure.

TECHNOLOGY DEVELOPMENT, DEPLOYMENT AND USE

Multiple types of "efficiencies" points to the need for policies that promote and reward, both directly and indirectly, the development and use of innovative technologies and practices. The phrase "technology development, deployment and use" incorporates the basic aspects of technology transfer, from innovation, commercial viability and diffusion, to the ability to maintain and utilize devices and systems appropriately. These three elements of technological innovation also have geographic components, as illustrated in Table Four.

Table Four: Geographical Dimensions of Technological Innovation

	Technology and Innovation		
	Development	Deployment	Utilization
Global	●	–	–
Regional	○	●	○
Local	–	○	●

Most new technologies are global in nature, developed by global technology companies aimed at global markets. There is no such thing as an East Asian gas-turbine, or a Sub-Saharan photovoltaic systems. To be sure, there are tailoring of these technologies for specific regions–vegetative types for biomass gasification, building configurations to match temperature and humidity ranges of specific climates, clean coal technology to match regional coal characteristics. These requisites are indicated by the black and white circles under the development column in the Table Four.

Deployment of new technology has a much more of a regional and local dimension. As described above, technologies will be deployed more quickly in rapidly growing economies. Additionally, national or regional market structures, standards and regulations, meteorology, geology, and social attitudes towards given technologies also help determine how appropriate a given technology or system might be for an area. Reichel and Semrau (9) in fact refer to this social dimension of technology change as "social acceptance" in their discussion of sustainability drivers. Ultimately, the ability to construct, maintain and operate systems–on the local level–determines how well they will be employed, and their ultimate effectiveness at moving a region towards sustainability. So just as “all politics is local,” so ultimately is technology use, and the need for “capacity building” *worldwide* so that future technologies can be put to their best use.

Of course much general economic behavior, when it comes to technology acquisition and use, is shared among the world’s peoples. With some recognition of regional differences, responses of various populations to price signals and technology constraints can be estimated. Tosato, Contaldi and Pistacchio [12] provide several scenarios for Italy whereby various policy options can alter the choice and use of technologies. By eliminating subsidies for select electricity users, modifying financial expectations for energy improvements (discount rate modification) and applying carbon taxes, significant reductions in fossil fuel consumption–and therefore greenhouse gas emissions–can be expected. The techno-economic model used in their research successfully reflects both the initial state of Italy’s energy infrastructure and consumption patterns, thereby giving quality guidance to policy makers about the range and extent of emissions reductions that might be possible.

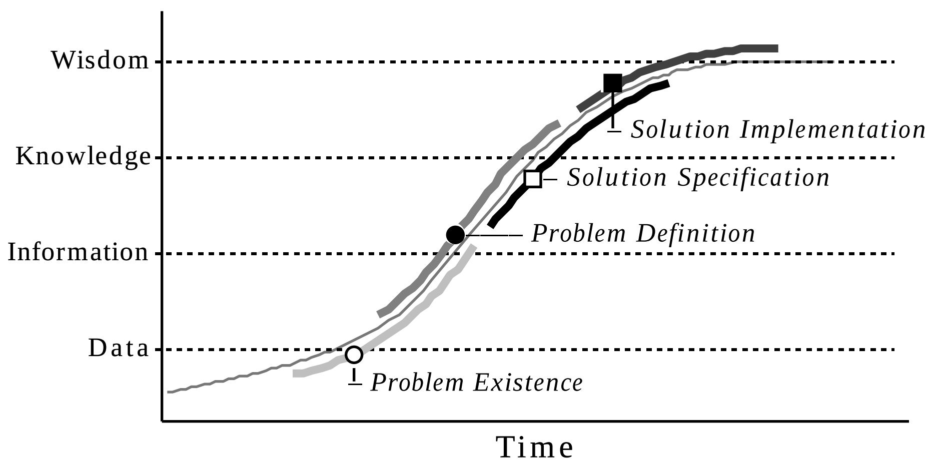
BECOMING A MORE “KNOWLEDGEABLE” SOCIETY

Looking at current inter-regional disparities, the broad long-term challenges of sustainable development, the need to manage infrastructure development under greater private ownership, the fundamental need to foster greater technological innovation and integration, and the fact that substantial and sustained progress towards sustainability requires the active participation at *all* local levels–ultimately we must become smarter and more knowledgeable as a people. Broad-based innovation and integration must be preceded by education. The “Three R’s of Sustainability”– Reduce, Reuse, Recycle, must follow the “Three R’s of Learning”– Reading, Writing and Arithmetic.

To rally popular support for many of the changes that will need to be made, a better–and shared–understanding of the problems must become “common knowledge.” Knowing what to do, as well as how to do it is equally important. This requires that society move up the “Knowledge Infrastructure Learning Curve.” The concept of a “knowledge infrastructure” is common to those in higher education and high tech industries. It implies that society has people with the skills and training to identify prospective problems, evaluate them effectively, and devise and implement appropriate solutions.

Figure One illustrates the concept of the knowledge infrastructure learning curve. It begins with a recognition that we build knowledge over time, and that it is comprised of not just of facts or *data*, but a growing understanding of the trends in those data–*information*, what those trends mean–*knowledge*, and what those trends don't mean–*wisdom*. It also implies a capability to act under uncertainty; uncertainty surrounding environmental issues, as well as a general uncertainty regarding the future. These are the x- and y-axes of the figure.

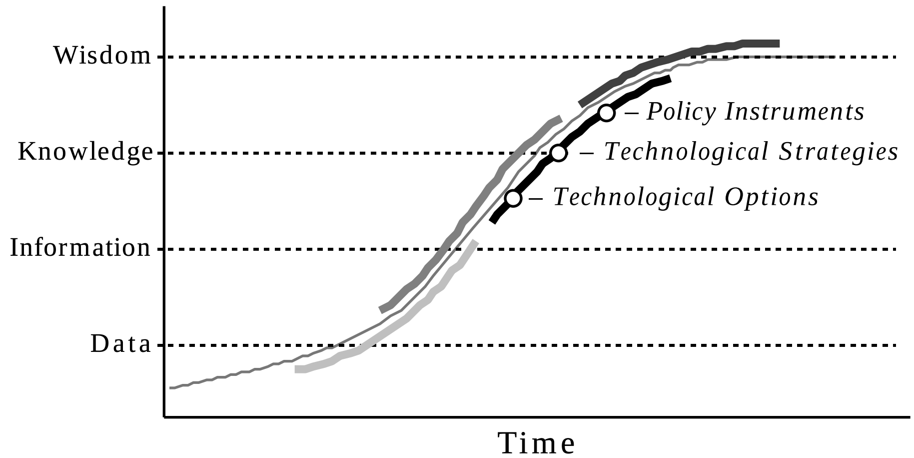
Figure One: *Taxonomy of the Knowledge Infrastructure Learning Curve*



The learning curve itself describes the activities that must occur to identify and solve a given problem. The first stage is "Problem Existence." Using the climate change debate as an example, noting increasing atmospheric concentrations of greenhouse gases identifies that there might be a problem. Atmospheric scientists, oceanographers, and other physical scientists trying to understand the scope of the problem in terms of temperature increases, storm systems, sea level rise, shifting rainfall patterns and the like comprise the second, overlapping stage–"Problem Definition." With an improved understanding of the problem, "Solution Specification," the identification of feasible, cost-effective responses can proceed. Ultimately these solutions must be implemented, the "final" stage–"Solution Implementation."

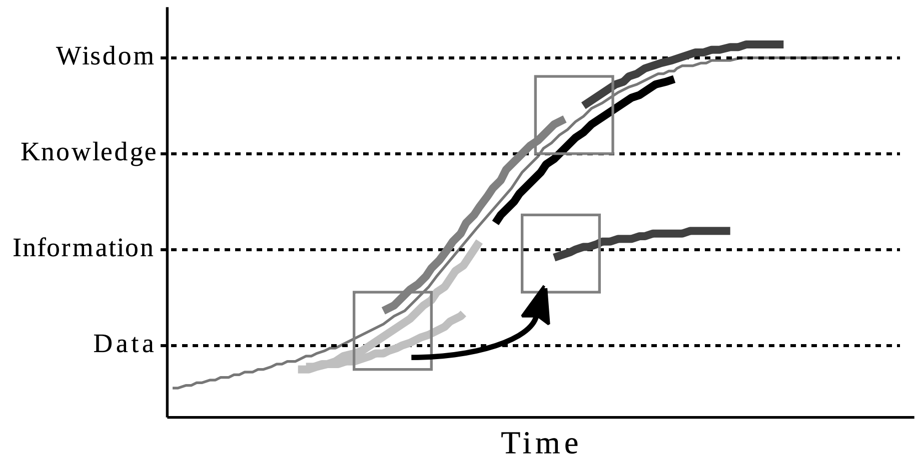
The majority of papers reviewed here have focused on where the solution specification and solution implementation stages have overlapped. Except for the exploration of economic disparity and migration issues by McCarthy, (8) the problems to be solved–economic, social and environmental, have remained implicit, which is appropriate given their regional dimensions. Several of the papers, most notably those by Bruneau [4], Virdis, Friedman and Woodruff [13], and Mangan and Groberg [7] have focused more directly on the solution specification stage. The solution specification stage, as illustrated in Figure Two, can be thought of as a series of three components, the development of technological options, their combination into strategies, and the development of policies to promote their development and deployment.

Figure Two: Elements of the Solutions Specification Stage



Readers can decide for themselves where on the knowledge infrastructure learning curve society resides for various issues. Do we have a sufficient understanding of threats to the atmosphere and local ecosystems to act? Have we developed cost-effective techniques to increase standards of living without endangering the environment? The curves illustrated above presume that decisions are made with “sufficient knowledge” as opposed to the “best available information.” However, ultimately politics *is* local, and often dictates that we act now, rather than wait for more informed responses. This tendency to “jump to conclusions; jump to solutions” is illustrated in Figure Three. It shows that society is all to often down at the base of learning curve, rather than up where the problem definition, solution specification and solution implementation stages meet. A “rush to judgment” has often led to the creation of new problems, leaving the original ones half solved.

Figure Three: *Jumping to Conclusions; Jumping to Solutions*



Bisconti and Richards [2] addressed this topic most directly in their discussion of methods to increase public involvement and educate the public more generally. A more knowledgeable and informed populous may wait for a better solution, and be better prepared to implement it. Such “grassroots” local initiatives will still require innovation and integration at the technical and policy levels, but by working at each stage along the knowledge infrastructure learning curve, Reichel and Semrau’s [9] concept of the “ecologilization of the economic system” might yet occur.

CONGRESS PAPERS REVIEWED

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(2) Bisconti, A. and M. Richards. *Constructive Public Involvement in Decision-Making for Long-Term Sustainable Systems*. Bisconti Research. Washington, D.C., U.S.A.

(3) Boutarfa, N., R. Abdoun, and M. Bounar. *Perspectives d Partenariat au MAGHREB dans le Domaine de l’Utilisation du Gaz Naturel et/ou des GPL pour la Production d’Electricite: un Example de Solution Regionale Alternative ou Complementaire aux Projets de Production Independante Envisageables dans le Differents Pays de la Region*. SONELGAZ, Alger, Algérie.

(4) Bruneau, A. *Public Policy Challenges in Pursuit of Sustainability*. Energy Council of Canada.

(5) Cánovas del Castillo, C., and H. Gonzalvez. *Innovative Financing Instruments and Renewable Energy*. IDAE. Madrid, Spain.

(6) Figueroa, M., O. Davidson and G. Mackenzie. *Matching Transport and Environment Agenda in Developing Countries*. UNEP Collaborating Centre on Energy and Environment, Risø National Laboratory. Roskilde, Denmark.

(7) Mangan, A. and D. Groberg. *By-product Synergy: A BCSD-GM Blueprint for Implementing Sustainable Development on a Microeconomic Scale.* Business Council for Sustainable Development–Gulf of Mexico. Austin, Texas, U.S.A.

(8) McCarthy, G. *Resource and Infrastructure Intensities: Navigating a Path from Global Disparity to Global Sustainability*. EPRI. Palo Alto, California, U.S.A.

(9) Reichel, W. and G. Semrau. *Task of Energy Industry in Future Concept "Sustainable Development."* National Hard Coal Association. Essen, Germany.

(10) Schlenker, H. and W. Strassburg. *A Call for New Form of Co-operation for Long-Term Sustainable Development*. RWE Aktiengesellschaft. Essen, Germany.

(11) Streicher, A. and J. Fitch. *The Role of Technology in Closing the Efficiency Gap: A Global Challenge*. Hagler Bailly. Arlington, Virginia, U.S.A.

(12) Tosato, G., M. Contaldi and R. Pistacchio. *Implications of Different Command and Control Schemes in the Energy Sector: A Long Term Economic Equilibrium Analysis with the New MARKAL Model for Italy*. ENEA. Roma, Italy.

(13) Virdis, M., K. Friedman and M. Woodruff. *Fostering Technological Change: Critical to the Global Energy Future.* International Energy Agency. Paris, France.

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– S. Connors, June 1998 –