STAKEHOLDER POSITION PAPER ON R&D FROM THE SCIENCE AND TECHNOLOGY COMMUNITY[1]

The call of governments and multi-governmental task forces for increased emphasis on renewable energy development and application and related research and development (R&D) is becoming ever more urgent.

- The G8 Renewable Energy Task Force Final Report (2001) noted that "Energy is the lifeblood of modern societies, and is a prerequisite for the welfare and well-being of all people. But, despite admirable accomplishments in providing energy for human purposes, it is increasingly clear that current energy systems are unable to provide needed energy to all people in a sustainable and affordable way. There is a growing realization that new patterns of energy supply and consumption are needed to move toward greater sustainability, and that renewables are a key element of that pathway… Use of renewable energy addresses all three of the pillars of sustainable development: economic progress, development and social improvement, and an improved environment."

- The opening language of the "*Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001*" states: "The Community recognizes the need to promote renewable energy sources as a priority measure given that their exploitation contributes to environmental protection and sustainable development. In addition, this can also create local employment, have a positive impact on social cohesion, contribute to security of supply…"

The G8 Task Force further emphasized:

> "The G8 countries should continue and expand support for research and development (R&D) of renewable energy technologies that address all sectors of the energy economy—buildings, industry, transport, and utility energy services. Cooperation with developing countries on R&D will assist in technology transfer towards systems tailored for developing country use."

And just this year (2004) Philippe Busquin, the European Research Commissioner, stated "Although fossil fuels will stay with us for a long time, we have to develop alternative energy sources to make Europe's growth really sustainable."

The energy R&D carried out today will define the world's future sustainable policy choices.

World support for energy R&D in general, and for renewable energy R&D in particular, peaked around 1980, and then fell to less than half of that level, where it remains today with only a few exceptions. In his 2004 Thematic Background Paper for this conference, *Research and Development—The Basis for Wide-spread Employment of Renewable Energies*—Prof. Joachim Luther wrote :

> "*The wide-spread employment of renewable energies is a vital prerequisite for the transformation of the global energy system towards sustainability.* This evolutionary process can only be successful if intensified research and development (R&D) efforts

[1] *This document was authored on behalf of the International Solar Energy Society (ISES) by Dr. Donald W. Aitken, based on input from the International Council for Science (ICSU), the World Conservation Union (IUCN), and the research and development stakeholder community.*

> provide suitable foundations. *The current global trend of declining energy R&D expenditure does not meet the challenges of sustainability*."

This decreasing trend in energy-related R&D stands in stark contrast to the increasing strategic importance of the energy sector's evolution.

The current trend of declining R&D budgets implies a narrowing range of future options. The European Commission recently noted that

> "The threat of global climate change and the warnings about energy security will force Europe to drastically change and diversify its sources of supply, relying more and more on renewable energy."

Security from attack and terrorism has become a new and urgent driving force in the development of policies and strategies. Isolation from anticipated geopolitical stresses resulting from competition for dwindling oil and gas supplies will be of major policy urgency in the near future. [For greater in-depth discussion of these and other factors affecting the renewable energy transition, see the White Paper by the International Solar Energy Society, *Transitioning to a Renewable Energy Future* – (www.whitepaper.ises.org).]

The focus on energy R&D is shifting and narrowing, and needs to be broadened

The European research focus is changing. The EU R&D budget for renewables has become more oriented toward applied R&D, rather than to basic research. Energy security remains a primary driver for EU R&D in renewables, but environmental protection (mitigating global warming and climate change), economic competitiveness, and institutional security (from social disruption by terrorists) are now the important drivers.[2]

An economic focus of EU R&D funding has been to "help European firms to capture a major portion of the growing worldwide market for renewable energy technologies". This is indeed one important national facet of R&D, but by itself it cannot produce a sustainable energy system in the long run. There is also evidence of significant declines in private sector R&D investments, where deregulation and the subsequent introduction of competitive forces in the energy industry have led to investments being redirected from longer-term, basic research towards low-risk, market-oriented research.

R&D cannot just be supported by governments. Ultimately, it is also the lifeblood of industries that expect to remain relevant and competitive in a changing market and in response to evolving demand by the public. Private sector R&D partnerships with governments, where governmental incentives are matched by private investments, or where governmental incentives can stimulate greater R&D spending by the private sector, must emerge as an important policy element. Toward this end, the specific needs and requirements of the private sector must be better understood by policy makers to identify future shared incentive and investment programmes.

Enhancing the implementation of existing, already-competitive renewable energy technologies (e.g., wind, hydro, biomass) is a necessary but not sufficient component of a

[2] Notwithstanding the decrease in total funding, the largest single investment of the European Union's five-year Frameworks has been energy research, spurred by the world oil shock of 1973. Energy research was first seen "as a matter of survival" for the EU. By the late 1990's the proportion of EU funding for energy R&D had grown to 14%, and to 12% for efficiency. In this context, it is highly significant that the European Commission agreed to invest US$2 billion in *sustainable energy* research for the 2002-2006 period, an amount that is *20 times* the expenditure for the 1997-2001 five-year period.

future sustainable energy system. It is widely acknowledged that no existing solutions are sufficient for meeting the world's tremendous, diverse energy needs in the coming decades. A fully sustainable energy system will require a long-term expansion of renewable energy sources that have unlimited potential (i.e. solar, aided by the capacity for energy storage and conversion that can be met by hydrogen produced by renewable energy sources). These technologies require further development, and, indeed, require some major new technological breakthroughs, in order to become more economically feasible and acceptable to energy infrastructures and markets.

The door must be fully open to technological innovation

The continued improvement and accelerated deployment of presently existing energy technologies and the development of new and innovative technologies and applications will inevitably be at the heart of any major transition to a sustainable energy future. Technological evolution and change has historically been a primary driving force in determining the structure of energy systems and services. But technological developments do not occur spontaneously. Technology *evolution* is usually driven by market pressures and opportunities and growing field experience. Technology *innovation*, however, generally results from significant, long-term investment in R&D. And that investment, in turn, must receive institutional support, in particular as a result of long term and appropriately targeted policy support.

Countries with the most advanced R&D programmes will become the technology leaders of tomorrow. The international competition in wind and PV technologies, for example, is already fierce, for the marketing and job-producing rewards are great, even though innovation in the wind industry has slowed from its previous outstanding pace.

The future advancement of the renewable energy technologies and the market acceptance of those technologies will very likely depend upon further technological innovation -- “breakthroughs” and “leaps” in new ideas, new designs, and new technologies, all of which will complement and expand upon the further development and refinement of today’s already-advanced renewable energy technologies and applications. Evidence of this can be seen in photovoltaic energy research, for example, where new breakthroughs have been announced in the production of very thin and flexible crystalline silicon cells with efficiency that is superior to the present ten-times thicker ones, advancing silicon cell PV technology. But equally important is the work that is emerging in flexible and printed organic solar cells that might ultimately have better efficiency, longer lifetime and lower production costs than silicon-based technologies. Similarly, advances are now being made in plastic and plastic/hybrid solar cells, with potentially enormous practical benefits over crystalline cells. And these are just three R&D areas in the multiplicity of opportunities across all of the renewable energy resources. (Luther, in his Thematic Background Paper for this conference [referenced above], lists many other important R&D areas in many other technologies).

A wide array of research issues must be addressed to continue the evolution of renewable energy sources. This work will build upon the insights of physics, chemistry, and other 'basic' sciences, and upon rapidly developing 'hybrid' fields such as biotechnology and materials science. But while it is necessary to advance the development of particular energy sources, R&D in the development of comprehensive energy systems–including cost-effective conversion, transport, and utilization of energy—is equally important.

In addition, reducing vulnerability to societal disruptions by terrorist attacks on central energy generation plants and major energy distribution facilities must accelerate the evolution of energy systems to operate in reliable, integrated “distributed utility” modes. Multiple local energy production facilities must increasingly substitute for vulnerable central power plants, and on-site energy use (e.g. building-integrated PV and fuel cells) must increasingly

substitute for networked and interconnected energy distribution. (This is confirmed by the enormous and expensive electricity supply interruptions experienced by the U.S. and Italy toward the end of 2003 from interconnected transmission system breakdown, and by the heightened security now required in and around all central power stations.) R&D in the development and implementation of distributed utility energy sources and systems, and integration with present or new societal infrastructures, must be supported with urgency.

This viewpoint was also advanced by Luther in his Thematic Background Paper:

> "In addition to mere energy conversion, it is vital to develop novel supply structures; distributed generation and grid optimization, trans-regional energy transport and a global link, energy storage, load management, etc. It is also essential to improve the solutions for end-users: domestic cogeneration of electricity, heat and cold based on renewable energy sources…In all these cases emphasis should be put on ecologically benign technologies…In this context, continuous R&D efforts are essential for economies of scale…."

Enhancing R&D efficiency and competitiveness by international collaborations.

Prof. Luther, in his Thematic Background Paper for this conference (referenced above) noted that "The basis for R&D in these areas [renewable energy] must be set up or reinforced globally. The chances and prospects of international collaboration and task sharing must be taken into account." He offered the suggestion that a "World Energy Research Programme" could be established as a UN programme, in analogy to the World Climate Research Programme, supported by scientific input from an Intergovernmental Panel on Sustainable Energy (IPSE), also in analogy with the Intergovernmental Panel on Climate Change (IPCC).

Toward this end, it is encouraging to note the formation in 2004 of a consortium of 13 European technology, academic and manufacturing partners to collaborate on a 30-month project to develop flexible organic solar cells. A very important element of this industrial collaboration is the support from the EU, which is providing over 50% of the funding for this effort. This is consistent with the recommendation offered earlier in this document for governmental support in partnership with private investment. Similarly, on January 27, 2004, the European Wind Energy Association (EWEA) launched a network of 200 companies and institutions from throughout Europe to collaborate on a coordinated R&D programme in wind energy.

Equally important, though, is collaborative research with developing countries, for it is almost non-existent today, and there is little support for capacity building efforts. It is imperative to do more than simply 'transfer' existing energy technologies to the developing world. Rather, it is necessary to engage these countries as true partners in the development of new energy technologies appropriate to their conditions and cultures. This is not meant to imply a "trickle down" theory, in which yesterday's technologies in the developed nations are offered to the developing nations, always keeping them behind their richer cousins. The different technological requirements of the developed and developing nations must drive the appropriate R&D programmes and technology transfer efforts. The following expands upon that.

A broader view of renewable energy R&D needs to be developed

Margolis and Kammen wrote (in *A Reader in Climate Change Policy* , Island Press, 2001):

> "A broader view of the energy R&D process needs to be developed. This broader view would include focusing on pressing but often overlooked problems – what one might call the 'mundane' research on sustainable energy technologies and the

> policies conductive to bringing these technologies into use. This is particularly pressing given the fact that more than two billion people world-wide (roughly 35% of the world's population) rely primarily on wood, charcoal and other traditional biomass fuels to meet their energy needs. Many more rely on kerosene lanterns and diesel generators. Meanwhile, a disproportionate share of energy technology R&D resources are focused on advanced combustion systems, commercial fuels, and large centralized power facilities. We would argue that small-scale, decentralized energy systems can play a significant role in meeting the combined challenges of development and environmental conservation, yet there has been a general pattern of neglect of and underinvestment in such systems. There is now an important opportunity for even relatively small investments in 'mundane' energy technology R&D to produce large environmental and social returns."

The same two authors conclude in *Underinvestment: the Energy Technology and R&D Policy Challenge* (Science, Vol. 285, 30 July 1999, 690):

> "The energy technology and policy options of industrial and developing nations are closely linked together in a global energy economy…a broader collaborative environment is needed to support diverse energy research and implementation options and policies that work within and between highly industrialized and developing nations."

This was echoed in 2004 in Berlin by the participants in the European Conference for Renewable Energy, as reported in the EWEA announcement of the new multinational coordinated R&D in wind energy:

> "E.U. research program funding should be increased, in recognition of the growing commitment to using renewable energy technologies in the future. R&D can drive innovation, reduce costs, and stimulate market development in both developed and developing countries."

These considerations therefore suggest the urgent need for research that goes beyond the scientific and engineering arenas into the socially relevant fields of economics, political science, and other social sciences, for example:

- reorganizing the R&D planning and support process where specified goals, not the politics of 12 - 24 month budget cycles, are articulated and then maintained, such as $1/Wp PV cells
- making a commitment that support for R&D by and for developing nations will be real support for local institutions, not just setting up parallel institutions
- identifying methodologies and support to transfer innovations from the laboratory through demonstration to socially beneficial applications
- identifying methods of, and creating institutions for, financing the evolution of the energy systems
- creating management structures to implement, organize, and monitor this global transformation
- determining the effects of globalization in the energy sector
- identifying and capitalizing on the factors that affect public acceptance of new technologies, conservation practices, etc.
- identifying and the removing the individual and institutional barriers that hinder the widespread use of renewable energies.

R&D in renewable energy must be part of a long term vision, supported by a strategy

Everything discussed in this position statement presupposes a coherent *strategy* by governments, based upon a long term *vision* of the future that they want, the relevance of that vision to their particular economic and cultural frameworks, and the role of energy systems and resources in bringing about that vision or result. Luther concluded in his Thematic Position Paper,

> "R&D measures must be adapted to the overall *strategy for the evolution of energy systems*. Certain technological solutions and non-technological approaches have to be ready for implementation at particular points in time."

Those "points in time" must be *anticipated* during the development of short, medium and long-term renewable energy R&D plans and programmes. If they are not, they will be missed, possibly resulting in economic and societal chaos, if not collapse.

We thus call upon the world's governments and industry leaders to greatly increase investment in R&D for renewable energies, including significant international support for R&D capacity building and cooperation among developing countries. Coordinated international programmes for research funding, planning, and assessment should be established as needed to facilitate these goals. All programmes should be implemented in the framework of long-term visions of desired societal outcomes, and established to meet specific goals over time, independent of political changes.