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White Paper on the IEEE and Sustainability
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Introduction

The concept of *sustainable development* and, more broadly, *sustainability* was popularized by the 1987 report from the World Commission on Environment and Development (informally known as Brundtland Commission) entitled *Our Common Future*. While definitions and ambiguities have proliferated since then, two strands of thought generally characterize the sustainability dialog: environmental protection, and social equity (usually but not always characterized as an equitable distribution of resources and opportunities within and among human generations). While contentious, the idea of sustainability as an element of modern engineering is gaining in acceptance: for example, the American Society of Civil Engineers has launched a Committee on Sustainability as well as PERSI, an initiative to explore Practice, Education and Research for a Sustainable Infrastructure; the American Institute for Chemical Engineering has launched the Institute for Sustainability, which among other things has created a Sustainability Index, seeking to establish benchmarks for sustainable practices and implementation in chemical related industries; and the National Science Foundation has funded the creation of a Center for Sustainable Engineering, a consortium involving Carnegie Mellon University, Arizona State University, and the University of Texas aimed at encouraging the development of sustainable engineering education at the undergraduate and graduate levels.

In light of these developments, a workshop was convened on September 8, 2008, by the in-coming president of the IEEE to address the issue of what, if anything, the IEEE might consider doing in the general area of sustainability. Attendees and a list of participants is included in the workshop summary documents attached as Appendix II. More specifically, looking both at external sustainability initiatives, and internal IEEE capabilities, the workshop addressed the questions of whether there is a useful role for the IEEE in this domain, and, if so, how might it best be addressed, and what resource requirements might be implied by different options. This White Paper summarizes the conclusions of that workshop; in doing so, however, it reflects the opinions, interpretations, and understanding of the authors only, and is not necessarily representative of the views of the IEEE or IEEE leadership.

Sustainability: An IEEE Role?

A review of existing sustainability institutions and the current state of the sustainability dialog indicates a focus dominated by environmental issues. Thus, techniques such as life cycle assessment (LCA) and Design for Environment (DFE), and

fields such as “green engineering” and industrial ecology are either explicitly environmental in focus, or heavily biased towards environmental perspectives. Many of the existing “sustainability initiatives” in academia (e.g., Yale, Duke, University of Michigan, Arizona State University, University of California at Santa Barbara), as well as elsewhere, have a similar environmental emphasis. In part, this is a reflection of the fact that much of the sustainability community, especially in Europe and the United States, grew out of environmental organizations; in part it reflects the fact that the drivers for the development of many of the existing engineering and design methodologies and tools were, in the first instance, environmental. There are a few exceptions that focus on economic development, the most important of these probably being the Earth Institute at Columbia University, which is heavily coupled to the United Nations, and thus reflects more of a development economics approach. The private industry approach, by and large, reflects these tendencies, primarily because private industry has approached sustainability as a stakeholder management issue, and therefore reactively reflects the values of the most activist stakeholders, which tend to be environmental.

From an internal perspective, the most obvious and fundamental characteristic of the IEEE is its technological competence; indeed, the IEEE introduces itself on its web site as “the world's leading professional association for the advancement of technology.” (www.ieee.org/web/aboutus/home/index.html). Additionally, the IEEE has a number of sustainability initiatives across its 324 global sections, 1,784 chapters, 38 societies, 7 technical councils, and 390 affinity groups. Many of these are historically and substantively rich: for example, the IEEE International Symposium on Electronics and the Environment, which began in 1993, is probably the best resource available anywhere on the development of DFE methodologies, as well as the evolution of environmentally sensitive electronics manufacturing techniques and the application of LCA to complex manufactured articles and, to a lesser extent, information and communication technology (ICT) networks and services. The IEEE has also sponsored several conferences on renewable energy, targeted at public policymakers as well as technologists. These include Hydrogen Economy (2004), Electric Ships (2005), Wind Power Symposium (2006), and Energy 2030 (2008). IEEE Standards activities are increasingly relevant in sustainability domains (e.g., the IEEE 1680 standard for green electronic procurement). Moreover, through its technical organizations the IEEE has taken on an important role in support of an ambitious 60-nation enterprise to create a worldwide Earth monitoring system known as the Global Earth Observation System of Systems (GEOSS). A more detailed survey of relevant IEEE activities and publications is attached to this White Paper as Appendix 1.

This rich historical base suggests that the IEEE can, in fact, not only play a role in the sustainability dialog that is useful and not duplicative of others, but also one that lies squarely within its competency and mandate. Perhaps because of its environmental origin and a focus on developing rather than developed countries, it is remarkable how little attention the sustainability community, institutions, and dialog pay to questions involving emerging technologies (in fact, in some cases there is an element of technophobia in sustainability discussions). This is an increasingly problematic gap, especially given the accelerating evolution of the five foundational technologies of

nanotech, biotech, robotics, ICT, and applied cognitive science – and, to add to the complexity, their integration. An example that will be familiar to readers of *Spectrum*, but is essentially unknown to the sustainability community, is the possibility that electrical engineering and computer science models and algorithms, combined with advances in biotech and applied to human systems, has a reasonable probability of leading to radical extensions of life expectancy in developed economies. Evaluating the sustainability implications of such possibilities as part of the overall technological assessment, and helping the sustainability community to understand the possibility of emergent technologies with challenging sustainability implications, is an important but currently unfilled role. Similarly, the potential for substitution of ICT for more material and energy intensive options in many areas, such as transportation, has long been recognized, but rigorous studies of the systemic implications of such socio-technological shifts are lacking.

In short, the IEEE's strengths in technology, technological systems, and technology policy are well matched to filling a critical, and as yet significantly underappreciated, gap in the current sustainability dialog: that of helping engineers, technologists, educators, and society generally perceive, understand, and respond intelligently to the emergence of new and powerful technology systems. We conclude that the IEEE has a useful and perhaps unique role to play in creating the deeper understanding of technology and sustainable systems that is a precondition for serious progress on sustainability issues. Moreover, we note that the IEEE Mission Statement provides that "IEEE's core purpose is to foster technological innovation and excellence for the benefit of humanity[.]" while the IEEE Vision Statement explicitly provides that the "IEEE will be essential to the global technical community and to technical professionals everywhere, and be universally recognized for the contributions of technology and of technical professionals in improving global conditions." Our interpretation of both of these strong statements of position is that it provides not just the rationale, but in fact a mandate, for constructive engagement with sustainability issues from the perspective of technology systems and technologists.

Addressing the Gap

As noted above, the IEEE is already responding in many ways to the intellectual and pragmatic challenges posed by sustainability, including both the environmental and broader social aspects. This suggests that an effort to centrally control this domain could well be counterproductive, and limit desirable experimentation and initiative in various particular areas of IEEE expertise. Moreover, any centralized effort that replicated what different entities within the IEEE are already doing would be wasteful. On the other hand, some coordination that enables the IEEE to integrate, learn from, and disseminate the results of these activities would have a high value for the organization, and for society. Moreover, the IEEE at an institutional level can play an important role in facilitating communication among those interested in sustainability, especially from a technological perspective, and providing more rigorous, policy relevant, and useful information on technology and sustainability to the public and policymakers. Accordingly, we suggest the following steps:

1. Launch a “Presidential Sustainability Initiative” (PSI) as a Board-level ad hoc committee with the charge of coordinating across IEEE operating units, and compiling a better map of what is going on in the sustainability domain across the IEEE. It is important that this committee be sophisticated in both sustainability issues, and IEEE activities, because a lesson from other organizations is that individuals involved in research, publication, and publicity surrounding particular technologies might not realize the sustainability implications of their work.
2. We also suggest the establishment of a technical committee under the Technical Activities Board that would form the institutional anchor (for convenience we will call this the Sustainability Technical Committee, or STC, without implying that a technical committee as opposed to, for example, a council is necessarily preferable in the long term). This could be either a new organization, or it could be vested in an existing organization. If the latter course is chosen, we suggest that the Technical Committee on Sustainable Systems and Technology, (formerly the Technical Committee on Electronics and the Environment), now under the Computer Society, be shifted to this function for several reasons. These include the expertise of the individuals active in that organization, which includes both technical and sustainability experience, and the fact that this TC already has an annual conference with a fifteen year record which can be expanded to provide a forum for broad exploration of the IEEE sustainability domain. Joint membership of at least some individuals between the necessarily temporary PSI and the more permanent technical committee would help ensure smooth coordination between the two.
3. The PSI and STC should undertake an effort to map external activities, and identify which ones offer opportunities for collaboration that would be worthwhile and support the IEEE’s agenda effectively. For example, the Center for Sustainable Engineering has already approached the IEEE about a collaborative activity to institutionalize sustainable engineering educational material, and groups such as the AAAS offer strong partnering possibilities. On the other hand, everyone in this field is familiar with initiatives that are naïve, or represent posturing and positioning more than content, and should therefore be avoided. In this light, the PSI and STC should be given the administrative support to plan and conduct a large conference in 2010, which would focus on the identified IEEE space of technology, technological systems, and sustainability, and have the explicit purposes of at least a) exploring ongoing initiatives; b) identifying opportunities for networking and joint activities; and c) establishing an agenda that, while not intending to replace ongoing activities, attempts to identify gaps and opportunities for future initiatives.
4. From the beginning, any IEEE initiative in this space should be an important part of IEEE’s contribution to a more rational and informed public dialog about technology and its implications (indeed, canon 5 of the IEEE code of ethics requires IEEE members “to improve the understanding of technology, its appropriate application, and potential consequences.”). There should thus be a public outreach plan associated with any such initiative (the involvement of *Spectrum*, for example, is crucial; one possibility would be a ongoing column on

this issue, for example). This is particularly important because the IEEE sustainability initiative should be understood (and managed) as a potentially significant mechanism for improving the public visibility of the IEEE specifically, and engineering and science generally, and thus also indirectly increasing public awareness of engineering and scientific contributions to issues of significant public concern (e.g., environmentally and socially sensitive manufacturing and design; lifecycle management of electronic products; ICT services and their cultural, social and environmental implications; energy systems and global climate change monitoring and mitigation). More specifically, the IEEE should make its large and important body of technical work more accessible to professionals, educators, policymakers and the public; the PSI and STC should be charged to make appropriate recommendations in this regard expeditiously. Moreover, in light of the educational role regarding technology and sustainability that appears appropriate for the IEEE, attention should be particular focused on mechanisms to make socially and environmentally important implications apparent, and strengthen the appeal of IEEE information and communications to younger audiences.

5. Similarly, a number of organizational units have noted a falling off of membership interest, conference attendance, and the like. Because emerging technologies, and their social and environmental implications, are exciting areas for many members, as well as their students, co-workers, and policymakers with whom they deal, an IEEE sustainability initiative should also be coupled to membership management across the IEEE as a whole. This is especially true with younger and student members, where the sustainable systems and technology message is likely to be of significant interest.
6. In addition to being an important positive contribution to the public visibility and understanding of engineering and science, the sustainability initiative should also be framed in terms of the engineering profession producing not just technological excellence, but also leadership. Many stakeholders, including firms and others who hire engineers, have argued that a technologically sophisticated economy, which is experiencing the challenge of accelerating technological evolution, require engineers not to be just technically competent but also public leaders. Enhancing the social and environmental awareness of engineering students, and practicing professionals, is an important component of the skill set required for leadership in modern institutions.
7. In addition to these efforts, the workshop identified many other potential activities, such as a journal or virtual journal cutting across IEEE as a whole from a sustainable systems and technology perspective, that would benefit from, and contribute to, the broad view of technology and sustainability that the IEEE initiative will hopefully develop. The PSI and SC should identify and help foster such initiatives as an important part of their remit. Additionally, the Distinguished Lecturers Program should recruit appropriate talent that conferences, chapters, and sections can draw on for panels or speakers for their more specialized audiences might be useful. Such a network could encourage a similar cross-fertilization of ideas in publications by arranging guest columnists and special issue co-editorships.

Conclusion:

We believe that there is both a useful and a unique role for the IEEE in contributing to the sustainability discourse. A precondition for sustainable development is greater understanding of technological opportunities, and technological development processes, especially given the powerful emerging technologies of nanotechnology, biotechnology, robotics, information and communication technology, and applied cognitive science, yet this is an area that current sustainability initiatives do not adequately address. The IEEE has a long history of relevant activities, and strong technological competence, and is ideally suited to respond to this critical gap in the sustainability discourse. It should do so. We make several suggestions as to how the IEEE might proceed should it agree with this recommendation, but emphasize that we present those to enable discussion and rational choice, rather than because we take them to be the only appropriate responses to the challenge. We believe that by moving forward now, the IEEE will, true to its mission, better serve its members, the professions it represents, and society as a whole.

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APPENDIX 1

IEEE OVERVIEW OF ACTIVITIES RELEVANT TO SUSTAINABILITY

**IEEE & Sustainable Development:
Overview of Actions to Promote Sustainability**

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1. Introduction

The IEEE is the world's leading professional association for the advancement of technology. At the end of 2007, the organization had more than 375,000 members including nearly 80,000 student members in more than 160 countries. There were 324 sections, 1,784 chapters, and 1,616 student branches. The impressive membership of IEEE allows one to fairly say that there may be no other organization in the world that is as aptly positioned to take a leading role in pursuing sustainable development. Through its members, sections, and chapters, the IEEE is in a position to rally global support of sustainability initiatives – and has successfully done so on a number of occasions, but there remains an immeasurable amount of work yet to be done.

The following is a review of IEEE's actions in the realm of sustainable development. The discussion will begin with the organization's early work, focusing on the Electronics and Environment (E&E) Committee, which in 1994 set the sustainable development path for the broader organization. Next, the document will highlight current work by IEEE, IEEE sections, and IEEE organizations in the realm of sustainability. The discussion then moves to priority areas where IEEE should expand in the coming years. The final section provides a listing and brief explanation of IEEE publications (journals, conference proceedings, and books) and IEEE conferences/symposia which focus on a sustainability theme.

It is found that IEEE has conducted a significant quantity of work in the realm of sustainable development. From the work completed by IEEE societies and committees, to research published in IEEE journals and books, to information conveyed at IEEE conferences and symposia, IEEE has proven its commitment to sustainability. Yet, it is arguable that, as the world's largest professional society, IEEE has not done enough to foster sustainable development. Indeed, the work completed to-date by IEEE should serve only as a

foundation for expanded, more effective, and more far-reaching work in the future.

2. Early Work

2.a. The Electronics and the Environment Committee

The Electronics and Environment (E&E) Committee was elected a formal committee of the IEEE Technical Activities Board in 1994. In that time, it has held five international symposia, helped to formulate IEEE Policy Statement 9.21 - Environment, Health and Safety (which articulates IEEE's commitment to integrating environmental objectives and considerations into all electrical and electronics engineering activities, worldwide), and sponsored a research and development workshop which focused on current research on environmentally conscious products and materials for electronics (IEEE, 2002).

The most important work in the area of sustainability to be conducted by the E&E Committee is their 1995 *White Paper on Sustainable Development and Industrial Ecology*. The white paper served to better define the concept of sustainable development within the broader IEEE community and to highlight priority issues. Although the paper covered many areas of sustainable development, the primary focus was on industrial ecology, thus cementing industrial ecology as a priority IEEE issue.

The white paper reads:

The E&E believes that the original approach to environmental impacts and their mitigation, characterized by centralized "command-and-control" regulation targeted at emissions and existing waste sites, is far too limited to support the achievement of a sustainable economy. It must be replaced by a more comprehensive approach. As recognized in the document, *Technology for a Sustainable Future* (OSTP, 1994), technology, science and environmental considerations must be integrated both in the U.S. and, eventually, throughout the global economy. ... Moreover, there is clearly a necessary role for government at all levels in supporting basic research in this area, particularly in developing the field of industrial ecology, and encouraging the development and diffusion of the resulting knowledge and technologies (IEEE, 1995).

The E&E Committee white paper argued that the traditional definitions of sustainable development embody a worthy vision, but are inherently ambiguous, and expressed in value-laden terms subject to different ideological interpretation. The E&E Committee contended that in order to operationalize the concept of sustainable development, one must understand the role of industrial ecology. Industrial ecology is...

a multidisciplinary study of industrial and economic systems and their linkages with fundamental natural systems. It incorporates, among other things, research involving energy supply and use, new materials, new technologies and technological systems, basic sciences, economics, law, management, and social sciences. Although still in the development stage, it provides the theoretical scientific basis upon which understanding, and reasoned improvement, of current practices can be based. Oversimplifying somewhat, it can be thought of as 'the science of sustainability.' It is important to emphasize that industrial ecology is an objective field of study based on existing scientific and technological disciplines, not a form of industrial policy or planning system (IEEE, 1995).

It is important that the white paper identified energy supply and use, new materials research, new technologies and technological systems, basic sciences, economics, law, management, and social sciences as the priority issues of industrial ecology as these issues would also embody the majority of future work to be done by the IEEE in the realm of sustainability. Of particular importance is the white paper's outlining of *design for environment* (DFE). DFE is the implementation of the principles of industrial ecology in the near term at the private firm or individual level (IEEE, 1995). By outlining the basics of industrial ecology and DFE, the E&E Committee provided a definition of sustainable development which it believed could be operationalized.

The second major subject of the E&E Committee white paper regarded the role of IEEE in fostering sustainable development. The white paper expressed the importance of electrical, electronics, and telecommunications sectors in supporting the critical trend of providing increased quality of life while using less material and energy – one of the founding concepts of sustainable development. The white paper called for IEEE to act as a facilitator and a source of substantive expertise in the realm of sustainability.

It is arguable – as is demonstrated through the remainder of this document – that IEEE has lived up to the call of the E&E Committee to take a

leading role in sustainable development studies. Through its many societies, chapters, publications, and conferences, IEEE has demonstrated its commitment to sustainable development.

3. Current Work

The vastness of IEEE makes it difficult to organize and present information regarding all of the organization's activities in the realm of sustainable development. There are countless instances where societies or sections of IEEE have conducted small-scale sustainable development initiatives. For example in March 2008 the IEEE London Section, as part of their Sustainability and the Seminar Series, held a seminar entitled Opportunities for Collaboration between Forest and Chemical Industries. The event focused on the forest sector and their opportunity to use products of the chemical industry to increase the sustainability of the forest sector overall (see http://london.ieee.ca/2008-03-26_Opportunities-Sarnia/index_Collaboration.html). Small examples, such as the London Section's seminar, are found throughout the many organizational branches of IEEE.

The following sections attempt to highlight the most prominent work being completed by IEEE in the realm of sustainable development, including actions by societies, special programs, forums, and sub-organizations.

3.a. IEEE Societies

The most prominent work by IEEE in the realm of sustainable development has been completed at the society-level. The work is presented primarily through the society's publications and sponsored conferences, most of which are highlighted later in this document. The following is an overview of the

most active IEEE societies in terms of the breadth and impact of their work on sustainable development.

3.a.i. IEEE Geoscience and Remote Sensing Society

A primary area of IEEE concern is remote sensing. “In the broadest sense, remote sensing is the small or large-scale acquisition of information of an object or phenomenon, by the use of either recording or real-time sensing device(s) that is not in physical or intimate contact with the object (such as by way of aircraft, spacecraft, satellite, buoy, or ship)” (wikipedia.org, 2008b). Opportunities to explore sustainability through remote sensing are numerous, and IEEE has taken advantage of many of these opportunities. For example, the IEEE and the IEEE Geoscience and Remote Sensing Society (GRSS) were both exhibitionists and primary sponsors of the 2007 and 2008 International Geoscience and Remote Sensing Symposia. Each symposium gathered expert individuals and organizations from around the world to discuss the impacts of remote sensing on understanding the planet. Some specific topics included remote sensing of hydrologic and soil parameters, sensing of wetlands, underwater sensing, ozone layer monitoring, and environmental monitoring of land and sea, among many, many other sustainability-oriented topics. The upcoming 2009 symposium in Capetown, South Africa will likely be equally as impressive.

The GRSS also hosts a number of remote sensing conferences oriented towards sustainable development education. For example, the Review of Atmospheric Transmission Models Conference in June 2008, Oceans 2008 upcoming in September 2008, or the Seventh African Association of Remote Sensing of the Environment Conference in October 2008.

(See <http://www.grss-ieee.org/conferences/topicalconferences> for a full list of GRSS conferences.)

The primary publication of the GRSS – IEEE Transactions on Geoscience and Remote Sensing – regularly publishes on issues of sustainability. For example, Luzi et al. (2007) use remote sensing to observe glaciers and obtain information from their surface topography. Another example is Yu, Privette, &

Pinheiro (2008) who use remote sensing to monitor land surface temperature for the purposes of hydrological, meteorological, and climatological applications.

3.a.ii. IEEE Computer Society Technical Committee on Sustainable Systems and Technology

In 2008 the 16 year old IEEE Technical Committee on Electronics and the Environment (TCEE) reorganized itself as the Technical Committee on Sustainable Systems and Technology. It also renamed its most prominent symposium to the IEEE International Symposium on Sustainable Systems and Technology. Further, the Committee has begun extensive partnerships with peer societies within IEEE and particularly strong partnership with the Society on Social Implications of Technology (SSIT).

The upcoming 2009 IEEE International Symposium on Sustainable Systems and Technology will be in Phoenix, Arizona and is expected ...

To be the premier event addressing the sustainability of engineering systems and technology, fully encompassing the previous TCEE focus on electronics products, information communications technology (ICT) services, and ICT in complex engineered systems. On top of that historic focus, we expect to add sessions on sustainable built infrastructure (such as roads and buildings), nano-bio-cognitive science, sustainable energy production and distribution, life cycle assessment, ethics, and education. To promote cross-fertilization of ideas and methods, we will leverage our co-located event with a shared parallel track (ISEE, 2008b).

Registration for the event is now open and the program is available online (see <http://www.regconnect.com/content/isee/>).

3.a.iii. IEEE Society on Social Implications of Technology

The IEEE Society on Social Implications of Technology (SSIT) works on issues such as environmental, health and safety implications of technology; engineering ethics and professional responsibility; history of electrotechnology; technical expertise and public policy; peace technology; and social issues related

to energy, information technology and telecommunications (SSIT, 2008). A review of IEEE literature has revealed that the SSIT's *IEEE Technology and Society Magazine* is the foremost publisher on issues of sustainability and sustainable development within the IEEE (see *Publications* below).

3.b. The IEEE & the Global Earth Observation System of Systems (GEOSS)

In 2004, IEEE took on an important role in support of an ambitious 60-nation enterprise to create a worldwide Earth-monitoring network to address issues of sustainable development, including weather, climate, drought, and air and water quality (Reppert, 2005). The network, known as the *Global Earth Observation Systems of Systems* (GEOSS), involved bringing together data gathered by thousands of gages, sensors, buoys, weather stations, and satellites measuring conditions across the land, oceans, and atmosphere.

IEEE's support of GEOSS began in 2004 with the formulation of the Committee on Earth Observation (CEO), composed of members of several IEEE societies. IEEE's support for the project became publicly apparent when IEEE President-elect Michael Lightner joined representatives of more than 30 other international organizations, the European Commission, and nearly 60 world governments at the third Earth Observation Summit in February 2005 (Longshore, 2005). At the summit, the participants worked to adopt a 10-year implementation plan for the comprehensive GEOSS endeavor. It was outlined that one of IEEE's primary roles in the GEOSS venture would be the contribution to the formulation of standards and interoperability measures. Interoperability in GEOSS will be achieved primarily by specifying how GEOSS components exchange data and information at their interfaces (IEEE, 2007).

Since the early stages of the conception of the GEOSS project, the IEEE Committee on Earth Observation (ICEO) has hosted and/or sponsored a number of workshops, all of which have been free and open to the general public. Since 2005, ICEO has hosted GEOSS workshops on regional applications for Asia and

the Pacific Rim, Africa, Europe, and North America. Subject-specific workshops have covered GEOSS and wind energy, public health, systems and interoperability, communications and networking, engineering and information infrastructure, and science modeling and data policy. Sustainability and environmental workshops have covered GEOSS and water security, air quality, coastal ecosystems, health, oceans, environmental disaster, climate change, biodiversity, and agriculture. Clearly the ICEO is committed to providing public education regarding GEOSS and its lengthy list of potential uses. IEEE's commitment to GEOSS is a foremost example of the organization's dedication to sustainable development progress and awareness. (More information on ICEO GEOSS Workshops can be found here:

<http://www.ieee-earth.org/default.taf?menu=conferences&feature=geossworkshops&title=GEOSS%20Workshops>

3.c. AAES Engineers Forum for Sustainability

IEEE co-sponsors and participates in the American Association of Engineering Societies (AAES) Engineers Forum for Sustainability (EFS). Co-sponsored by IEEE, ASCE, ASEE, ASME, and the AIChE Institute for Sustainability, the Engineers Forum on Sustainability is a regularly-meeting group of professionals who seek to represent the interests of engineers in the US in the realm of sustainability. Established in 1997, the forum seeks to “promote the principles and practice of sustainable development by: (1) providing a meeting place for interdisciplinary discussion and exchange of information; (2) identifying and distributing information on engineering education programs that incorporate sustainable development; (3) encouraging practicing engineers to apply sustainable development principles and participate in sustainable development programs and activities at local, regional, and national levels; and (4) keeping abreast of international developments that can contribute to global

sustainability” (AAES, 2008a). The forum meets 3 times a year at the National Academy of Engineering.

The most recent meeting of the Forum included discussion on green buildings in the Energy Act of 2007, an overview of the Global Environmental Outlook Report by a member of the UNEP, a discussion on tools by which to quantify sustainability in terms of chemical and other environmental impacts, and a briefing on the Higher Education Associations Sustainability Consortium (HEASC) (AAES, 2008b). The Forum will hold three more meetings in 2008 (see <http://www.aes.org/communications/events.asp>).

3.d. IEEE-USA

IEEE-USA is actively involved in educating IEEE members and the public-at-large on matters relating to sustainable development. The IEEE-USA 2008 Annual Meeting, held in Indianapolis, was entitled “Green Engineering: A Push Toward Sustainability”. The meeting included sessions on green engineering, IEEE sections going green, environmental innovation, and how to engage the political system on the local level.

IEEE-USA’s *Energy Policy Committee* (EPC) seeks to assist in the resolution of energy problems through the provision of rational, sound, technical and professional counsel based upon the best resources which the IEEE is competent to bring to bear upon these problems in the United States. Although the EPC has not published a position statement on sustainability *per se*, basic concepts of sustainability are embodied in most of the work undertaken by the committee.

Existing position statements include those on plug-hybrid electric vehicles, advanced nuclear power, energy efficiency, photovoltaic technology development, distributed energy resources, and renewable energy technologies (IEEE-USA, 2008).

(IEEE-USA EPC position statements are downloadable here:

<http://www.ieeeusa.org/volunteers/committees/epc/default.asp#positions> .)

3.e. The IEEE Sustainable Development Forum

The IEEE website hosts the IEEE Sustainable Development Forum (<https://www.ieeecommunities.org/sd>), which provides information resources for engineers and community stakeholders concerning sustainable development and other related public imperatives. The forum attempts to provide a virtual location for engineers and professionals from other fields to share ideas, information, and best practices in areas related to sustainable development. The goal is to have discussion based on social, economic, political, and technical issues such as supply chain issues, energy conservation, sustainable technology for developing countries, renewable energy development, and increasing the involvement of the engineering community in public awareness.

Although the conception of the forum is a commendable one, its membership and usefulness must be questioned. Despite having existed since 2005, the Sustainable Development Forum has only 206 members. This is in contrast to the IEEE-USA Forum which has almost 3000 members or the Power & Energy Society Forum which has almost 2000 members. Clearly, actions must be taken to promote the IEEE SD Forum if the benefits of having open communication between IEEE members are to be fully realized.

4. Future Work

There are two primary areas of concern to IEEE and its members which will likely serve as focal points for future sustainability work by the organization. These are Information and Communications Technology, and Signal Processing Technology. The following sections highlight current and future work in each of these areas.

4.a. Information and Communications Technology

Information and Communications Technology (ICT) is an umbrella term that includes all technologies for the manipulation and communication of information. ICT encompasses any medium to record information; technology for broadcasting information; and technology for communicating through voice, sound, or images (wikipedia.org, 2008a). In light of recent elevated discussion on sustainable development, prominent ICT people, companies, and organizations have begun to shift their focus from traditional ICT to ICT built in the sustainability lens. Loosely referred to as “Green ICT”, organizations are formulating future ICT efforts based on development, social justice, controlling emissions, smart growth, and other sustainable development themes. Interest in green ICT has gained popularity due to the notion that ICT technologies have the potential to save energy consumption and reduce CO₂ emissions by a considerable amount. For example, Matsumoto et al. (2005) show that environmentally conscious ICT could reduce energy consumption and CO₂ emissions by 1 to 5 percent in Japan by 2010.

Consider, for example, Cisco Systems, Inc., a multinational corporation of more than 66,000 employees. Cisco has demonstrated its commitment to working towards sustainable development by playing a key role in the Clinton Global Initiative. Through the initiative, Cisco explores strategies to reduce dependency on physical travel by investing in collaboration technologies that

help reduce carbon emissions (Cisco, 2008b). Specifically, Cisco has announced that it will reduce its emissions of carbon dioxide (CO₂) by 10 percent, primarily through a 20 percent company-wide travel reduction. Cisco has also devoted itself to sustainable urban development through its Connected Urban Development (CUD) program. CUD seeks to explore ICT solutions for cities to reduce their levels of CO₂ by working with experts at the Massachusetts Institute of Technology (Cisco, 2008a). Launched at the end of 2006, CUD is a five-year program, with a \$15 million investment in people, research and equipment from Cisco (Cisco, 2008c).

Professional societies have also jumped on the sustainability bandwagon. The Australian Computer Society (ACS), for example, has begun pursuing green ICT as part of its central focus. The organization conducted an emissions audit in 2005 which revealed that ICT usage by Australian Businesses generated 1.5 percent of the nation's total CO₂ emissions. Using this statistic as a leverage point, the ACS has implemented a Green ICT Special Interest Group for its member and other ICT professionals interested in discussing and being part of the solution to the climate change issue (ACS, 2007). Additionally, ACS began to publish on the need to design ICT equipment and technologies that are more resource efficient, and has called on the Australian government to extend its Energy Rating System to cover domestic and commercial ICT equipment to assist ICT professionals and consumers in making more energy efficient choices.

Some organizations have formed with the specific interest of promoting green ICT. The Association for Progressive Communications (APC), for example, focuses on the internet and ICTs for social justices and sustainable development. Holding consultative status to the United Nations, the APC focuses on ICT for civil society in developing countries and places special emphasis on the minimization of emissions, e-waste, the usage of toxic materials, and other areas of environmental impact (APC, 2008). In addition to those highlighted here, there are many other companies and organizations which have begun to pursue green ICT such as Intel, the Wuppertal Institute, Verizon, NTT Communications, Yahoo! and others.

The sustainability of ICT primarily depends on environmental factors throughout the life cycle of products. Products that are in need of particular attention include electric domestic appliances, office machinery and computers, electrical machinery and apparatus, and communications equipment (Griese et al., 2001). Analysis of these technologies needs to be done on multiple levels, including raw material acquisition, manufacturing stages, packaging and transportation and distribution, installation and use, and end of life processes. During analyses it is necessary to determine the overall consumption of materials, energy and other resources; the anticipated emissions to air, water, and soil; the anticipated pollution through physical effects such as noise, vibration, radiation, electromagnetic fields, etc.; the expected generation of waste material; and the possibilities for reuse, recycling, and recovery of materials (Griese et al., 2001). These are all areas where the IEEE can and must become involved.

The IEEE has been involved in pursuing sustainable ICT through its many publications. For example, Koehler and Som (2005) discuss the effects of pervasive computing on sustainable development in the IEEE Technology and Society Magazine. The authors show that pervasive computing may lead to an increase in society's power consumption for digital networks, e-waste streams, and exposure to non-ionizing radiation. Or consider Majdalani (2004) who presents a case study of ICT used in Cap-Net and its affiliated networks to address capacity building initiatives for sustainable management of water resources. Through its publications, IEEE is able to show that it is interested in sustainable ICT, but the publications do not necessarily demonstrate IEEE's *commitment* to the issue. More work is required on the part of IEEE in the realm of sustainable ICT.

4.b. Signal Processing

Signal processing is the analysis, interpretation, and manipulation of signals. This includes signals of sound and images, and biological signals such as ECG, radar signals, and many other types (wikipedia.org, 2008c). Signal

processing is an extremely important component of IEEE's work and there is considerable room for sustainability research within the area. Unfortunately IEEE has not done much in this area. The organization's premier signal processing publication, IEEE Transactions on Signal Processing, has never published an article on sustainability or sustainable development within the field. Similarly, IEEE Transactions on Audio, Speech and Language Processing has never published on sustainability issues. Nor have IEEE Transactions on Image Processing or IEEE Transactions on Information Forensics and Security.

However, relevant articles have been published elsewhere, including Ramanathan et al. (2006) who discuss the possibilities of designing wireless sensor networks in a manner to assist in sustainable development in developing countries and water quality management in Bangladesh and California. Another example article would be Xiwang et al. (2008) who, at the most recent International Conference on Neural Networks and Signal Processing, discussed the environmental, societal and economic impacts of building a television tower antenna in Henan, China. As with the two aforementioned articles, almost all sustainability work in the realm of signal processing is available only through conference proceedings – the work has not yet made its way to established journals, IEEE or elsewhere.

IEEE has considerable opportunity to explore sustainability implications within the realm of signal processing. Soliciting for articles regarding ties between sustainable development and signal processing would be a good start. It is also necessary to expand the signal processing conferences to more explicitly include sustainability topics.

5. IEEE Publications on Sustainability

5.a. Journals

Publication of sustainability issues within IEEE journals, periodicals, and books is an interesting phenomenon. Outside of IEEE, sustainability is primarily discussed in journals oriented towards environmental science, ecosystems, climate change, etc. Since the majority of IEEE work is more technical, topics of sustainability have found their way into the traditional engineering, computer, and power publications. Although IEEE does not have a journal dedicated to sustainability, almost any of its technical publications would be suited to publishing on sustainability-related issues. The following is a list of IEEE publications, or publications sponsored by IEEE which have published on areas important to sustainable development, as well as indication of specific articles of interest.

IEEE Systems Journal

- This journal is created to provide a systems-level focused forum for application-oriented manuscripts that address complex systems and system-of-systems of national and global significance.
- Sustainability-related articles include: Kouloumpis et al. (2008) on assessing sustainability using fuzzy logic.

IEEE Technology and Society Magazine

- Covers the impact of technology (as embodied by the fields of interest in IEEE) on society, the impact of society on the engineering profession, the history of the societal aspects of electrotechnology, and professional, social, and economic responsibility in the practice of engineering and its related technology. A literature review has revealed that the Technology and Society Magazine is the foremost

IEEE publication carrying content of relevance to sustainable development.

- Sustainability-related articles include: Boyle and Coates (2005) on sustainability principles and practice for engineers, Seigneur (2005) on eco-computing, Sotoudeh (2005) on sustainability assessment and definitions, Farrell (1997) on applying sustainability to technological expertise, Koehler and Som (2005) on the effects of pervasive computing on sustainability, Byrne et al. (1991) on energy and environmental sustainability, Herkert et al. (1996) on the role of technological innovation in sustainable development, Beder (1994) on the role of technology in sustainable development, Rose (1997) on energy efficiency and sustainable development, and Sotoudeh (2005) on technological development and sustainability.

IEEE Computer Magazine

- The flagship publication of the IEEE Computer Society, this magazine publishes highly acclaimed peer-reviewed articles written for and by professionals representing the full spectrum of computing technology from hardware to software and from current research to new applications.
- Sustainability-related articles include: Surana et al. (2008) on videoconferencing and telecommunications impacts on sustainability in India.

IEEE Transactions on Energy Conversion

- Provides reviews of analysis, control, planning, and economics of sources of electrical energy, distributed and cogeneration power plants, central station grid connection, and equipment for generation and utilization of electric power, including electric machinery and energy storage systems.

- Sustainability-related articles include: Hammons et al. (1999) on power development in developing countries and impact on global sustainability projects.

IEEE Engineering Management Review

- Reprints articles from other publications of significant interest to members.
- Sustainability-related articles include: Fokkema et al. (2007) on the basics and necessity of sustainability, and Boyle (2007) on educating engineers on sustainability.

IEEE Transactions on Systems, Man & Cybernetics

- Publishes articles on the fields of systems engineering and human machine systems: systems engineering includes efforts that involve issue formulation, issue analysis and modeling, and decision making and issue interpretation at any of the lifecycle phases associated with the definition, development, and implementation of large systems.
- Sustainability-related articles include: Haimes (1992) on natural resource management and sustainable development, and Rao (2001) on remote sensing of land water resources for sustainable development.

IEEE Transactions on Automatic Control

- Covers the theory, design and application of control systems, encompassing components, and the integration of these components, as are necessary for the construction of such systems.
- Sustainability-related articles include: Kouvaritakis et al. (2006) on quantitative approaches to sustainable development policy assessment.

IEEE Transactions on Components and Packaging Technologies

- Publishes research and applications articles on the modeling, building blocks, technical infrastructure, and analysis underpinning electronic, photonic, MEMS and sensor packaging.
- Sustainability-related articles include: Bar-Cohen and Iyengar (2003) on technological breakthroughs in heat sinks for sustainable development.

IEEE Intelligent Systems Magazine

- Bimonthly publication of the IEEE Computer Society, provides peer-reviewed, cutting-edge articles on the theory and applications of systems that perceive, reason, learn, and act intelligently.
- Sustainability-related articles include: Wang and Tang (2004) on management and control strategies for transportation systems through the lens of sustainable development.

IEEE Power and Energy Magazine

- Dedicated to disseminating information on all matters of interest to electric power engineers and other professionals involved in the electric power industry. Feature articles focus on advanced concepts, technologies, and practices associated with all aspects of electric power from a technical perspective in synergy with nontechnical areas such as business, environmental, and social concerns.
- Sustainability-related articles include: Rahman (2007) on renewable energy's role in achieving sustainable development, and Gurney (2005) on the hydrogen economy.

IEEE Journal of Selected Topic in Applied Earth Observations and Remote Sensing (J-STARS)

- New journal whose first volume will appear in 2008. Dedicated to publishing current issues and techniques in applied remote and in situ sensing, their integration, and applied modeling and information creation for understanding the Earth. Topics can include observations, derived information such as forecast data, simulated information, data assimilation and Earth information techniques to address science and engineering issues of the Earth system.

Earthzine (<http://www.earthzine.org/>)

- Sponsored by the IEEE, Earthzine is an online publication for the international Earth-observing community that fosters Earth observation and global awareness. Earthzine serves as an arm for vitally-needed public outreach by providing information on the science and technology underlying Earth observations and the need and utility for Earth information. Earthzine is a contribution of the IEEE Committee on Earth Observation to the Group on Earth Observation in support of GEOSS. Earthzine publishes on agriculture, biodiversity, climate, disasters, earth observation, economy, ecosystems, energy, health, politics, technology, water, and weather.

IEEE Pervasive Computing

- Sometimes sustainability appears in less-expected sources. For example, the IEEE Computer Society's journal *IEEE Pervasive Computing*, will be publishing a full special issue on environmental sustainability in December 2008. The journal's editors have realized that environmental sustainability is rapidly emerging as an important and timely topic for pervasive computing research. The call for papers is currently active, decisions will be made in August through October 2008 (Mankoff, 2008).

IEEE-USA Today's Engineer

- A monthly Web publication devoted to the issues affecting U.S. IEEE members' careers, such as professionalism, management skills, engineering performance, engineering skills and competencies, product development practices, project management issues, innovation and entrepreneurship, business practices.
- Sustainability-related articles include: Buck (2008) on green businesses, Meyer (2007) on plug-in hybrid electric vehicles, Zobrist

(2008) on solar energy, Williams (2008) on energy policy, and Chowdhury (2006) on alternative energy.

IEEE Spectrum

- Explores the development, applications and implications of new technologies. It anticipates trends in engineering, science, and technology, and provides a forum for understanding, discussion and leadership in these areas.
- Sustainability-related articles include: Sweet (2008) on greenhouse gases, Sweet (2006) on climate change, Cherry (2007) on green cities, Voelcker (2008) on environmentally-friendly automobiles, Guizzo (2008) on wind power, and Blau (2007) on carbon caps.

5.b. Wiley-IEEE Books and other IEEE Publications

The following is a list of IEEE books which focus on issues of sustainable development and renewable energy.

Social, Ethical, and Policy Implications of Engineering: Selected Readings

By Joseph R. Herkert

<http://www.wiley.com/WileyCDA/WileyTitle/productCd-0780347129,miniSiteCd-IEEE2.html>

Renewable and Efficient Electric Power Systems

By Gilbert M. Masters

<http://www.wiley.com/WileyCDA/WileyTitle/productCd-0471280607,miniSiteCd-IEEE2.html>

Integration of Alternative Sources of Energy

By Felix A. Farret and M. Godoy Simoes

<http://www.wiley.com/WileyCDA/WileyTitle/productCd-0471712329,miniSiteCd-IEEE2.html>

Elements of Tidal-Electric Engineering

By Robert H. Clark

<http://www.wiley.com/WileyCDA/WileyTitle/productCd-047010709X,miniSiteCd-IEEE2.html>

IEEE Bronze Book: IEEE Recommended Practices for Energy Management in Industrial and Commercial Facilities

By IEEE

<http://grouper.ieee.org/groups/739/index.htm>

- Discusses energy conservation and cost-effective planning in areas of engineering design, applications, utilization and the operation and maintenance of electric power systems.

5.c. IEEE Conferences on Sustainability

5.c.i. International Symposium on Electronics and the Environment

Since 1993, IEEE has sponsored the International Symposium on Electronics and the Environment (ISEE). Today ISEE has become the premier event addressing the sustainability of electronics products, Information and Communication Technology (ICT) services, and ICT in complex engineered systems (ISEE, 2008a). The latest meeting, held in San Francisco in May 2008, included a wide range of sessions covering subjects such as, but not limited to (for detailed conference program see ISEE, 2008b):

- Industrial Ecology;
- Life cycle assessment;
- Environmentally conscious manufacturing;
- Sustainable power generation;
- Solar and wind power;
- End-of-life analysis;
- Life time energy consumption;
- E-waste;
- International trade in second-hand electronic products;
- Energy use in the semiconductor industry;
- Corn ethanol;
- Remanufacturing processes for IT-equipment;

- Plastics recycling and reduction;
- Environmental applications of RFID;
- Energy and emissions impacts of telecommunications; and,
- Alternative power for mobile phones.

For more information, see the section on conference proceedings below, which has a list of the most prominent sustainability-themed articles published in the proceedings of the ISEE.

ISEE serves as a prime example of actions being taken by IEEE in the realm of sustainable development. Despite the success of ISEE, the E&E Committee calls for IEEE activities in the realm of sustainable development to be significantly expanded. The E&E Committee argues that there are significant limitations in the existing intellectual framework within which environmental issues are defined, and the IEEE can play a role in redesigning the framework to encourage sustainable development.

5.c.ii. Conferences & Symposia

IEEE and its societies host, sponsor, and co-sponsor hundreds of conferences per year, many of which have been or would be an appropriate venue for sessions regarding sustainable development. Below is a sampling of the most prominent IEEE conferences which focus on environment, energy and alternative energy, and society-technology relationships.

IEEE International Symposium on Electronics and the Environment

<http://www.regconnect.com/content/isee/>

- Sponsored by IEEE & the IEEE Computer Society

IEEE International Requirements Engineering Conference: Requirements Engineering for a Sustainable World

<http://sites.upc.edu/~www-gessi/re08/>

- Sponsored by the IEEE Computer Society and numerous corporate sponsors.

IEEE Committee on Earth Observation and GEO GEOSS Workshops

<http://www.ieee-earth.org/default.taf?menu=conferences&feature=geossworkshops&title=GEOSS%20Workshops>

- Sponsored by IEEE, ICEO & GEO.

Oceans '08

<http://www.oceans08mtsieekobe-technoocean08.org/>

- Co-sponsored by IEEE.

Middle-East Power Systems Conference

<http://www.svu.edu.eg/mepcon08/>

- Co-Sponsored by IEEE-PES.

IEEE Rural Electric Power Conference

<http://www.ieeerepc.org/>

- Sponsored by IEEE.

IEEE Power India Conference

<http://ewh.ieee.org/r10/delhi/powercon.htm>

- Co-sponsored by IEEE and IEEE-PES.

IEEE International Conference on Sustainable Energy Technologies

<http://www.icset2008.org/>

- Co-sponsored by IEEE.

IEEE Energy 2030

<http://ewh.ieee.org/conf/energy2030/>

- Sponsored by IEEE, IEEE-USA, IAS, PES, and PELS.

International Conference on Clean Electrical Power

<http://www.iccep.net/>

- Co-sponsored by IEEE-IES.

International Conference on the European Electricity Market

<http://www.eem08.org/>

- Co-sponsored by IEEE and IEEE-PES.

Annual North American Power Symposium

<http://www.naps2008.net/>

- Co-sponsored by IEEE-PES.

Electrical Power & Energy Conference

<http://www.ieee.ca/epc08/>

- Sponsored by IEEE Canada.

Asia-Pacific Power and Energy Engineering Conference

<http://www.srpublishing.org/appeec2009Submission/website/appeec/index.aspx>

- Co-sponsored by IEEE and IEEE-PES.

IEEE Power & Energy Society (PES) Annual Meeting

<http://ewh.ieee.org/cmte/PESGM08/>

- Sponsored by IEEE-PES.

IEEE Photovoltaic Specialists Conference

<http://www.33pvsc.org/public/>

- Co-sponsored by IEEE and IEEE-EDS.

IEEE Energy Conversion Congress and Exposition

<http://www.ecce2009.org/>

- Sponsored by IEEE, IEEE-PELS, and IEEE-IAS.

IEEE International Symposium on Technology and Society

http://www.istas08.ca/index.php/Main_Page

- Sponsored by IEEE SSIT.

5.c.iii. IEEE Conference Proceedings on Sustainability

The most prominent sustainability-themed conference proceedings amongst IEEE publications are the Proceedings of the IEEE International Symposium on Electronics and the Environment (ISEE). The ISEE proceedings have been published annually since 1993 and provide the most thorough database of sustainable development within areas of IEEE interest. Example articles of interest include:

- **Finn et al. (2008)** on efficiency of wind generated electricity using demand side management.
- **Kahhat et al. (2008)** on the creation of an e-market reuse and recycling market for e-waste.
- **Matsuno et al. (2007)** on the evaluation of environmental impact of information communications technology (ICT) and the development of eco-efficiency guidelines.
- **Masanet & Horvath (2006)** on strategies for reducing the life-cycle energy use and greenhouse gas emissions of personal computers.
- **Fisher et al. (2005)** on energy recovery methodologies in the sustainable recycling of plastics from end-of-life electrical and electronics products.
- **Boks et al. (2000)** on economic and environmental considerations in cellular phone design.
- **Kincaid et al. (1996)** on design for the environment (DFE) and the evaluation of clean technologies in the PWB industry.
- **Chen et al. (1993)** on the development of a computer-based analysis tool that can be used to analyze changes in product design and recyclability.

Additional conference proceedings exist outside of the proceedings of the ISEE. The following is a brief list of conference proceedings regarding issues of sustainable development from miscellaneous conferences:

- **Afgan et al. (2006)** on managing system property in a sustainability context.
- **Swarr et al. (2004)** on evaluating supply line sustainability and business environmental risk.
- **Dunn et al. (1995)** on agricultural sustainability and fuzzy logic.
- **Kemppainen et al. (2007)** on sustainability in first-year engineering programs.
- **Gao and Zhou (2004)** on sustainability targets for businesses and products.
- **Yang and Song (2006)** on product design and product lifecycle sustainability.

5.d. IEEE Standards

Countless IEEE standards pertain to sustainability-related issues, such as efficiency and conservation, and renewable energy interconnection, among many others. There are two standards, however, which have a particularly important impact on sustainable development. They are as follows:

IEEE 1127-1998

IEEE Guide for the design, construction, and operation of electric power substations for community acceptance and environmental compatibility

<http://ieeexplore.ieee.org/servlet/opac?punumber=5693>

- A particularly important standard through the lens of sustainable development due to the fact that it considers both communal (i.e. societal) impact as well as

environmental impact of planning and designing electric power substations. Including societal impact as component of IEEE standards is not a common occurrence – although if sustainable development is to occur, societal impacts will eventually need to be included in all standards.

IEEE 1680-2006

IEEE Standard for Environmental Assessment of Personal Computer Products

<http://ieeexplore.ieee.org/servlet/opac?punumber=10876>

- Allows computer purchasers within businesses and other organizations reduce the environmental impact of the computers they buy, use, and discard. The first US standard to supply environmental guidelines for institutional purchasing decisions involving desktop and laptop computers and monitors (McCabe, 2006).

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APPENDIX II

SUMMARY OF WORKSHOP FINDINGS VISUAL PRESENTATION

Crafting a Role for IEEE in Sustainable Development

Workshop Summary

September 7, 2008 Newark Airport, NJ



Participants

- ◊ Ali Akansu
- ◊ Brad Allenby*
- ◊ Clint Andrews*
- ◊ Sarah Banas
- ◊ Gailanne Barth
- ◊ Chris Fallon
- ◊ Bichlien Hoang
- ◊ Russ LeFevre
- ◊ Richard Linke
- ◊ Scott Matthews*
- ◊ Molly McCluskey
- ◊ Adrienne McGarr
- ◊ Veronika Rabl
- ◊ Amarnath Raja
- ◊ Thomas Schneider
- ◊ Fran Tardo
- ◊ Lew Terman
- ◊ Barbara Terman
- ◊ Cherry Tom
- ◊ John Vig
- ◊ Mary Ward - Callan
- ◊ Thomas Wiener
- ◊ Arup Dasgupta
- ◊ Gerard Dijkema
- ◊ Mike Gorman
- ◊ Donna Hudson
- ◊ Maike Luiken
- ◊ Jay Pearlman
- ◊ Bill Ratcliff
- ◊ Janet Rochester
- ◊ Peter Wiesner

* Organizers



Workshop Charge

**Given other external sustainability initiatives and IEEE's capabilities, is there a useful role for the IEEE in this domain?
Is there a unique role?**

If there is such a role, suggest how might it be best addressed, operationally and financially?

[IEEE mission: "...for the benefit of humanity and the profession ..."]



Workshop Agenda

8:30 am Introductions

9:00 am Presentation of workshop rationale and charge. Discussion to clarify charge

9:30 am Presentation of what various organizations are doing in sustainability. Discussion: what might be IEEE's niche?

10:45 am Break

11:00 am Presentation of what IEEE is already doing. Discussion: what existing IEEE activities are missing from this list? What IEEE functions could be engaged (confs, pubs, membership, etc)?

12:00 noon Lunch

1:00 pm Presentation of some possible paths forward for IEEE. Discussion: what are some additional possible paths forward? How might we bring them together, and what are their pros and cons?

2:45 pm Break

3:00 pm Discussion: what do we recommend IEEE do next?

4:00 pm Summary wrap -up

4:30 pm Adjourn



General Observations (1/2)

The sustainability discourse, and the IEEE 's history in sustainability -related activities, tend to focus on environmental and, to a lesser extent, economic domains.

It is a difficult discourse in part because it requires significant integration across disciplines and worldviews.



General Observations (2/2)

With some exceptions, most sustainability institutions tend not to be technologically sophisticated.

Opportunity: IEEE has a long history of relevant activities, and strong technological competence.



The IEEE Sustainability Storyline

Sustainability is a “system” property

IEEE technologies improve the system by reducing undesirable impacts and expanding carrying capacity

Sustainable development is about gracefully managing transitions, relating people and their technologies to evolving systemic contexts

Deeper understanding of technological opportunities and technology development processes is a precondition for sustainable development

IEEE and its members can help with this



What are other organizations doing in sustainability?

- AIA (architects)** - national targets, design standards & guidelines, continuing education
- AIChE** - created technical society w/ members, conferences, short courses
- ASCE - PERSI** - focus on infrastructure, inter -society cooperation
- ASME** - inserting sustainability into existing activities
- AWMA (waste mgmt)** - created committee, looking for inter - society partnerships
- TMS (minerals)** - sustainability one of two foci, waste electronics interest, seeking partners
- AAAS** - created center, sustainability science a frequent conference & pub theme



What is IEEE already doing in sustainability?

A lot, for a long time, but scattered

Regions/sections/chapters: many local events

**Society conferences & pubs: GRSS, CS TC
SST, SSIT, PES, others**

IEEE-USA conferences & position papers

Standards: few in place, more coming

Corporate: online forum, discourses

External partnerships: GEOSS, AAES



What are some paths forward for IEEE in sustainability?

Bottom-up: continue to let 1000 flowers bloom

Top-down: President's Sustainability Initiative

Technical: TAB Sustainability Council or Committee
(conference, publication)

Coordination: Multi-OU Sustainability Committee
(strategic planning docs)

Communication: Corporate (web portal, *Spectrum* features), IEEE-USA (position papers, workshops)



Workshop Conclusions

Is there a useful role for the IEEE in this domain? YES

Is there a unique role? YES

How might it be best addressed, operationally and financially? MULTI - FACETED STRATEGY (see next slides)



Elements of an IEEE Sustainable Development Strategy (1/4)

Specify desired outcomes:

- Outside world believes IEEE is engaged in sustainable development
- Sustainability discussions become more technologically sophisticated
- "we want to foster progress toward a sustainable global society"

Play to IEEE strengths:

- Technical publishing, IP capture and archiving
- Technical conferences and meetings, community creation
- Informing public policymakers
- Professional education and training
- Facilitating & convening to build consensus, standards



Elements of an IEEE Sustainable Development Strategy (2/4)

Prioritize our efforts:

- Focus on subtopics (such as global warming, green engineering), not “everything”
- Listen to members and industry, engage their interests, survey them
- Coordinate and build on existing IEEE activities, don't cannibalize them
- Selectively pursue external partnerships

Support the many local initiatives in sections & chapters:

- Provide distinguished lecturers, accessible multimedia & print journalism, materials for staging debates
- Make local efforts more visible with uploading opportunities (YouTube -style), event summaries



Elements of an IEEE Sustainable Development Strategy (3/4)

Enhance the technical foundation:

- keep producing good conferences and publications**
- create a TC or council in TAB to encourage cross-cutting work**

Make technical foundation more accessible:

- develop lay/popular/market -oriented keyword search capability**
- invest substantially more in journalistic efforts to create scalable content, links from deep tech jargon to sustainability talk**



Elements of an IEEE Sustainable Development Strategy (4/4)

Build new model for corporate communication:

- Add an external focus to current internally focused efforts
- Coordinate better from *Xplore* to *Spectrum* , with regular harvesting of technical highlights, boiling down to nuggets of interesting content, horizon scanning; needs \$\$\$
- Strengthen links to EAB to target young audiences

Send signals from the top:

- "President's sustainability initiative " would be a good follow-up to current Humanitarian Technology Challenge
- Board-level ad hoc committee could coordinate across OUs



Next Steps

Offer a vision, recruit the right people, ask them to prioritize, then start doing things, while establishing a constructive relationship to existing activities.

Revise and circulate white paper

Organize an externally -oriented “monster” conference

Schedule a special issue of the *Proceedings*

Form ad hoc committee on creating a TC or council, starting with workshop participants

Launch presidential sustainability initiative



Backup



**Bottom-up: continue to let 1000
flowers bloom**

Status quo scenario

Strengths: adaptive, self -regulating

Weaknesses: invisible, sub -critical

**Opportunities: minor coordination can
leverage much activity**

**Threats: IEEE looks out of touch,
misses young recruits**



Top-down: President 's Sustainability Initiative

Visionary leadership

Strengths: involves all of IEEE

Weaknesses: ad hoc, not institutionalized

Opportunities: use bully pulpit to seed institutionalization

Threats: will IEEE follow?



TAB Sustainability Council or Committee

Technical view of sustainability

**Strengths: generates revenue, fits into
standard product lines (confs , pubs, stds)**

Weaknesses: invisible to non -experts

**Opportunities: cross -cutting topic, new
pub/conf potential**

Threats: turf battles, ideology vs analysis



Multi-OU Sustainability Committee

Coordination, strategic thinking

Strengths: IEEE -wide

Weaknesses: no -one owns it, no precedents?

Opportunities: link educational, communications & technical activities

Threats: infighting, apathy



Corporate (web portal, Spectrum features), IEEE -USA (position papers, workshops)

Communication focus (public, policy)

Strengths: makes IEEE efforts visible to outside world

Weaknesses: who decides what we say?

Opportunities: attract new, younger members worldwide, policy impact

Threats: capture by a few voices, potential disconnect from technical underpinnings

