

## TECHNOLOGY FOR SUSTAINABILITY SUBCOMMITTEE

### Face-to-Face Meeting Summary U.S. Environmental Protection Agency Andrew W. Breidenbach Environmental Research Center Cincinnati, Ohio April 25-26, 2007

**WEDNESDAY, APRIL 25, 2007**

#### **Welcome and Designated Federal Officer (DFO) Remarks**

*Ms. Clois Slocum, Office of Research and Development (ORD), U.S. Environmental Protection Agency (EPA), Subcommittee DFO*

Ms. Slocum reviewed the Federal Advisory Committee Act (FACA) procedures that are required for all BOSC Subcommittee meetings. As the DFO for the BOSC Technology for Sustainability Subcommittee, Ms. Slocum serves as the liaison between the Subcommittee, the public, and EPA and ensures that all FACA requirements are met. She explained that the BOSC is a Federal Advisory Committee that provides independent, scientific peer review for EPA's ORD.

Ms. Slocum stated that all meetings and conference calls involving substantive issues, whether in person, by phone, or by e-mail, that include one-half or more of the Subcommittee members must be open to the public and a notice must be placed in the *Federal Register* at least 15 calendar days prior to the call or meeting. The information for this meeting was published on April 4, 2007, and entered into the federal docket management system (<http://www.regulations.gov>; Docket ID EPA-HQ-ORD-2006-1010). The Subcommittee Chair and DFO must be present at all conference calls and meetings.

Ms. Slocum is the point of contact for any requests made by the Subcommittee members. The contractor is responsible for all logistical aspects of the meeting. If contractor support is needed by any of the Subcommittee members, the requests should be submitted via Ms. Slocum.

The Technology for Sustainability Subcommittee has a specific charge as laid out by the BOSC Executive Committee. The Executive Committee will evaluate the Subcommittee's report and submit it to the Assistant Administrator for Research and Development. The role of the Subcommittee is to provide independent, peer review of EPA's Science and Technology for Sustainability (STS) Program.

Today is the first face-to-face meeting of the Subcommittee. The third conference call is scheduled for May 30, 2007. The Subcommittee Chair will preside over the meeting, with EPA staff providing information orally for the Subcommittee members at the request of the Chair. EPA presenters will interact only with Subcommittee members after they have been recognized by the Chair. The minutes are being taken by the contractor and will be publicly available on the BOSC Web Site (<http://www.epa.gov/osp/bosc>) following certification by the Subcommittee Chair. The posters will be available for viewing before and after the poster presentations.

There will be time for public comment at 9:30 a.m. on Thursday, April 26, 2007. Public comments are limited to 3 minutes each. There were no requests from the public to make comments prior to the meeting.

### **Welcome and Outline of Purpose**

*Dr. John Giesy, University of Saskatchewan, Subcommittee Chair*

Dr. John Giesy, Chair of the Technology for Sustainability Subcommittee, welcomed the Subcommittee members to the meeting and thanked them for the time and effort that they already had put in and for the work they would be completing at this face-to-face meeting. He asked the Subcommittee members to introduce themselves and provide some background about their sustainability activities. He explained that Peter Blaize Corcoran, the consultant to the Subcommittee, could not be present at the face-to-face meeting and Dr. Concepción Jiménez-González would be joining the meeting shortly. Following the introductions, Dr. Giesy explained the logistics of the face-to-face meeting and covered some housekeeping issues.

He reviewed the meeting agenda, including some last-minute changes, and explained that the Subcommittee members would give an oral overview of their preliminary results to EPA staff before the meeting adjourned. The goal is to complete as much of the draft report as possible before departing.

### ***Discussion***

Dr. Wayne Landis asked about the audience for the draft report. Dr. Giesy responded that EPA staff and leadership are the audience, as the draft report will provide advice to EPA about its STS Program.

### **Research Program Overview: The Evolution From P2 to Sustainability**

*Mr. Gordon Evans, ORD, EPA*

Mr. Gordon Evans explained that EPA now is incorporating a systems-wide approach to its way of doing business, and this Program is at the core of that effort. He presented a timeline of Pollution Prevention (P2) Program research through to sustainability efforts, explaining that two sustainability-focused efforts were launched in 2004. The revised strategy of the P2 Program, now called P2NT for “Pollution Prevention and New Technologies,” was introduced and included the goals of developing tools, methods, and technologies to promote P2. Another goal of the P2NT Program was to investigate systems-based environmental management schemes. The P2NT Program will formally conclude in September 2007.

Mr. Evans explained that the details of the specific programs would be described in later presentations but gave an overview of some of the successes of the Program, including decision tools and methods (e.g., Waste Reducing Algorithm, PARIS II Solvent Design Software, and the Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts [TRACI]); grant programs (e.g., Technology for a Sustainable Environment and the Collaborative Science and Technology Network for Sustainability [CNS]); in-house research programs (e.g., Green Chemistry, Sustainable Environmental Systems Group, and life cycle assessment methodology work); the Environmental Technology Verification (ETV) Program, and the Small Business Innovation Research (SBIR) Program.

EPA received input from the 1987 World Commission on Environment and Development, which views sustainability in an intergenerational manner; the 1992 Rio Earth Summit, including the interconnectedness of the “Three Pillars of Sustainability”; and the National Academy of Engineering, which declares that the role of technology is central to sustainability. In 2003, the then-Science Advisor of ORD, Dr. William Farland, asked EPA leadership to develop a broad, crosscutting strategy for sustainability research that would tie together all EPA Multi-Year Plans (MYPs). The strategic plan is consistent with EPA’s overall goals and strategies, and establishes a key link between stewardship and sustainability.

In establishing the strategic direction, a distinction between environmental protection and environmental sustainability was made so that the perspective could be expanded beyond a “stovepipe” approach (i.e., a water approach, a land approach, or an air approach). Because EPA by law is focused on human health and the environment, there was a conscious decision to focus on the third pillar of sustainability, the environment. The six themes chosen for environmental sustainability resulted from exhaustive research of ideas in use by academia, industry, foreign countries, and so forth.

The development of the research plan was guided by: (1) relevance to the Agency’s mission and the needs of client offices, (2) resource availability, (3) potential for having a high impact, (4) ORD research capabilities, and (5) systems-based research. The Long-Term Goals (LTGs) are distinct but integrated, because metrics (LTG 1) feed into tools (LTG 2), which in turn lead to technologies (LTG 3). The LTGs guide EPA through issues with environmental stewardship and sustainable environmental practices. The LTGs address a large number of themes set forth in the strategy, although not everything is or can be covered.

EPA’s *Science Advisory Board Report on the Sustainability Strategy and Plan* suggested that the Program undertake a “higher risk–higher payoff” project. Is this the right thing to do or will it divert attention from the current goals?

The P2NT Program has met 100 percent of its Annual Performance Measures (APMs) as established under the Government Performance and Results Act. From 1996 to 2006, the Program’s intra- and extramural researchers published 659 papers, of which 28.4 percent were identified as highly cited (top 10%) papers. One-third of the papers were published in high-impact journals.

***Discussion***

Dr. Landis commented that it is difficult to transition to a systems manner of thinking and asked how this Program is accomplishing that. Mr. Evans responded that the P2NT Program contained a specific LTG to begin to address this type of thinking. There has been a conscious effort to bring together a wide range of experts, as the real success is driven by the people who get involved. Specific leadership was chosen to bring everyone together to “think outside the box” and learn each others’ “languages.”

Dr. Landis asked how this effort differed substantially from the U.S. Forest Service (USFS) or U.S. Geological Survey (USGS) programs. He did not note that there was any discussion with other federal land management agencies in any of the background materials. Mr. Evans replied that EPA is moving into this area, and the next presentation would address collaborations with the National Park Service (NPS) and the Bureau of Land Management.

Dr. Earl Beaver asked if EPA’s view of and/or approach to sustainability was that it was a path or a destination. Mr. Evans responded that EPA is trying to achieve decision-making on a number of levels that lead to sustainability, ultimately thinking of outcomes and affecting public change. Dr. Beaver then asked if there was a shift in programmatic focus from “sustainable development” to “sustainability.” Mr. Evans replied that the nomenclature change was a result of a literature shift.

Dr. Beaver commented that there is a movement toward not using the term “social” and using the term “societal” instead. Mr. Evans responded that in developing the strategy, there was a conscious effort to move away from that issue, because there are some things that the Agency cannot address. The biofuels question also is bringing this problem to light.

**LTG 1 Overview: Metrics**

*Dr. Herb Cabezas, ORD, EPA*

Dr. Herb Cabezas explained the “System Path” concept, which includes dimensions (economic, technological, ecological, and legal/social) over time into which a system trajectory must fit. The goal of

sustainability is to ensure that this system trajectory has boundaries that allow humans to survive long-term on this planet. The development of metrics helps to determine the overall health of the system trajectory. To establish the foundation for a metrics research program, a multidisciplinary research team is necessary. The core of the team is the Sustainable Environments Branch, which includes environmental economists, hydrologists, chemical engineers, an environmental lawyer, ecologists, and a systems analyst (public policy).

The first project that the Branch undertook was the Shepherd Creek (Cincinnati, Ohio) Project, in which a systems-based approach was used to manage stormwater runoff in urban areas (local spatial scale). The collaborative effort with local stormwater management agencies included persuading local property owners to implement best management practices for stormwater management, including rain barrels and water gardens. The project has met all of its APMs to date. This project is coming to a close, but a San Luis Basin (Colorado) Project is starting that will utilize sustainable systems metrics development and application to environmentally manage an area at the spatial scale of a region. A future integrated, sustainable environmental management project at the scale of an island is being planned for Puerto Rico, which has a \$75 billion/year industrial economy that produces 25 percent of the world's pharmaceuticals.

The three classes of metrics are: informational, process, and system. Informational metrics are designed to inform the public, with sustainable outcomes currently being defined by EPA senior management. Process metrics are suitable for assessing the sustainability of industrial processes and technologies and have an interest in energy, efficiency, environment, and economics. System metrics must cover as many elements of the System Path as possible. The Branch attempted to develop metrics that captured the elements of the System Path, were broad, covered the system as a whole, and were practical (i.e., cost-efficient). One method to accomplish this was the Trans-Atlantic Research and Development Interchange on Sustainability (TARDIS), a collaboration between ORD (EPA's National Risk Management Research Laboratory [NRMRL]) and the Austrian Federal Ministries. TARDIS workshops include representatives from each major sustainability research group and provide an opportunity for communication and networking while attendees discuss themes such as modeling and sustainability, sustainability principles, and energy.

The metrics for the San Luis Basin Project were derived from a TARDIS workshop and include sums of macro-level items about which many decisions are possible by stakeholders, governments, and so forth. One debate about the project involved the decision to limit boundaries to watershed boundaries or include political boundaries as well. NRMRL and the National Health and Environmental Effects Research Laboratory (NHEERL) are participating in the project, and clients of the project include EPA Region 8, the NPS, and the USFS.

### *Discussion*

Dr. Martin Abraham commented that it is possible to build incredible complexities into analyses and asked what precisely was being measured. For example, was rain barrel production considered when rain barrels were placed in people's yards? Dr. Cabezas answered that rain barrel production was not considered in the life cycle analysis (LCA). The fact that rain barrels cost significantly less than building a treatment plant was considered, and the efficiency of rain barrels was analyzed so that a treatment plant did not have to be built. This was a first effort at integrated environmental management.

Dr. Ted Tomasi commented on the need to choose where to focus, because many problems can be considered global in scale. The question of boundaries must be logically addressed to determine if important considerations have been left out and at what cost. Dr. Abraham added that how to determine where boundaries are drawn perhaps gives a better framework for how to answer questions.

Dr. Beaver asked if the System Path concept was considered national, international, or regional. Dr. Cabezas responded that the natural boundary is the planet, which obviously is huge. It is necessary to draw tighter boundaries while still considering the system as a whole.

Dr. Beaver asked if the ecological footprints used as metrics for the San Luis Project were standard footprints used by other agencies or if EPA used its own. Dr. Cabezas replied that standard footprints are used, and the change of the footprints over time is what is being measured.

Dr. Jiménez-González joined the meeting, introduced herself, and asked how the Program accounted for different interactions between the metrics (e.g., synergies). Dr. Cabezas responded that it was not completely orthogonal or independent because they all measure the same endpoint. The metrics used are sufficiently different, because if metrics appear highly correlated, a duplicate is present, and one metric is eliminated.

Dr. Landis asked if there was a citation for the System Path diagram, because his group has been using one that is nearly identical since 2000. Dr. Cabezas responded that it had been published in several papers.

Dr. Landis asked if the metrics were predictive. Dr. Cabezas answered that the metrics are computed by the data gathered. Dr. Landis commented that this is only part of it; metrics must be predictive and data can be used to back up the predictions. Dr. Cabezas replied that these metrics provide a short-term projection into the future. A few years into the future, an analysis will determine their predictive value. The current interest is in viewing footprint changes over time because changes can indicate a problem down the line. Fairly strong statements based on science can be made that are connected to such data.

### **LTG 1 Poster Session**

#### ***Regional Sustainable Environmental Management: San Luis Basin Project Poster***

Dr. Cabezas explained the data contained in the poster entitled, “Regional Sustainable Environmental Management: San Luis Basin Project.”

Dr. Beaver commented that the audience for the project is affected people in the San Luis Basin, but Fisher information may be too complicated for this audience to understand. He asked how Fisher information is explained to the clientele. Dr. Cabezas explained that the term “Fisher information” is not used, and the explanation given to the audience is that a measure of overall system health is used to determine if the system is functioning well. The team is aware that this is a communication challenge and recognizes that each discipline, including communications, is necessary. Dr. Beaver commented that renaming the term “Fisher information” and choosing a term that conveys the message to the listener may be a possible solution. Dr. Jiménez-González commented that audience message mapping may be necessary. Different audiences (e.g., stakeholders, government, public, etc.) may need different key messages so that the message does not get lost but is transferred effectively to the target audience.

Dr. Tomasi commented that different decision-makers at different levels respond to different incentives. Conveying different metrics will help communicate complex information and meaningful metrics. He suggested explaining how the metrics benefit the stakeholders in addition to explaining how they work. The question is how different metrics are used to avoid redundancy and how different metrics respond to being uncorrelated. Do uncorrelated metrics necessitate a “meta-metric”? Dr. Cabezas commented that metrics associated with different aspects of a system do not associate with others. Some metrics respond strongly to certain changes and not to others. A human medicine metaphor that explains this is that temperature (a metric) is associated with infection, whereas blood pressure (another metric) is correlated with hypertension. Fisher information responds to the two changes but does not explain why. Dr. Tomasi continued the medical analogy, stating that the choices are similar to living with long-term disease with low side effects or deciding to have surgery that may or may not work.

Dr. Landis commented that there is a huge amount of uncertainty associated with metrics and yet uncertainty has not been discussed at all. These metrics are much more complex than blood pressure and

temperature in a medical analogy. Potential outcomes can be used to communicate successfully to audiences.

Dr. Giesy asked if the group has a metric or a group of metrics to determine if the project is a success. Dr. Cabezas replied that the goal is to determine that the metrics have worked, and the group has devised a method for testing this but has not implemented it yet.

### **LTG 2 Overview: Decision Support Tools**

*Dr. Michael Gonzalez, ORD, EPA*

Dr. Michael Gonzalez explained that ORD has a rich history of creating decision-making tools that promote sound environmental choices for P2 and sustainability. The goal is to ensure that decision-making tools are directing the Agency down a sustainable path. LCA methods can provide a cradle-to-grave or gate-to-gate approach, and this Program has had several key publications in this area that moved LCA usage into the public eye. Other LCA outputs include a 1993 guidance manual for completing LCA, an Agency-sponsored Web portal for LCA information (LCAccess), and the *Nanotechnology and Life Cycle Assessment Report*. This Program is intertwined with EPA sister offices, including the Office of Pollution Prevention and Toxics and the Office of Solid Waste and Emergency Response.

Environmental impact assessment modeling must determine where the impact lies within the life cycle and if one or many chemicals are involved. NRMRL's work on impact models began in 1997 and resulted in TRACI. This research resulted in a publication that ranked in the "top 1 percent" of all papers cited in the field of environment/ecology. TRACI has a variety of clients and customers, including the U.S. Marine Corps.

Sustainability necessitates a broader expansion of problem definition that involves system-wide issues, multiple stakeholders, intergenerational time horizons, and multimedia considerations. EPA always has had sustainability in its sights, but it is in the forefront now that the transition from P2 to STS is underway. Ensuring that LCA is viable is the first and foremost step in this direction. Another future direction is examining the integration of LCA methods and technologies. A tool called GREENSCOPE (Gauging Reaction Effectiveness for the Environmental Sustainability of Chemistries with a multi-Objective Process Evaluator) has been developed that allows researchers to compare one process to another and examines the four "Es": efficiency basis, economic basis, environmental basis, and energy basis. LCA methods must be easy to apply and interpret. The goal is to expand the toolbox offered to decision-makers so they can make informed decisions with respect to sustainability.

The CNS, established in 2004, is an extramural research program focused on preventive, forward-looking, integrated environmental protection. CNS has funded a variety of projects in most EPA regions. The three posters to be presented represent research topics, including the CNS, which originated within the P2NT Program and will be carried forward into the STS Program.

### ***Discussion***

Dr. Jiménez-González commented that an important aspect of LCA is the transparency and the quality of data and asked how quality data assessments were being integrated. Dr. Gonzalez answered that transparency has been considered in all projects. A list of sources from which data are derived and details on what data are missing are available. It must be determined if logical assumptions and decisions can be made with missing data.

Dr. Jiménez-González stated that, in regards to GREENSCOPE, a challenge is communicating outcomes to stakeholders and asked how the Program was dealing with this aspect. Dr. Gonzalez responded that the question of how to portray results is always considered. There is a basis for what would be considered 100 percent sustainable, and theoretical base numbers are calculated. How to relate to the audience and if metrics and indicators can be related and translated to a different audience have been considered.

Dr. Jiménez-González asked how the gap between optimal existing technologies and emerging technologies was being bridged. Dr. Gonzalez replied that emerging technologies are being examined to improve existing technologies, and cost, benefits, and so forth are analyzed. Sometimes emerging technologies create new products and different variants on how to use a technological model.

Dr. Tomasi asked about the concern for the intergenerational timeline. Dr. Gonzalez responded that the resource standpoint is the concern. Elongating available resources so that they are available for future generations is the goal.

Dr. Tomasi asked if there was a need to develop a set of intergenerational metrics independent from an economic standpoint. Dr. Gonzalez answered that the economic component cannot be delineated because there always is a scarcity/cost aspect.

Dr. Beaver asked who in industry was using LCA and GREENSCOPE. Dr. Gonzalez replied that GREENSCOPE is under development. Data are being retrieved by an industry partner via a Cooperative Research and Development Agreement (CRADA).

Dr. Beaver asked if the Department of Defense and the U.S. Army Corps of Engineers are using these tools for infrastructure repairs in Afghanistan and Iraq. Dr. Gonzalez replied that, to his knowledge, EPA has not been approached regarding such use.

Dr. Beaver asked if the nanotechnology LCA is in the manufacturing phase. Dr. Gonzalez confirmed this and added that it is being used to ensure that nanotechnology manufacturing is environmentally friendly. Research will move into ensuring that nanotechnology use and reuse is safe as well.

Dr. Beaver asked if TRACI was being used in the field of nanotechnology. Dr. Gonzalez answered that efforts are moving in that direction but still are in the early stages. Many aspects still need to be determined.

Dr. Beaver commented that he was unable to find the highly cited TRACI paper in the bibliometric analysis that was provided to the Subcommittee members. Dr. Gonzalez answered that he was speaking of one specific article, in the *Journal of Industrial Ecology*, that was listed as one of the top 10 percent of cited papers.

Dr. Beaver asked if research is built on the available body of work or if it is built from scratch. Dr. Gonzalez replied that existing data are used to determine if the current research could be streamlined or simplified.

Dr. Beaver stated that he was concerned with the gate-to-gate approach because in a real-life example reduction was increased by “taking the gate down.” Real opportunities for reduction are derived with production and the customer. Dr. Gonzalez responded that chemical production is the focus of the work, which lends itself to gate-to-gate analysis, but if a client needs/desires to go further, the capability to expand the gate-to-gate approach is present. Researchers have the ability and resources to perform cradle-to-grave, cradle-to-use, and similar analyses.

## **LTG 2 Poster Session**

### ***The Collaborative Science and Technology Network for Sustainability (CNS) Poster***

Dr. Diana Bauer presented the poster entitled, “The Collaborative Science and Technology Network for Sustainability (CNS).”

Dr. Beaver asked if the material flow analysis was within the process/product or examined national impact. Dr. Bauer responded that it examined regional impact. A network of material flow in Columbus,

Ohio, is being developed as well as tools that examine economics, toxicity, and so forth that can be applied more broadly.

Dr. Beaver asked if there were any linkages with the World Resources Institute (WRI) study funded by the National Science Foundation (NSF). Dr. Bauer responded that the WRI study was on an international/national scale. The Columbus study is examining methods of managing waste and managing material, which ties in with the WRI study and the Resource Conservation and Recovery Act.

Dr. Landis asked Dr. Bauer to identify the top three research questions for the CNS Program. Dr. Bauer responded that the top three questions are:

1. How can communities across multiple jurisdictions make planning decisions, and how can built infrastructure best be developed to align with collective long-term environmental, economic, and social goals?
2. What core set of principles can best be used to guide the design and management of human-built systems (such as land use, buildings, transportation, systems) in a manner that protects natural systems and ensures resource sustainability?
3. How can organizations access leverage points in materials, water, and energy use cycles so the environmental benefits of pollution prevention, green chemistry and green engineering, environmental management accounting, life cycle management, and so forth are realized on a regional scale?

Dr. Landis asked if these were social questions. Dr. Bauer replied that they were social and infrastructure questions. Dr. Landis commented that there were no scientific, toxicological, or other technical questions. Dr. Landis and Dr. Bauer discussed organizational versus scientific approaches, and Dr. Bauer cited the example of the Nature Conservancy study regarding the flow of reservoirs. This study examined water quantity for human health as well as variation of flow for environmental protection. Data were collected and a model developed that changed decisions about when to turn on and off the water flow to protect the environment. The model is being prepared for national use.

Dr. Abraham asked if the model discussed in the poster could be transferred to other watersheds. Part of analysis is to develop a more generally applicable model or to collect specific data. Dr. Bauer responded that it is a generally applicable model that is grounded in real data.

Dr. Tomasi commented that the question being addressed is not necessarily the measurement of environmental degradation but more the integration of environmental issues with reservoir operations issues within a decision framework. Therefore, research questions regarding decision frameworks for evaluation are different but legitimate to ask in a grants program. Dr. Bauer responded that researchers were attempting to learn from those types of questions. The CNS Program's innovativeness is not in the fundamental, basic science but in the integration of the various pieces.

Dr. Beaver cited the example of Hetch Hetchy, a canyon in Yosemite National Park that was walled off in the early twentieth century to provide a reservoir of water for San Francisco. It is possible to backcast to the original decision to test current approaches. Hetch Hetchy has a land use perspective and a backtesting perspective and provides an opportunity to let science and technology and cultural values determine if Hetch Hetchy remains as a reservoir or reverts to its original valley environment.

Dr. Tomasi asked Dr. Beaver if it was possible to test a catastrophe by examining a past catastrophe.

Dr. Beaver replied that Hetch Hetchy is a perfect example of being able to do just that.

***Life Cycle Assessment Methodology Development and Application for Sustainability Poster***

Ms. Mary Ann Curran presented the poster entitled, “Life Cycle Assessment Methodology Development and Application for Sustainability.”

Dr. Jiménez-González asked if sensitivity analysis had been considered. Ms. Curran responded that sensitivity analysis is a very important part of the whole process, and TRACI models include this component. The methyl tert-butyl ether (MTBE) project currently underway, unfortunately, did not lend itself to sensitivity analysis. The researchers do, however, realize the importance of sensitivity analysis.

Dr. Beaver asked if there is a mechanism by which it can be determined if ethyl tertiary butyl ether (ETBE) is better than MTBE or ethanol in certain categories or if researchers are constrained by binary choice (i.e., can the comment be made that the infrastructure in making MTBE is there and by making ETBE there are more “positives” and less “negatives”?). Ms. Curran responded that it is possible to do this, although comparing products often produces similar results and separating each out is difficult. LCA is an iterative process.

Dr. Beaver asked if the research could be published, even if clients did not like the results. Ms. Curran replied that the research is published no matter what the results because the research effort itself has merits that need to be shared.

Dr. Beaver asked what the researchers thought about streamlining the LCA concept and performing the LCA thought process without data. Ms. Curran answered that there is a difference between life cycle thinking and LCA. Researchers prefer to perform a full LCA but accept that broad thinking also has its advantages. Ultimately, an LCA should be performed to ensure that no burdens are shifted elsewhere in the cycle.

***TRACI – Tool for the Reduction and Assessment of Chemical and other environmental Impacts Poster***

Ms. Jane Bare presented the poster entitled, “TRACI – Tool for the Reduction and Assessment of Chemical and other environmental Impacts.”

Dr. Beaver asked what the difference was between disability-adjusted life years (DALYs) and quality-adjusted life years. Ms. Bare replied that DALYs are based on World Health Organization (WHO) definitions, but EPA prefers to utilize definitions based on human health without drastic extremes. Quality of life remains within EPA’s goals, strategies, and framework.

***Discussion***

Dr. Giesy opened the discussion to include all three posters presented in this poster session.

Dr. Abraham asked how LTG 2 is fundamentally different from LTG 1. Dr. Gonzalez answered that the three programs cannot stand alone and must be integrated as the data are gathered; metrics that are developed in LTG 1 guide LTG 2 in answering the question of how the state-of-the-system can be improved from a technology standpoint. The state-of-the-system must be understood before moving forward. Dr. Landis asked if LTG 1 addressed the state-of-the-system. Dr. Gonzalez responded that it is possible to metric it as the current status. Dr. Landis asked within what paradigm. Dr. Gonzalez responded that it was in a rebounding mode. Dr. Abraham asked for further clarification of the specific differences between LTG 1 and LTG 2. Dr. Giesy commented that a metric is a meter that has been measured. The tools are the methods by which the meter (predictions) can be improved. The next step is to develop technologies to examine the sensitivity of the meter. In this context, the differences between LTG 1 and LTG 2 are clear, and yet the two LTGs still are intertwined. Dr. Jiménez-González added that a metric is a parameter that needs to be measured, whereas a tool is something that will allow an

assessment to be performed. Dr. Cabezas stated that Dr. Giesy's explanation about the differences between LTG 1 and LTG 2 was accurate.

Dr. Giesy asked if there was a plan in place to assess progress or if there was a tracking method that could be communicated. Dr. Gonzalez responded that APMs and Annual Performance Goals are in place and currently a tool is being developed to measure progress. Possible metrics include software development/distribution, journal article publication, formation of industry partnerships, and so forth.

Dr. Giesy commented that there is a difference between outcomes versus outputs and asked if there was a method to track outcomes. Dr. Gonzalez answered that this was better tracked on a program level. Mr. Evans added that measurement of outcome is part of the Office of Management and Budget's Program Assessment Rating Tool (PART) process.

Dr. Beaver asked if metrics were necessary for measurement or if an obvious, recognizable increase of use as a decision-making tool in industry was enough. Dr. Jiménez-González commented that "obvious, recognizable" is subjective. Does the term mean that 50 percent of companies are using it? Or does it mean 70 percent, 90 percent, or something else altogether? Dr. Beaver maintained that the number of companies using it can be deceptive because small companies may not be considered equal to large companies such as Dow, DuPont, and BASF. Dr. Jiménez-González replied that the inequality between small and large companies also was part of her point.

Dr. Jiménez-González asked for clarification about cradle-to-grave versus gate-to-gate analysis used in the studies. Dr. Gonzalez responded that one of the dilemmas with LCA and GREENSCOPE is not that one is inferior to the other but that they are complementary to each other. The metrics for the information are determined *a priori* so that the inclusions within the process that can be realized by examining an alternate use of technology are known beforehand. From an LCA perspective, cradle-to-grave is the definition. The scope of GREENSCOPE could be extended to an LCA perspective, but the current manner in which it is being developed will not be able to examine the outside-the-gate aspect. Dr. Jiménez-González clarified that it is mainly a tool to compare two different processes, but the boundary is gate-to-gate. Dr. Gonzalez confirmed this and explained that GREENSCOPE is being developed to identify opportunities for improving a process.

Dr. Landis commented that he did not notice any ecology in any of the LTGs, and toxicity is not the same as toxicology. Dr. Gonzalez responded that these disciplines are under evaluation and various components will be incorporating ecology, because researchers understand that it is an important component of sustainability.

### **LTG 3 Overview: Technologies**

*Dr. Douglas Young, ORD, EPA*

Dr. Douglas Young explained that contributing to sustainable outcomes is particularly important to LTG 3. The technology goals from the P2NT MYP are unified because they did not concentrate on stovepipe issues. The ETV and SBIR Programs are important components of LTG 3. The first step in developing the LTG was to identify environmental problems and analyze them. Investment in research, development, partnerships, verification, and so forth occurred next, followed by dissemination of information and tracking the adoption of technologies and subsequent environmental improvement. Investment in research includes utilizing in-house expertise and funding extramural grants for supplemental research.

The achievement of sustainable outcomes is driven by the adoption of new and innovative technologies. Current EPA Programs in this effort include the People, Prosperity and the Planet (P3) Student Design Competition for Sustainability; Green Technologies; ETV; and SBIR. EPA also designed the Environmental Technology Opportunities Portal (ETOP) in response to a congressional mandate. ETOP

allows users to find appropriate support from EPA in the areas of proof of concept, development, demonstration, verification, and utilization.

The P3 Student Design Competition was created to introduce undergraduate students to the concept of environmental sustainability, and it addresses sustainability challenges faced by both the developed and developing worlds. The P3 Program has many success stories, including exceptional projects at Rochester Institute of Technology, the University of Colorado at Denver, Oberlin College, and Portland State University.

The goal of the Green Technologies Program, an in-house-based research effort that utilizes CRADAs, is to develop and demonstrate cleaner synthesis for commodity and specialty chemicals through improved catalysis or the use of solvent-free or alternative reaction media and raw materials. A success story for this program is the alternative catalyst design, which was developed in-house via a CRADA with Solutia, Inc. The new process improves conversion of a commercially important chemical from 4-7 percent with the current nitric acid-based process to 65 percent with the EPA-developed, oxygen-based process. Dr. Beaver interjected that he was concerned with the safety of the process as a result of the possible mixture of cyclohexane and oxygen resulting in a thermonuclear-like reaction. Dr. Jiménez-González asked if this was a change in the process design. Dr. Young responded that it was a change in catalyst design.

The ETV Program was initiated in 1995 and has developed 86 testing protocols and verified 386 technologies; more than 500 stakeholders participate in the ETV Program. Currently six ETV centers are in operation. ETV success stories include diesel retrofits that reduce pollutants, vapor reduction units that have led to emissions reductions and natural resource conservation, and the adoption of ETV reports by state regulators.

The SBIR Program was established by the Small Business Innovation Act of 1982. Phase I of the program provides funding for proof of concept, and Phase II provides funding for development and commercialization. There is a link between the SBIR Program and the ETV verification process. One SBIR success story is the development of a process for plastic packaging films that uses water-based and solventless printing inks by Sigma Technologies International. This process eliminates volatile organic compound emissions and has no hazardous solvent disposal.

Future directions include continuing the P3 Student Design Competition and achieving a fully cost-shared ETV Program. The Green Technologies Program will increase its emphasis on using metrics and tools and examine areas such as biofuels recovery and nanomaterials, including production and life cycle implications. The SBIR Program will continue to address Agency priority problems and issues, including nanotechnology, biofuels, concentrated animal feeding operations (CAFOs), homeland security, and green buildings. Another future goal of the SBIR Program is increased interaction with the ETV Program that will strengthen the relationship between the two programs.

### *Discussion*

Dr. Beaver commented that although the ETV Program is 12 years old, the public is much more aware of the SBIR Program than the ETV Program. Why is this the case? Dr. Young replied that, unlike the SBIR Program which provides funding to companies to develop technologies, the ETV Program does not provide money to the company whose technology is being verified, and the vendor must pay for certain aspects of the ETV process.

Dr. Abraham commented that LTG 3 states that better technologies are going to be developed and asked how and what measurements have been performed and if they were inherently contained in all projects. Dr. Young responded that the Green Technology Program predominantly focuses on green chemistry issues, and LCA is a new concept that will be examined in greater detail when the STS Program gets underway in the fall.

Dr. Abraham asked why a future direction of the Green Technology Program is sulfur removal of diesel. Dr. Young answered that this is in response to an EPA mandate as a result of new regulations.

Dr. Jiménez-González asked if the scope of the Program was going to be expanded. Dr. Tomasi added that sustainability includes land, but he did not see this addressed in the LTG. LTGs 1 and 2 are evolving to be better integrated, but LTG 3 is more narrowly focused. Dr. Young responded that LTG 3 is the culmination and integration of work from LTGs 1 and 2. Efforts will not be duplicated, but LTG 3 will rely on work from LTGs 1 and 2. LTGs 1 and 2 can provide guidance, whereas LTG 3 can provide feedback.

Dr. Giesy asked what percentage of products would be from EPA mandates versus researchers' choice. Dr. Young responded that each program is different; less than 50 percent of the Green Technologies Program research is derived from mandates, whereas ETV and SBIR may be around 50 percent.

Dr. Giesy asked if there were any programs for extramural funding for academia versus industry partnerships. Dr. Young responded that the funding came only from the four programs mentioned.

Dr. Beaver commented that CAFOs are a large problem, especially considering there are air and groundwater considerations, but they seem to be just a footnote in these programs. Dr. Young responded that there also is a human health component to CAFOs with the release of endocrine disrupting compounds (EDCs). He noted that most research on CAFOs is being done by other EPA programs, not the STS Program.

### **LTG 3 Poster Session**

#### ***Environmental Technology Verification Program (ETV) Poster***

Ms. Teresa Harten presented the poster entitled, "Environmental Technology Verification Program (ETV)."

Dr. Beaver asked why the Navajo Nation, the Bureau of Indian Affairs, or the Department of the Interior are not listed under the subject of drinking water and arsenic and uranium treatment. The worst situation for arsenic and uranium in drinking water is on the Navajo Nation's land at Four Corners. Ms. Harten responded that ETV has advertised for vendors not collaborators.

Dr. Giesy asked if ETV centers receive substantive funding. Ms. Harten replied that each center has a scope, and if proposed research is within the scope and the stakeholders and EPA agree, then research can be performed. The ETV centers have worked on the Agency's goals but are not mandated to verify specific issues.

Dr. Beaver asked if there was a plan to make the ETV Program more visible to the public and if EPA advertises what has been verified or if that is up to the client. Ms. Harten answered that EPA does not advertise; vendors are responsible for performing their own promotion following verification. EPA does, however, publicize what has been verified. It is necessary to remember that verification indicates that the data are of a certain quality, not that the technology has been certified as having met a standard. EPA is not endorsing a technology but verifying that the data meet certain criteria.

Dr. Abraham asked about the extent of the analysis of some of the components and where boundaries are drawn. Ms. Harten responded that energy production is compared to a grid and as local an analysis as is possible is performed to determine the quality of the data. Including other components in the verification (e.g., LCA) would add caveats to the verification.

Dr. Tomasi asked if the ETV Program tracks any outcomes for clients. Ms. Harten responded that sometimes they receive client feedback (e.g., “We saw a 10 percent increase in sales.”) but this is voluntary and not verified.

### ***Small Business Innovation Research (SBIR) Program Poster***

Dr. Gary Foley presented the poster entitled, “Small Business Innovation Research (SBIR) Program.”

Dr. Beaver asked if there is a mechanism in place to learn from failures. Dr. Foley responded that failures are not ignored, but the emphasis is on success.

Dr. Beaver expressed his concern about the possibility that the SBIR Program could support the development of a product that already existed of which the peer reviewers were not aware. Dr. Foley replied that every effort is made to ensure that this is not a common occurrence, but it does happen occasionally.

Dr. Giesy asked about patent implications. Dr. Foley answered that the SBIR contractor is named on all patents.

Dr. Giesy asked what the implications of the transition from P2NT to STS were for the SBIR Program. Dr. Foley replied that the metric that has been promoted under the transition is commercialization and how the technology can move toward sustainability. If this is the focus of the overall STS Program, then it also should be the emphasis of the SBIR Program.

Dr. Jiménez-González asked about metrics as part of the peer review process. Dr. Foley responded that metrics were acceptable as long as they did not stifle the competition. Congress has imposed a competition advocate to ensure that the program is not so narrow that it stifles competition. Dr. Abraham added that some of the success stories from the SBIR Program do address sustainability. All that is necessary is to tweak the solicitation so that the emphasis is on STS instead of P2NT in a manner that does not stifle competition but utilizes LTGs 1 and 2 (metrics and tools).

### ***Discussion***

Dr. Giesy opened the discussion to include both posters presented in this portion of the poster session.

Dr. Beaver asked to what extent the Program has a grasp on what technologies are needed versus what already exists (i.e., meeting present needs versus anticipating future needs). Dr. Foley replied that EPA regional offices express current needs, whereas EPA researchers convey future needs. Between the two, there is a blend of present and future. Additionally, extramural researchers who submit proposals have further ideas. Dr. Beaver asked, as a specific example of his previous question, if there would be a Request for Proposals (RFP) regarding the biological production of nanomaterials. Dr. Foley responded that this type of RFP would come from the NSF. SBIR is more likely to examine what technologies will utilize nanomaterials for stabilizing pollutants in the environment. Ms. Harten added that stakeholders notify ETV about current research needs. More technological assessments are occurring at the laboratory level.

Dr. Beaver asked for clarification about the junction of ETV and SBIR and how the funding operates. Dr. Foley explained that Phase II of the SBIR Program provides companies with \$225,000; if the company can demonstrate that ETV can promote commercialization of its technology, then the company is awarded an additional \$50,000 to cover the cost of verification. Dr. Tomasi asked if this was considered cost sharing. Ms. Harten responded that it is counted as a cost share.

Dr. Tomasi asked if methods by which these programs could be extended into land/ecosystems had been considered. Ms. Harten responded that the Greenhouse Gas Center has similar programs and is entering

these areas as the need arises. Dr. Foley added that the closest the ETV centers had come to this was water reuse, which involves the ecosystem to some extent. This has not been in demand in the Agency.

Dr. Landis asked if SBIR funds a lot of “widgets.” Dr. Foley responded that most SBIR projects do something or measure something. Dr. Beaver introduced a discussion regarding the differences between “stuff” and “things.” “Stuff” is materials and components, whereas “things” are what are made up of materials and components. The outcome of the conversation included the fact that the ETV and SBIR Programs involve mostly “things.”

### **Working Session**

#### *Subcommittee Members*

In a closed working session on Wednesday afternoon, the Subcommittee discussed details for completing their review and report.

The meeting was recessed at 5:48 p.m.

## **THURSDAY, APRIL 25, 2007**

### **Review of Tuesday’s Activities and Overview of Thursday’s Agenda**

*Dr. John Giesy, Subcommittee Chair*

Dr. Giesy reconvened the meeting at 8:30 a.m. with a review of Wednesday’s activities and the revised schedule for the day. He asked Subcommittee members to provide their requests for additional information needed from EPA staff. Dr. Landis submitted his request for information regarding transition teams and the incorporation of ecological aspects and decision tools.

### **LTG 3 Poster Session (Continued)**

#### ***People, Prosperity, and the Planet (P3) Student Design Competition for Sustainability Poster***

Dr. Foley presented the poster entitled, “People, Prosperity, and the Planet (P3) Student Design Competition for Sustainability.”

Dr. Tomasi asked if there is tracking of eventual outcomes to determine overall success. Dr. Foley replied that projects selected for Phase II are tracked.

Dr. Abraham asked how the judging criteria compare to the metrics being developed for the other LTGs as the transition to the STS Program occurs. Dr. Foley answered that this program was designed with sustainability in mind, so the criteria already are in place.

Dr. Abraham asked about the judging component that required students to discuss their projects in terms of “people, prosperity, and the planet.” He asked if the student responses were judged on how they could be related to metrics and decision-making tools in the STS Program or if students discussed ideas without knowledge of the STS Program’s metrics. Dr. Foley responded that the students discussed their own ideas without conforming them to the Program’s metrics.

Dr. Giesy asked if there was a precursor to the P3 Program. Dr. Foley answered that this program and the CNS Program were established as part of an effort to create a global, virtual laboratory for sustainability that produced ideas for EPA to consider.

Dr. Landis asked if students present their projects in other venues, including at professional society meetings. Dr. Foley answered that the students present seminars at local universities and that he imagines there are presentations at professional society meetings as well. Additionally, press releases are issued, and the students talk to their local media as well as the Washington, DC, media.

Dr. Beaver asked if there were program partners outside of the United States and if 2-year institutions participated in the program. Dr. Foley responded that there are partners outside of the United States and that proposals are received from both 2-year and 4-year institutions. Based on the merit of the proposal, 40 projects are funded, regardless of the type of institution.

Dr. Beaver commented that during the first year of the program, the nonfunded proposals were made public so that they had the opportunity to be funded by interested parties. Does this process still occur? Dr. Foley replied that he was unsure but would find out.

Dr. Giesy asked how many proposals are received each year and what percent are funded. Dr. Foley responded that he would have to research this and get back to the Subcommittee.

### ***Green Technologies Research Program Poster***

Dr. Leland Vane and Dr. E. Sahle-Demessie presented the poster entitled, "Green Technologies Research Program."

Dr. Beaver commented that prior to this work a common problem for paper companies was black liquor. One project attempted to convert black liquor to a pharmaceutical precursor but created additional effluents that were harmful to the environment. He asked if this technology could produce a mild oxidation, as the current oxidation seems severe. Dr. Sahle-Demessie replied that the paper industry is interested in the new technology as a result of the Pollution Prevention Act of 1990. A major concern is air treatment, not liquids, because they are cycled back into the system. Even if some of the chemicals found in liquid are valuable, they are contained in a mixture and would need to be separated out. The oxidation is more severe because the industry wanted a more complete oxidation.

Dr. Jiménez-González commented that the presenters mentioned applying decision-making tools such as LCA for choosing materials. She asked how researchers knew what was greener as the data were not complete. Dr. Sahle-Demessie responded that much data are needed, and once the data are collected, the analysis can proceed. Cradle-to-grave analysis only is performed when a potential for benefit is seen.

Dr. Jiménez-González asked if decision-making tools were prioritized. Dr. Vane answered that in the early stages tools regarding energy and materials usage were of priority, and GREENSCOPE hopefully will be another tool. Dr. Jiménez-González asked if there will be a link to these tools, and Dr. Vane responded that there would be a link.

Dr. Beaver asked if high sheer reactor work translated to process intensification. Dr. Vane replied in the affirmative. Dr. Beaver then asked if anyone at EPA was observing the solicitation efforts of other agencies to determine if a technology truly is green or sustainable. As an example, the U.S. Department of Energy is researching separation of ethanol. Dr. Vane responded that he was not aware of anyone responsible for examining the work of other agencies, but researchers do look at small business solicitations. He explained that in terms of coordination, a program for interaction is in place. Coordination among agencies is occurring, but he was not aware of agency coordination with regard to solicitations. Dr. Sahle-Demessie added that the Department of Agriculture also is working along similar lines. It is difficult to coordinate collaboration efforts among agencies, but individual researchers from the various agencies do collaborate. Dr. Beaver stressed the importance of ensuring that someone is watching to ensure that the technologies are sustainable and green.

Dr. Tomasi asked how targets are selected within the program; for example, via the observation of an absence of research in a particular area in the private sector. He was curious about the selection criteria and how they relate to broad applications or EPA concerns. Dr. Vane responded that there is a marriage of capabilities, consideration of hazardous materials that are a concern for other parts of EPA, consideration of outside groups' research, and observations of niche areas where there are technological voids that no other group is attempting to fill. The researchers examine where their research could have a

unique impact with a focus on the future and sustainability. Dr. Sahle-Demessie added that the research is generic in nature and not specific to one industry so that it can be applied broadly. Dr. Tomasi asked if these criteria for determining research focus areas just come naturally or if they are written down. Dr. Vane responded that they just come naturally.

Dr. Abraham asked how the work performed under this program is different from that occurring in academia. Dr. Vane replied that the work in academia is complemented by an education component, whereas this is not. There is less turnover, as career scientists are performing the work. Additionally, EPA has a government mandate and also has scale-up abilities when working with industry partners. Dr. Sahle-Demessie added that this research investigates areas of interest to the Agency and is driven by Agency needs.

### **Public Comments**

Dr. Giesy offered members of the public the opportunity to comment at 9:30 a.m. No comments were offered.

### **LTG 3 Poster Session (Continued)**

Following the call for public comments, the discussion of LTG 3 posters continued.

Dr. Jiménez-González asked if reaction mass efficiency and other parameters were tracked as part of the process indicators. Dr. Sahle-Demessie replied that in evaluating a chemical reaction, the source intensification of the reaction is examined for increased conversion and decreased waste byproducts. EPA examines the full process, not just a specific chemical reaction, because even if a specific reaction is green, this may not be true of the overall process. Therefore, the whole process must be examined.

Dr. Beaver asked if there is crosstalk between EPA and industry so that each is aware of what the other is doing. Dr. Sahle-Demessie replied that crosstalk is desirable, so researchers attempt to work with industry as much as possible and let them know what EPA is doing. The bigger challenge is bringing things to market. Dr. Vane added that EPA researchers publish and present as much as possible to get the information in the public domain. The bigger challenge is industry sharing its work with EPA because of the confidentiality associated with industry research. EPA researchers do their best to perform extensive literature and other searches, but if industry intentionally is not publishing/presenting its work, then there is little more that EPA can do to determine what is being done by industry.

Dr. Giesy asked about the predecessor to this program. Dr. Vane responded that this program came out of the Water and Hazardous Waste Treatment Division reorganization during the mid-1990s. At that time, a P2NT approach was embraced.

Dr. Giesy asked how many patents and publications came out of this work. Dr. Vane responded that approximately 10 patents have come from this work. Dr. Sahle-Demessie replied that more than 100 publications had resulted from this work.

Dr. Giesy asked Dr. Vane to rate the image of the program's researchers. Dr. Vane responded that certain researchers were considered in the top 1 percent in the world. He himself is known as an expert, as evidenced by the number of international researchers who contact him about the state-of-the-science. The research group has a good reputation.

Dr. Giesy commented that this program has a high value despite being relatively small in terms of funding and asked why industry was not funding more programs like this one. Dr. Vane responded that many small businesses and innovators are working along similar lines even though larger companies generally are not. EPA supports small businesses in this venture by providing facilities, funding, and so forth. This type of synergy with small businesses increases the value of the program to taxpayers.

Dr. Giesy asked if it was possible to be more quantitative than qualitative with metrics in assessing the program. Dr. Vane responded that the entire Agency will be better at tracking because there has been a shift away from output-based methods to outcomes-based methods that measure implementation of technologies.

## **General Discussion**

Dr. Giesy opened the discussion to include all topics covered since the beginning of the meeting and asked if there was a transition plan in place. Dr. Foley replied that the plan is not developed fully but parts are in the works. The part regarding metrics is underway. The final plan will change following the BOSC's input.

Dr. Giesy asked if there was a plan to integrate with an ecological research program. Dr. Foley answered that there are 12 research plans within ORD, and if the BOSC Executive Committee approves, there will be a major restructuring of the ecological research program into ecosystem services. All staff members participate in various research programs, and some STS programs will feed into the restructured ecological program, but all will work together within the strategy to achieve sustainability.

Dr. Landis asked what program within the Agency has the lead on sustainability. Dr. Foley replied that this question concerns Agency strategy and how EPA works as a whole. Although the STS Program is small, it is attempting to encourage all other programs to embrace sustainability.

Dr. Giesy asked why the STS Program has no National Program Director (NPD). Dr. Foley responded that he was not sure why senior management had decided that the STS Program did not need an NPD, especially given that the NPD's role is to collaborate and provide a liaison to other programs. This program feeds into all other programs, and all programs are invited to its meetings. If sustainability is to permeate through EPA, the Agency must embrace change.

Dr. Landis asked about the advocate for the program. Dr. Foley responded that the previous Assistant Administrator for Research and Development, Dr. Paul Gillman, had been the program's advocate.

Dr. Foley was asked by the Subcommittee members to address a question about the bibliometric analysis. He explained that the bibliometric analysis is performed by a support contractor. Because the in-house and extramural research are considered integrated, these separate components are not teased out of the bibliometric analysis. EPA is sensitive about keeping them together so there is no appearance of nonintegration.

Dr. Beaver commented that there were only 15 patents in a 10-year period. Dr. Foley explained that there is a balance between trying to introduce ideas and technologies to the public versus the need to benefit the individual researchers. Developing a patent is an expensive process, and in terms of trying to distribute a technology, it is not always beneficial to pursue a patent. The Agency balances each and every patent application with the benefits to the technology, the researcher, and the Agency.

Dr. Beaver asked why there were only two papers on influencing decision-making regarding sustainability on the provided list of publications; he also asked why nanotechnology was not present. Dr. Foley pointed out that the STS Program does not officially start until the fall of 2007, so it cannot be expected to publish before that time. The Agency only recently has moved into nanotechnology research.

Dr. Beaver asked if researchers attended the Decision Science Institute meetings. Dr. Foley responded that they did not. Dr. Landis commented that attendance could be incorporated into the planning process.

Dr. Beaver asked if someone from the Agency was a part of the Council for Environmental Cooperation. Dr. Foley was unsure.

## PROGRAM PERSPECTIVES

### **Collaboration Creates Exceptional Results: U.S. EPA and MAR Systems**

*Mr. Claude Kennard, Chief Executive Officer, MAR Systems*

Mr. Claude Kennard described his background and explained how he had come to be involved in a CRADA partnership with EPA. MAR Systems, a 2-year-old limited liability company (LLC) based in Cleveland, Ohio, arose as a result of a vision that small business could work with EPA. In 1999, Mr. Kennard established a relationship with EPA at Batelle's Environmental Technology Commercialization Center during a discussion regarding hazardous materials. He envisioned a possible solution to the problem, and EPA agreed to partner with him. Mr. Kennard found this to be advantageous, because EPA has resources that small businesses do not.

The commercialization of the product evolved during a number of steps starting in 1999 that included a 2001 CRADA approval that has been amended four times; a patent application; the formation of MAR Systems, LLC; an EPA-issued exclusive license that is different from the standard license; JumpStart funding of \$350,000; and the initiation of series A funding. Several people within EPA and NRMRL were instrumental in ensuring that this technology advanced. EPA resources also have been an immense help.

Arsenic, although a relatively small problem in the United States, affects 100 million people globally, with a treatment cost estimated to be in excess of \$100 billion. Arsenic compliance is mandated by EPA and WHO, and there will be an estimated 2.5 million cases and 300,000 deaths related to arsenic poisoning worldwide during the next 50 years.

The result of the project is a patent for a process that reduces inorganic contaminants from waste streams that removes arsenic from drinking water, removes mercury from flue gas, and evaluates the use of alumina for other heavy metal removal. The product, Sorbster33™, has addressed small community needs with a focus on point of entry and point of use. Specifically, MAR Systems investigates nonhazardous materials that industry is throwing away and examines how to use them to improve the environment.

To move forward to commercialization, industry needs to know how to better utilize EPA resources. The Agency needs to communicate to industry what areas need investigation so that industry can attempt to solve problems in partnership with EPA.

### ***Discussion***

Dr. Beaver asked about the mechanisms through which industry learns about opportunities to utilize this technology. He cited the example of the Navajo Nation, which needs help but does not want to utilize USGS testing. He then asked about the advocate who was responsible for getting this technology out to the people that need it. Mr. Kennard said that, following yesterday's discussions, Dr. Gonzalez had mentioned the need of the Navajo Nation. It is possible that MAR Systems can approach the Bureau of Indian Affairs. In a more general sense, MAR Systems is comprised of researchers that are trying to solve problems; it does not employ advocates.

Dr. Abraham asked Mr. Kennard to identify the value added by working with this laboratory. Mr. Kennard responded that the access to the laboratory resources was the best value added. The original problems of mercury and arsenic were conveyed by researchers in this laboratory, and without this, the problem would have remained unknown. Additionally, EPA researchers offered advice to produce a "Home Depot" version of the technology to make it more publicly accessible.

**BOSC Review—LTG 3 Program Perspective***Dr. Ryan James, Battelle*

Dr. Ryan James stated that Battelle and ETV have verified 120 technologies during the previous 10 years, with a 54:46 ratio of air to water technologies. Twelve different categories of tests exist for air and water. There have been 37 stakeholder meetings and 84 newsletters to publicize the program. He shared a recent stakeholder comment about ETV regarding the value added by ETV verification.

Examples of verified technologies include a chemical oxygen demand analyzer, estrogen enzyme-linked immunosorbent assay kits, continuous water quality monitors that provide an early warning system to detect signs of intentional or accidental contamination of more than 160,000 U.S. public drinking water systems, and two mercury monitoring technologies that provide users with an informed choice.

A current program being undertaken with a collaborator is a ballast water exchange at sea to prevent aquatic invasive species from altering native aquatic populations, which will result in increased ecological protection as a result of better monitoring tools and the ability to enforce regulations. Another current program involves atrazine monitoring. A joint verification with the Department of Defense Environmental Security Technology Certification Program involves passive groundwater samplers.

***Discussion***

Dr. Landis asked if any technology had been transferred to Battelle facilities. Dr. James replied that he was not aware of this, but generally Battelle's role is to take what the vendor provides, develop a testing plan, and perform the testing.

Dr. Landis commented that it would be easy for Battelle to move to the next step, utilizing technologies in its own programs, and asked why this did not occur. Dr. James responded that he was not in a position to answer that question. Dr. Landis stated that Battelle has an excellent setup for transition; is there a barrier that needs to be removed for transition to occur? Dr. James responded that he was not aware of any barrier and explained that the ETV Program does its best to communicate its benefits via presentations so that vendors who offer technologies in areas tested by ETV are aware of its existence. Dr. Beaver commented that Battelle helping the vendor commercialize its technology in turn assists the general public by getting sustainable technologies into mainstream use. Dr. James agreed that there is a considerable burden on the vendor to take the product to the public after the verification.

**Academic Community***Dr. Joseph Fiksel, Center for Resilience, The Ohio State University*

Dr. Joseph Fiksel described his background in sustainability and noted that the EPA researchers involved in the transition to sustainability have established extraordinary credibility in this field. Despite its relatively small size, the STS Program has extensive recognition in the academic community. He noted that a bibliometric analysis is not adequate to measure the impact the researchers have had on the scientific community.

Viewed from a systems perspective, academia is inadequately structured to deal with the systems approach. There is a need for academia to realize this and learn to work together with EPA, which is embracing the systems approach. EPA must be aware of what sustainable science is and avoid common pitfalls. New tools must be developed because old tools are not up to the task; old LCAs cannot be tweaked for use with sustainability. This EPA group is leading the way in providing new methods, without regurgitating old methods.

Dr. Fiksel, a recipient of an ORD CNS grant, described his industrial ecology application in Columbus, Ohio. With other stakeholders, his group is trying to stimulate awareness about using waste streams for other processes. The target audience is waste makers, waste users, and those who may be able to help

with the process. They are providing decision-making tools and models that will connect the processes and develop flow. A decision-making toolkit is being developed with EPA's assistance.

Looking ahead, it is clear that the development of decision tools and metrics is important. Metrics should not be abstract measurements if the goal is to influence sustainability in other areas, such as the private and public sectors. The STS Program potentially could lead the way in developing a framework for measurement that could relate broad environmental variables to the specific aspects of products and process that, in turn, will enable the understanding of contributions to sustainability. This program is uniquely positioned to make a difference in sustainability practice. A balance must be struck between traditional research and outreach and the influence of stakeholders.

***Discussion***

Dr. Beaver asked about the relationship between the Center for Resilience and the STS Program.

Dr. Fiksel responded that the Center for Resilience is a research center at The Ohio State University that works broadly across campus disciplines and is supported by external grants and contracts. The center has received a commitment of funding (i.e., doctoral stipends and tuition) from the STS Program to develop sustainable metrics for the college's medical program. It is an ORD grant that will be administered through the STS Program.

Dr. Beaver asked if there was a sense of frustration that the public and private sectors did not embrace the use of tools for sustainability. Dr. Fiksel admitted that there was some frustration because the work has been ongoing for a long time with little outside recognition of its merits.

**U.S. EPA Regional Office: Region 1**

*Ms. Maggie Theroux, Office of Environmental Stewardship, EPA*

Ms. Maggie Theroux described her background, including her business experience. Currently, she manages EPA's Center for Environmental Industry and Technology. In this capacity, she has had extensive involvement with the ETV and SBIR Programs. She has partnered with SBIR for the last 8 years and with ETV since its inception. Additionally, she developed a series of proposal preparation workshops for the SBIR Program.

In her position as the Leader of the ETV Lead Paint Action Team, she constantly is referring developers, EPA staff, and the regulatory community to ETV and SBIR. These programs have had a large impact; from the viewpoint of EPA's Environmental Technology Council (ETC), these programs are essential. Identifying problems, focusing SBIR topics to find solutions to these problems, and then receiving ETV verification is a key process.

The Lead Paint Action Team includes EPA staff members as well as individuals from outside of EPA, including representatives from the U.S. Department of Housing and Urban Development (HUD), the Centers for Disease Control and Prevention, state lead programs, and so forth. A lead abatement technology was funded by SBIR through Phase II. The technology went a year without funding, but EPA ensured that demonstrations were performed during that year so that it stayed in the public eye, and HUD funded the technology the next year. The private sector could not accomplish this; lead paint is not a priority for venture capital companies.

Another area in which the SBIR Program facilitated technological progress was in the area of lead paint test kits. The previous kits on the market were substandard, so the SBIR Program included a topic for lead test kit improvement in its solicitation. Two proposals were funded for Phase I, and one was funded for Phase II. The project that did not receive a Phase II award was considered worth funding, but the budget allowed funding for only one of the two projects.

It is important for agencies to collaborate; ETC has recognized this and has increased such collaborations. The need for ETV and technological verifications also will increase in the future. The value of the SBIR Program is that EPA is able to focus solicitations on priority problem areas, and it also provides developers who are struggling to develop a technology with proof of concept funding. Many technologies have been developed that would not exist without the SBIR Program because venture capital companies are not willing to assist with the proof of concept phase.

The value of ETV lies in the EPA name, which is well respected and independent. Also, EPA verification eliminates duplicate verification by states. Because the testing protocols are developed by stakeholders, credibility is gained. ETV also gives smaller companies recognition in the marketplace. Ms. Theroux cited a tangible example of ETV's value. When EPA Region 1 and the Commonwealth of Massachusetts learned of ETV cutbacks, Massachusetts officials analyzed the value of the ETV Program in an attempt to prevent the cutbacks. ETV performed stormwater verification for Massachusetts on eight technologies; the verification has been accepted by all 50 states, and it cost the commonwealth \$880,000. Without the ETV Program, the only alternative would have been a \$1.2 million dollar verification that 44 states might not accept.

### ***Discussion***

Dr. Abraham asked if the STS had membership on the ETC. Ms. Theroux responded that Ms. Sally Gutierrez, Director of NRMRL, is the Co-Chair of the ETC, and Ms. Harten frequently attends ETC meetings. Several ETC members also are involved in the STS Program. Regional members are aware of the STS Program as a result of membership on the ETC.

Dr. Beaver asked about the customer for the lead paint kits. Ms. Theroux replied that homeowners, renovators, contractors, and construction personnel were the customers, especially following the new law that states renovations cannot occur on pre-1970s homes in some areas without a lead inspection.

Dr. Beaver asked if Region 1 coordinates with the Toxic Use Reduction Institute at the University of Massachusetts at Lowell. Ms. Theroux answered that there is coordination, and it is funded by HUD Healthy Homes.

### **Subcommittee Working Time**

#### *Subcommittee Members*

The Subcommittee members assigned to the various sections of the report used the first segment of the working session to revise their portions of the program review report.

Subcommittee members summarized their sections of the report, commented on the sections completed by other Subcommittee members, collaborated with their workgroups on the language and structure of their assigned sections of the report, reached consensus on areas of disagreement, and exchanged information to assist overall preparation of the Subcommittee's report.

### **Wrap-Up and Report Out**

#### *Dr. John Giesy*

In debriefing EPA staff, Dr. Giesy summarized the Subcommittee's preliminary responses to the charge questions. He indicated that this review was slightly different than many other BOSC reviews, as usually the Subcommittee has 3 days onsite to investigate the program and prepare the initial report. Additionally, this is a program in transition. He thanked the EPA staff for their efforts and the Subcommittee members for their teamwork. He stated that the overviews and poster presentations were informative and helpful, and the Subcommittee members praised the quality and content of the poster presentations, as well as the enthusiasm of the Program's scientists.

A continuing theme that was noted in Subcommittee deliberations was communication. The STS Program, although relatively small, has a chance to be EPA's most important program, if EPA embraces sustainability and change. The Subcommittee's recommendation is that researchers must step up to be leaders, leveraging and partnering throughout EPA and outside of the Agency. The MYP overall was well done. The challenge will be the available resources. Learning to coordinate inside and outside of the Agency, as well as outside the borders of the United States, will help extend these resources.

Transition is wider in scope. The Agency has traditionally focused on chemicals in the environment, but now the world has many other stressors, especially in terms of sustainability. Researchers need to explore beyond chemicals, and leveraging and partnering will be critical in this effort. The scope must be increased to move toward sustainability. "How to get there" will be the challenge, especially because what may be a solution for one problem may create another set of problems in a different area.

Timeliness is another issue. EPA is a research organization with a scope beyond technology transfer. The tools developed will have to be timely and also presented in a manner such that people will accept and use them. The recommendation of the Subcommittee is to release technologies sooner rather than later. The researchers should continue to publish in the best journals but also find other, quicker venues to get the results of their research out.

Dr. Giesy concluded his comments by stating that the Subcommittee members have a lot of knowledge, excitement, and enthusiasm and are eager to advise the Program.

The meeting was adjourned at 4:55 p.m.

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**APPENDIX A: Meeting Agenda****TECHNOLOGY FOR SUSTAINABILITY SUBCOMMITTEE  
FACE-TO-FACE MEETING AGENDA****April 25-26, 2007**

Andrew W. Breidenbach Environmental Research Center (AWBERC) Facility  
Auditorium  
26 W. Martin Luther King Drive  
Cincinnati, OH 45268

**Wednesday, April 25, 2007**

8:00 – 8:30 a.m.	Registration	
8:30 – 8:45 a.m.	Welcome and Outline of Purpose - Subcommittee Charge	Dr. John Giesy Subcommittee Chair
8:45 – 9:00 a.m.	Designated Federal Officer (DFO) Remarks - Administrative Procedures/Federal Advisory Committee Act (FACA) Rules	Ms. Clois Slocum (ORD) Subcommittee DFO
9:00 – 9:30 a.m.	Research Program Overview: The Evolution From P2 to Sustainability	Mr. Gordon Evans (ORD)
9:30 – 10:00 a.m.	LTG 1 Overview: Metrics	Dr. Herb Cabezas (ORD)
10:00 – 10:30 a.m.	LTG 1: Poster Session - Sustainability Metrics - Poster Session Discussion	Subcommittee
10:30 – 10:45 a.m.	Break	
10:45 – 11:15 a.m.	LTG 2 Overview: Decision Support Tools	Dr. Michael Gonzalez (ORD)
11:15 – 11:45 a.m.	LTG 2: Poster Session - Collaborative Network for Sustainability	Dr. Diana Bauer (ORD)
11:45 a.m. – 1:00 p.m.	Lunch	
1:00 – 2:00 p.m.	LTG 2: Poster Session (Continued) - Life Cycle Assessment - Environmental Impact Assessment Modeling	Ms. Mary Ann Curran (ORD) Ms. Jane Bare (ORD)
2:00 – 2:15 p.m.	LTG 2 Poster Session Discussion	Subcommittee

2:15 – 2:45 p.m.	LTG 3 Overview: Technologies	Dr. Douglas Young (ORD)
2:45 – 3:00 p.m.	Break	
3:00 – 4:00 p.m.	LTG 3: Poster Session - Environmental Technology Verification (ETV) - Small Business Innovation Research Program	Ms. Teresa Harten (ORD) Dr. Gary Foley (ORD)
4:00 – 4:15 p.m.	LTG 3 Poster Session Discussion	Subcommittee
4:15 – 5:30 p.m.	Working Session	Subcommittee
5:30 p.m.	Adjourn	

**Thursday, April 26, 2007**

8:00 – 8:15 a.m.	Review of Yesterday’s Activities/ Overview of Today’s Agenda	Dr. John Giesy Subcommittee Chair
8:15 – 9:15 a.m.	LTG 3: Poster Session (Continued) - P3 Student Design Competition - Green Technologies	Dr. Gary Foley (ORD) Dr. Leland Vane and Dr. E. Sahle-Demessie (ORD)
9:15 – 9:30 a.m.	LTG 3 Poster Session Discussion	Subcommittee
9:30 – 9:45 a.m.	Public Comments	
9:45 – 10:00 a.m.	Break	
10:00 – 11:30 a.m.	Program Perspectives - Cooperative Research and Development Agreement (CRADA) Partner  - ETV Partner  - Academic Community  - U.S. EPA Regional Office: Region 1	Mr. Claude Kennard Chief Executive Officer MAR Systems  Dr. Ryan James Battelle  Dr. Joseph Fiksel Center for Resilience The Ohio State University  Ms. Maggie Theroux Office of Environmental Stewardship
12:30 – 1:00 p.m.	Lunch	
1:00 – 5:00 p.m.	Subcommittee Working Time, Wrap-Up, and Report Out	Subcommittee
5:00 p.m.		Adjourn

## APPENDIX B: Poster Session

### Posters List BOSC Review of the Sustainability Research Program

The table below lists the posters to be presented at the BOSC Review of the Sustainability Research Program. Poster titles, lead presenters and the poster numbers are listed under the corresponding Long Term Goal (green), and the research theme (blue). The poster abstracts that follow are presented in the order shown here and are marked with their poster numbers.

Title	Lead Presenter	Poster #
<b>Long Term Goal 1</b>		
<b>Sustainability Metrics</b>		
Regional Sustainable Environmental Management: San Luis Basin Project	Heriberto Cabezas	1-1
<b>Long Term Goal 2</b>		
<b>Decision Support Tools</b>		
The Collaborative Science and Technology Network for Sustainability (CNS)	Gary Foley	2-1
Life Cycle Assessment Methodology Development and Application for Sustainability	Mary Ann Curran	2-2
TRACI – Tool for the Reduction and Assessment of Chemical and other environmental Impacts	Jane Bare	2-3
<b>Long Term Goal 3</b>		
<b>Technology</b>		
Environmental Technology Verification Program (ETV)	Teresa Harten	3-1
Small Business Innovation Research (SBIR) Program	Gary Foley	3-2
People, Prosperity, and the Planet (P3) Student Design Competition for Sustainability	Gary Foley	3-3
Green Technologies Research Program	Leland Vane and E. Sahle-Demessie	3-4