Summary of the Making Green Jobs Safe Workshop

December 14–16, 2009
Mandarin Hotel
Washington, DC

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

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FOREWORD

Green jobs—good for the environment, good for the economy. But how do we assure that green jobs are also good for workers? The National Institute for Occupational Safety and Health (NIOSH), through the Prevention through Design Program, launched the Going Green: Safe and Healthy Jobs initiative to make sure that green jobs are good for workers by integrating worker safety and health into "green jobs" and environmental sustainability. Green jobs, which have been defined broadly as jobs that help improve the environment and enhance sustainability, offer opportunities as well as challenges for workers. Examples of green jobs include manufacture, installation, and maintenance of solar panels and generators; construction and maintenance of wind energy turbines; jobs related to recycling; jobs related to the manufacture of green products; and jobs where green products are used in traditional fields such as agriculture, healthcare, and the service sector. In some instances, the hazards to workers may be similar to those in established industries. However, some green and sustainable practices may pose new health concerns for workers.

In December, 2009, NIOSH, along with our sponsors, the Occupational Safety and Health Administration, Environmental Protection Agency, National Institute of Environmental Health Sciences, and the National Toxicology Program convened the Making Green Jobs Safe Workshop to gain input from 170 representatives from the occupational safety and health and environmental communities within industry, labor, academia, government agencies, and nongovernment organizations to discuss the occupational hazards and risks associated with green jobs and determine how to emphasize that green jobs should be safe and healthy for workers. This report is a summary of their words and deliberations. The outcomes of the workshop were considered in the development of specific goals to eliminate the hazards and minimize the risks associated with green jobs. These goals have been included in the Prevention through Design Plan for the National Initiative. In the interval, we have continued to work with our partners to advance our shared mission. We hope that the availability of these proceedings will help us collectively to assess the progress we have made since 2009, and to continue to identify and address ongoing needs.

The occupational safety and health movement and the environmental movement are interrelated. They reflect a common concern for preserving our vital resources, both human and natural. Environmental advocates and health and safety advocates supported each other in the 1960s and 1970s in building public consensus for the programs that still guide our respective missions. Today, we share the conviction that protecting worker health, safety, and the environment is integral to economic recovery and growth in the 21st Century. The most compelling message from the Workshop is that the environmental concept of sustainability must be enlarged. Although a green job must preserve environmental quality and/or produce green products and services, green jobs currently have no requirement that they be safe for those individuals performing the jobs. Our concept of a green job must be enlarged to one that can be performed safely and result in no impairment to worker health. For a green job to be truly sustainable, the work itself must also be sustainably safe for the person performing the job.

John Howard, MD
Director, National Institute for
Occupational Safety and Health
Centers for Disease Control and Prevention

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SUMMARY

In December 2009, 170 representatives from the occupational safety and health and environmental communities within industry, labor, academia, government agencies, and nongovernment organizations met to consider how to emphasize that green jobs should be safe and healthy for workers. This report is a summary of their words and deliberations.

The United States sees "green jobs" as one aspect of its economic and environmental future. The definition of a green job is mostly an operational one. The proposed Green Jobs Act of 2007 (H.R. 2847) centered around the energy efficiency and renewable energy sectors. The American Recovery and Reinvestment Act of 2009 (Public Law 111–5) expanded this definition of green jobs to include work that creates or supports transportation, buildings, and water/waste management utilities. Industry and consumer groups expand the concept of green jobs even further to include all aspects of production, including design, sourcing, manufacturing, usage, and disposal that have a favorable impact on the environment.

The most discussed aspects of green jobs are (1) the need for increased awareness by employers about how their economic activity touches or utilizes environmental resources, (2) the subsequent need to mitigate these negative environmental impacts, and (3) the need to communicate this information to workers and consumers. The purpose of this workshop was to develop a framework and plan for adding to this discussion specifically how to make green jobs safe and demonstrating that occupational safety and health and environmental protection are overlapping and equally laudable and achievable goals.

This workshop was designed to solicit input from stakeholders representing industry, labor, academia, government agencies, and nongovernment organizations. The 170 professionals in attendance were asked to give examples of jobs they perceive as being included in the U.S. green economy, to identify the types of risks those workers might face, and to recommend and prioritize action steps to close gaps and remove barriers that may prevent employee health and safety concerns from being addressed as green economic investments increase.

The viewpoints of 20 experts and government leaders were solicited in various plenary sessions and moderated discussion groups. Equally important, all of the attendees were invited to work within any two of six breakout groups to identify specific concerns and develop specific solutions for the following six areas of the economy where green investment is occurring or is likely to occur.

- Construction, Infrastructure, and Repurposing of Materials
- Manufacturing and Emerging Technologies
- Energy, Mining, and Building Operation and Maintenance
- Agriculture, Forestry, and Fishing
- Transportation
- Waste Management and Recycling

The first requests made to conference participants were to define what a green job looks like and then examine how risks in those jobs might differ from risks that occupational safety and health practitioners normally have to mitigate. The overwhelming conclusion by the plenary speakers and supported in the breakout groups was that most green jobs will be very similar to jobs people

are already doing and most risks will be the same risks people were facing before the term "green" was coined. The main difference is that green jobs are being performed for different purposes, often environmentally focused ones. Thus, many of the risks that green job workers face will look similar to classical occupational risks (e.g., falls from heights, electric shock, and exposure to toxic chemicals), but they will differ, for example, in the reason they are performing elevated work, or the source of energy in the equipment they are installing or maintaining, or the type and intended use of the chemicals to which they are exposed.

While some green job risks may be manageable with existing knowledge, a rush to benefit from the green funds that are available from government and the marketplace may have drawn employers' attention away from worker safety. New entrants to the job markets that are occurring in response to these new federal and business initiatives may not be given the same training or operate in the same business cultures as have been provided by traditional owners to their employees. The result, according to some of the plenary speakers, has been preventable injuries and deaths.

To develop comprehensive solutions, the Prevention through Design (PtD) framework can integrate occupational safety and health and environmental protection into all aspects of the design, construction, production, use, and reuse of goods and services. In PtD, the assumption is that many safety and health risks can be eliminated or mitigated in the design phase of a project [NIOSH 2010].

But several speakers also highlighted the need to create a more widely spread safety culture within and across multiple communities: such as owners, designers, contractors, operators, the work force, the family, and municipalities. How to do that—how to make safety and health an integral and conscious part of peoples' day-to-day lives, both personal and professional—was determined to require a combination of the following elements:

- increasing awareness that methods are needed to eliminate occupational and environmental hazards at their source
- training that is more frequent and engages all stakeholders in designing the hazards out, or minimizing the risks of a process, practice, or material
- collecting data on new hazards and potential risks
- setting the example through leadership whenever possible
- finding social and economic incentives to change organizational and individual commitment and behaviors

And to make sure that a developing safety culture is not undermined, many speakers proposed that a product, building, or process should not be allowed to be called green unless it can also be called safe.

The plenary speakers noted that holes in current regulations can also create gaps between safe and green practices. For example, U.S. regulations, including the Toxic Substances Control Act of 2002 [15 USC 2601–2692], do not yet require data on chemical hazards for many of the materials that are part of the green economy. In addition, the occupational safety and health community is not involved to a large extent in restructuring the statutes that create requirements for those data. But because of the estimated 20,000 cancer deaths and 40,000 new cases of cancer each year in the United States that are attributable to occupation, it was suggested that eliminating toxic chemical

risks within the green economy should be a priority. Furthermore, several speakers highlighted a need to "catch up" to this past decade's advances in European regulations in which at least 1,000 hazardous materials have been banned from their continent; failure to catch up could lead to the dumping of those banned materials on the U.S. market, which will likely be followed by a rise in exposures to these banned materials throughout the population, workers included.

In the breakout sessions, leaders from each breakout group guided their participants to brainstorm how to close gaps that were more specific to the likely green jobs in their sectors. A total of 237 recommendations were proposed over 10 sessions (see Table 1). (All groups with the exception of transportation and agriculture met twice.) The focus of each proposal was on how to close the gaps and remove the barriers that make it difficult for occupational health and safety to be a priority equivalent to that of the environment in any green job. Recommendations, many overlapping, were energetically offered as depicted by their number.

One overriding conclusion evolved from these breakout groups: safety must be a consideration in all aspects of our green activities including the careful identification of the impact to worker health and safety of contracts, procurements and specifications.

After laying out all the possibilities for how to integrate worker safety and health into the green job market, each session's participants voted as to which of their recommendations should receive priority for implementation. The top two recommendations by percentage of votes received within each group are listed below.

Table 1. Number of Proposals for Recommendations Considered by Breakout Groups

Group	Number of proposed recommendations
Construction, Infrastructure, and Repurposing of Materials	46
Manufacturing and Emerging Technologies	50
Energy, Mining, and Building Operation and Maintenance	54
Agriculture, Forestry, and Fishing	10
Transportation	29
Waste Management and Recycling	48

Construction, Infrastructure, and Repurposing of Materials

- Include, in all federal procurement and construction efforts, occupational safety and health provisions that promote best practices, not just compliance.
- Create and promote a rating system that highlights the effectiveness of worker protections during construction.

Manufacturing and Emerging Technologies

- Adopt precautionary principles in connection with green product and technology risk assessments.
- Advocate for formal codes and requirements that would mandate robust risk assessment so that one hazard is not replaced with another.

Energy, Mining, and Building Operation and Maintenance

- Develop and promote best practices for small businesses on the safe way of implementing each of the green technologies, as well as on the Prevention through Design process.
- Conduct data collecting and monitoring to inform risk assessments.

Agriculture, Forestry, and Fishing

- Engage workers in assessment of risks and job changes they face, as well as in devising solutions to those risks.
- Develop baselines of exposures for each industry.

Transportation

- Use government grants or stimulus funding to prioritize occupational safety and health initiatives in green transportation projects.
- Build case studies around the management of transportation risks; e.g., compelling reasons return on investment, technical and organizational solutions.

Waste Management and Recycling

Note: Three tied for top votes.

- Develop and fund community-specific green outreach, including process safety assessments covering recycling and trash policy, yard and food wastes, etc. An effective process safety assessment identifies potential workplace hazards and, if possible, seeks to eliminate or at least reduce their potential for harm.
- Develop new methodologies to perform better job hazard analyses and exposure assessments, accompanied by better data collection and monitoring for injuries and illness.
- Insert health and safety language in federal and municipal recycling grants and contracts.

When all breakout sessions were concluded, session leaders summarized not just their two top priorities as listed above, but their top eight recommendations and then presented those to the combined participants on the final day of the workshop. These 48 high priority items (8 from each of the six groups) were then further prioritized by the combined participants using an electronic voting system in which 1 was the designation for items that should get lowest priority and 5 was the designation for items deserving highest priority. These were considered as compelling activities.

In the end, since every one of the 48 compelling activities was assigned an average priority rating of greater than three, all were included in the Prevention through Design Plan for the National

Initiative to ensure that green jobs are safe and healthy for workers [NIOSH 2010]. However, seven common themes emerge to make worker safety and health an integral part of the green economy (see Table 2).

While Table 2 contains the same types of recommendations that the professional safety community has been making for over a decade to confront a number of worker health concerns, a nationwide movement to green jobs in multiple sectors creates an opportunity for the professional safety and health community to repackage and promote all these initiatives in one common framework. In so doing, not just green jobs but all jobs can probably be made safer.

Finally, just as the environmental community has recognized an opening in times of economic turmoil to gain positive support for their priorities, the safety community must use the movement to a green economy to demonstrate the value of making green jobs safe for workers.

Table 2. Top Recommended Themes for Making Occupational Safety and Health an Integral Part of the Green Economy

No.	Recommended theme
1	Make occupational safety and health a priority by leveraging the purchasing power that government and industry already have, be it via contracts or grant authority.
2	Integrate occupational safety and health data collection and monitoring into codes and standards of practice that already have wide support, so that improved safety and health protections also become standard practice.
3	Improve the data collection process to identify and understand safety and health risks and use those data to promote occupational safety and health investment more effectively.
4	Create better methods and better standard references that can be used by occupational safety and health professionals to better protect workers.
5	Invest more time and resources to train exposed populations and to increase awareness by those who may be unaware that they are being exposed to controllable risks.
6	Fix broken regulations—i.e., those where there are gaps in safety and health coverage mandates.
7	Conduct market research to create new motivators that will inspire owners, employers, and workers to make occupational safety and health a priority that cannot be ignored.

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I. INTRODUCTION

The realization of the need for an economy that is sustainable from a natural resources perspective was the backdrop for this workshop. In 2007, the Energy Independence and Security Act of 2007 (Public Law 110–140) was passed "to move the United States toward greater energy independence and security, to increase the production of clean renewable fuels, to protect consumers, to increase the efficiency of products, buildings, and vehicles, to promote research on and deploy greenhouse gas capture and storage options, and to improve the energy performance of the Federal Government, and for other purposes."

In 2009, the executive and legislative branches of the United States government passed the American Recovery and Reinvestment Act (ARRA) (Public Law 111–5), also known as the Stimulus Bill—a $787 billion investment in the country. The stated purposes of the legislation is to preserve and create jobs, assist those who lost their jobs to find new jobs, protect state and local government's ability to maintain essential services, and, for the purposes of this workshop,

- To provide investments needed to increase economic efficiency by spurring technological advances in science and health.
- To invest in transportation, environmental protection, and other infrastructure that will provide long-term economic benefits.

Within ARRA are specific investments totaling over $121 billion that seek to decrease the environmental footprint and energy dependency of the nation. Funds dedicated for this purpose include the following:

- $61.3 billion—loans and investments into green energy technology
- $23.7 billion—infrastructure investment into public transportation, rail transport, water and wastewater facilities
- $19.4 billion—investment into green government facilities, environmental utility development funds, and green government vehicle fleets
- $13 billion—to extend tax credits for renewable energy production (until 2014)
- $4.3 billion—home energy credit to provide an expanded credit to homeowners who make their homes more energy-efficient in 2009 and 2010

When over 15% of ARRA funds are dedicated to environmental initiatives "that will provide long-term economic benefits," it is safe to conclude that one of its overarching intentions is to foster creation of a new green economy.

While there is no legislated definition of a green economy, one point of view is that a green economy aims to find an investment balance that satisfies financial, environmental, and social needs such that all sectors can function and grow healthier over time. Another is that a green economy requires an accountability of old economy externalities that all consumed environmental and social services are paid before taking profits.

What might a green economy look like? Many green economic ventures initially focus on reducing energy consumption and fulfilling remaining energy needs from nonpetroleum based sources. But after that, ideas diverge on the type of activity that can be defined as green. On one side, efforts may focus on stopping ecosystem destruction and managing all sources of material and energy to prevent its depletion. On the manufacturing side, the focus may be on less use or fewer emissions of hazardous and toxic chemicals. On the consumption side, focus may be for less packaging material and less waste at the end-of-use cycle. And on the disposal side, focus may be on returning materials and energy into the economic cycle to reclaim any value that remains. The commonality in these examples is clear: Almost all are driven by environmental demands.

Requirements for the safety and health of people are often considered differently and sometimes in opposition to environmental requirements. One place where the requirements for an individual's health sometimes compete with the requirements for environmental protection is in the workplace.

To help develop a national strategy to minimize these conflicts and promote equally environmental and worker health initiatives, the Making Green Jobs Safe Workshop was held in Washington, DC, on December 14–16, 2009, at which participants were asked to frame the issues surrounding the integration of worker health and safety into the developing green economy and to recommend action steps to close gaps and remove barriers preventing that integration.

II. METHODS

The Making Green Jobs Safe Workshop was organized under the NIOSH Prevention through Design (PtD) Program [NIOSH 2009b]. The mission of PtD is to eliminate hazards and minimize risks to workers early in the design or redesign process and incorporate methods of safe design into all phases of hazard and risk mitigation [Schulte et al. 2008]. Experience indicates that PtD is an economically efficient framework in which to recognize and alleviate risks to workers early in the development of the green economy, compared to waiting for those risks to manifest in large scale and then apply retrofit solutions.

The workshop was designed to employ two distinct methods for framing the issues and recommending action steps:

1. Provide an opportunity for participants to gain perspective from recognized leaders on the need to ensure that green jobs are safe for workers.
2. Develop specific recommendations on how to proceed and establish priorities based on input from the participants during the breakout discussions.

II.A. Guidance from Occupational Safety and Health Leaders

The conference was cosponsored by the following agencies:

- NIOSH—National Institute for Occupational Safety and Health
- OSHA—Occupational Safety and Health Administration
- EPA—Environmental Protection Agency
- NIEHS—National Institute of Environmental Health Sciences
- NTP—National Toxicology Program

The conference purpose was framed in welcoming and opening remarks by the following occupational safety and health leaders:

- John Howard, M.D., M.P.H., J.D., director, NIOSH
- Paul Schulte, Ph.D., director, Education and Information Division, NIOSH
- John Bucher, Ph.D., associate director, NIEHS
- Christine Branche, Ph.D., principle associate director, NIOSH

The keynote address was delivered by Michael Wright, director of health, safety and environment for the United Steelworkers.

To conclude the first day, individuals from a cross-section of the economy provided remarks in the first plenary session about their views of the risks to workers that have arisen and will arise in a green economy and how we can more fully integrate health and safety into green jobs. They then joined in a panel discussion moderated by Donna Heidel, CIH, Prevention through Design coordinator for NIOSH, in which questions from the audience were invited. These panelists were:

- Jim Young, national education and policy director, Blue Green Alliance
- John Henshaw, president of Henshaw and Associates (and former OSHA administrator)
- Edward Quevedo, J.D., senior counsel, Paladin Law Group LLP
- Anthony Bernheim, FAIA, LEED® AP, sustainability principal, AECOM
- Mike Acott, president of National Asphalt Pavement Association
- Margaret Quinn. Sc.D., professor, Department of Work Environment, University of Massachusetts, Lowell

To kick off the workgroups on the second day, the following panelists from industry, academia, labor, and government highlighted the conflicts that can arise when occupational safety and health is not included in the planning stages of green economic ventures:

- Bruce Main, PE, CSP, president of design safety engineering, inc.
- Michael Wilson, Ph.D., M.P.H., research scientist, Center for Occupational and Environmental Health at School of Public Health, University of California, Berkeley; also associate director for Integrated Sciences of the Berkeley Center for Green Chemistry
- John Hatfield, senior manager for Global EHS Shared Services, Applied Materials
- Paul Renner, J.D., associate director, The Labor Institute
- Joseph "Chip" Hughes, Ph.D. director of Worker Education and Training Programs, NIEHS

In the second plenary session, two additional experts from industry and academia added their perspectives:

- Peter Binney, PE, vice president of sustainable planning, Black & Veatch
- Megan Schwarzman, M.D., M.P.H., research scientist, Center for Occupational and Environmental Health, School of Public Health, University of California, Berkeley;

also associate director for Health and the Environment of the Berkeley Center for Green Chemistry

At the end of the workshop on its third day, concluding remarks were provided by David Michaels, Ph.D., M.P.H., assistant secretary of Labor for the Occupational Safety and Health Administration.

Summaries of the speeches and the audience responses from all the above session are provided under Results.

II.B. Recommendations from Occupational Safety and Health Practitioners

The 20 leaders and experts listed above were part of a total workshop participation of 170 individuals representing mostly a diverse group from government agencies including the European Agency for Safety and Health at Work (40%); labor, nonprofits, and university centers (29%); and industry, including their trade associations, builders, and consultants (28%). After listening to the presentations of the invited plenary session speakers and panelists, all participants were asked to attend two breakout discussion groups to hone in on the occupational safety and health (OSH) needs within economic sectors likely to be affected as the economy transitions to green and more environmentally sustainable practices.

The six economic sectors that were explored were titled as follows:

- Construction/Infrastructure/Repurposing
- Manufacturing/Emerging Technology
- Energy, Mining, and Building Operation and Maintenance
- Agriculture, Forestry, and Fishing
- Transportation
- Waste Management

Each breakout session was led by a practitioner experienced in that economic sector, and each followed a similar path of exploration as described below and depicted graphically in Figure 1.

1. Because there is no one all-encompassing definition of what defines a green economy, each workgroup started by **listing examples of jobs that would likely be part of that economy.** Once examples were stated, the participants listed **the types of OSH risks that workers were likely to face in these jobs** and then discussed how they differed, if at all, from jobs in the recent historical economy. The purpose of this exploration was to build a framework for the discussions to follow. (Note: Subsequent to this workshop, the Bureau of Labor Statistics published in the Federal Register, a "Notice of comment received and final definition of green jobs" [75 Fed. Reg*. 57506(2010)].)
2. Once risks were defined for workers in the green economy, the breakout session participants set out to **explore and list gaps and barriers in current business practices that allow OSH to be overlooked.** These gaps were categorized in one of four ways:

*_Federal Register_. See Fed. Reg. in references

a. *conflicts between OSH and green* where promoting something for its environmental benefits could create greater risks for workers

b. *unrecognized or untapped synergies between OSH and green* where the OSH community has yet to partner with environmental advocates for common advantage

c. *knowledge deployment gaps* where existing OSH tools and expertise are available but not widely disseminated or used

d. *managing the unknown* where there is inadequate knowledge of either risks or inadequate surveillance for sentinel events to prevent serious safety and health failures

3. In the design of the workshop, the leaders were asked to spend the bulk of each 2-hour breakout session on this task, specifically asking the participants to **recommend activities to close the gaps and remove the barriers** that were just identified. Each recommended activity was categorized in one of four ways:

    a. *Policy and Leadership* includes OSH considerations that are incorporated in green economy standards, regulations, and guidance; and actions by a few will create significant incentives for many to adopt better OSH practices.

    b. *Practice* identifies or develops and then shares best practices for including OSH into green buildings, technologies, and products; and green job employers and workers adopt work methods that minimize risk.

    c. *Education* shares knowledge in classrooms and on the job about where the risks are and how to minimize them before exposure to the hazard.

    d. *Research* involves universities and agencies that investigate hazards and assess risks in more detail, evaluate control options, and generate guides that can be used to develop better policy, practice, and educational tools in the future.

4. Finally, the **activities were prioritized** by the participants using a three step process.

    a. Breakout session voting process: Each breakout group participant was given 10 votes. All the activities were listed on poster boards, and at the end of the session each person distributed their 10 votes in any manner they desired among all the recommended activities from the session.

    b. The leaders of the breakout groups then looked at all the recommendations and the votes received in the sessions they ran. Agriculture and Transportation were each explored in only one session, whereas all other economic sectors were explored in two independent sessions. From their findings, the leaders selected two recommendations per activity category to bring to the attention of the combined audience on the last day of the workshop for additional prioritization.

    c. Finally, 48 recommended activities culled from the process were posted in the last session and all audience members rated each on a scale of 1 to 5 as to which should be given priority to make OSH a more compelling aspect of the green economy. Those votes were collected and totaled.

Figure 1. Logic Flow for Conduct of Breakout Sessions

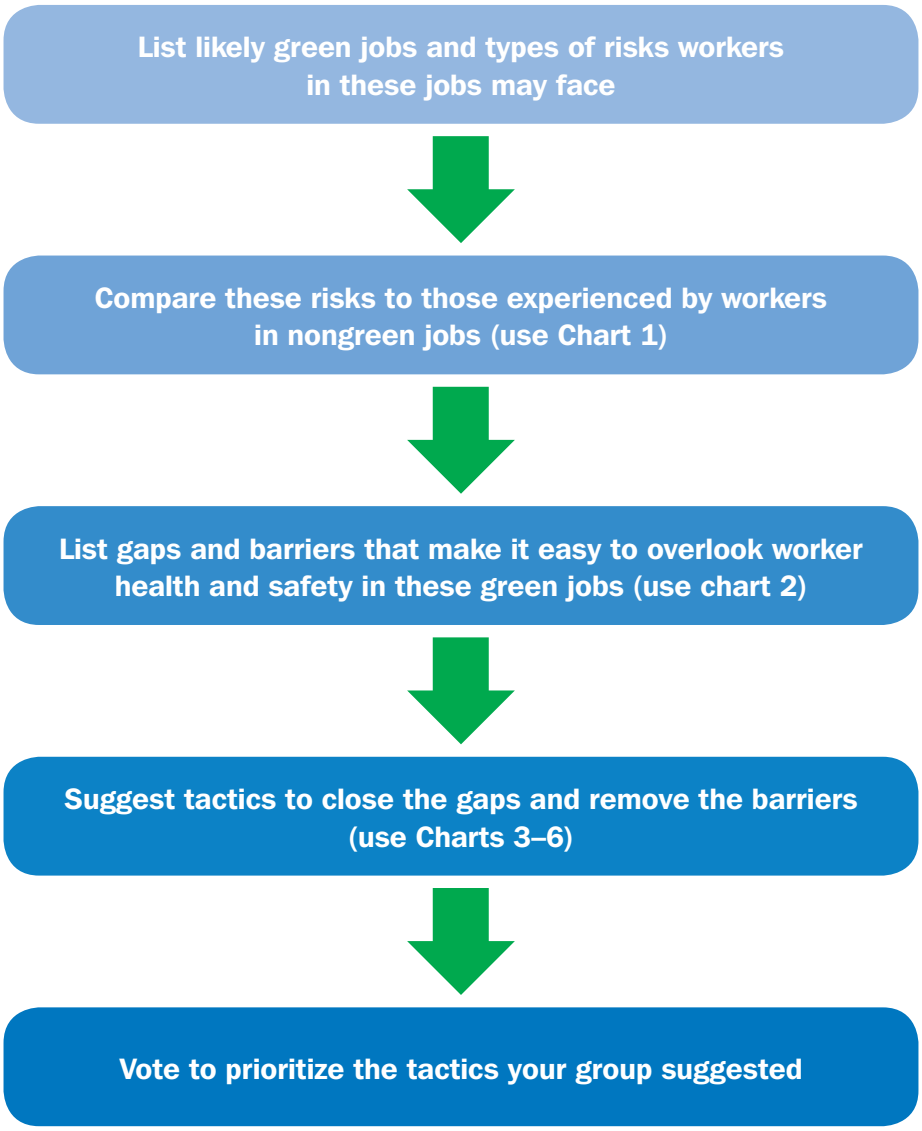

Chart 1. Identifying Green Jobs and Associated Hazards/Risks

(Name of sector breakout)		
Jobs in the Green Economy (where?)	Health and Safety Hazards/Risks	How they differ from historical jobs (if at all)

Chart 2. Gaps and Barriers in Current Practice Preventing Integration of OSH into Green

Conflicts between "Green" and OSH	Synergies between "green" and OSH
Re-deploying existing OSH knowledge	Managing the unknown

Chart 3. How to Remove Barriers and Make Green Jobs Safer via the Practice of OSH

Practice activities in (name of sector breakout)		
… making OSH more compelling	Who can make it happen?	Importance/Priority

Chart 4. How to Remove Barriers and Make Green Jobs Safer via Education and Outreach

Education and outreach activities in (name of sector)		
… Promoting "What we know"	Who can make it happen?	Importance/Priority

Chart 5. How to Remove Barriers and Make Green Jobs Safer via Policies and Leadership

Policy activities in (name of sector breakout)		
… creating new policies and standards	Who can make it happen?	Importance/Priority

Chart 6. How to Remove Barriers and Make Green Jobs Safer via Research

Policy activities in (name of sector breakout)		
… resolving "what we don't know"	Who can make it happen?	Importance/Priority

III. RESULTS

III.A. Guidance from Plenary Session Speakers and Panelists

III.A.1. What Makes a Green Job?

An initial take-away from the workshop was the understanding that a "green job" is not easy to define. Millions of jobs will be created by making buildings more energy efficient, manufacturing and installing renewable energy equipment, controlling toxic waste, and pursuing a variety of other green objectives. But if jobs like these are not also safe for those workers, should they really be considered "green?"

"Most descriptions of a green job state that such jobs cut consumption of energy, raw materials, and water through high-efficiency strategies and help to decarbonize the economy, ultimately reducing and reversing the trend to greater and greater greenhouse gas emissions," said **NIOSH Director John Howard, M.D., M.P.H., J.D.** But in several recent instances, "insufficient attention has been paid to how safe the newly greened process is," with the result that "a green job is not necessarily a safe one for workers."

For a green job to be truly sustainable, "the work itself must also be sustainably safe for the person who performs the job," which means that "the environmental concept of sustainability must be enlarged," Dr. Howard said. A green job "must be one that can be performed safely and result in no material impairment to worker health" [NIOSH 2009a].

John Bucher, Ph.D., associate director of NIEHS National Toxicology Program, said the development of alternative energy resources and green chemistry reflects a "simple societal recognition that we need to do things differently." But to bring that transition full circle, these jobs "need to be good jobs and they need to be safe jobs."

Christine Branche, Ph.D., principal associate director of NIOSH, noted that "green and sustainable practices are gaining momentum in the United States economy, and this gives us the opportunity to make a case for occupational safety and health" as a fundamental element of sustainability. Dr. Branche cited health and safety implications of three common green technology initiatives:

- isocyanates released during the application of polyurethane foam insulation
- respiratory and nervous system effects of 1-bromopropane, which was used as an alternative to ozone-depleting chlorofluorocarbons
- falls, fire hazards, and other risks associated with installing and maintaining wind turbines

David Michaels, Ph.D., M.P.H., assistant secretary of labor for OSHA, said the green revolution promises to transform the economy, while meeting demands for long-term stewardship of resources. But a sense of rush on the part of many employers draws attention away from worker safety, leading to many preventable injuries and deaths. The alternative is to identify potential hazards as they emerge, while working to integrate worker safety and health concerns into all aspects of green production [OSHA 2009].

Dr. Michaels said many people instinctively assume that green jobs are safe. But when staff at OSHA look at a weatherization or renovation project, they see the potential for lead or asbestos exposure. Foam insulation means the risk of isocyanate exposure, rooftop solar power brings fall hazards, and wind turbine construction represents a possible lockout hazard.

Bruce Main, PE, CSP, president of design safety engineering, inc., said green workplaces should adopt the risk assessment process of identifying hazards, assessing risks, reducing risks to an acceptable level, documenting the results, and following up. Incidents may still occur in settings where risk assessments have been carried out in good faith, but using risk assessments will identify more hazards and lead to reducing risk. Mr. Main provided an example of tasks on a wind turbine rotor hub that required a service technician to enter the rotor hub 300 feet above the ground without any way of locking the hub pin in place to prevent the pin from being released and the rotor unexpectedly turning.

John Hatfield, senior manager at Applied Materials cited two challenges for risk assessment in green high-technology jobs: the need for information on new chemistries and physical hazards and on the applicable regulatory requirements; and the emergence of new players, customers, and vendors.

"They may have different experiences and different tolerances for hazard, different knowledge levels and understanding," he said. The solution is to communicate more effectively, spend more time on initial job hazard assessments at the design stage of a project, and, sometimes, to introduce controls at a lower action threshold.

Jim Young, national education director with the Blue Green Alliance, affirmed the basic premise that solutions to environmental problems create jobs. He defined green jobs as "blue-collar jobs with a green purpose," noting that 8.5 million renewable energy and energy efficiency jobs already existed in the United States in 2006.

Many green jobs "are just the same jobs people have been doing for a long time, but for a different purpose or with a different process," Mr. Young said. But "a job that's exploitive and dangerous is not a green job."

Edward Quevedo, J.D., chair of the sustainability group at Paladin Law Group LLP, said removing negative impacts should be a minimum goal. "Our opportunity here is not to create change, but to create transformation. Change is always reactive, done from the outside," whereas "transformation comes from the inside of an enterprise, a person, or a nation-state." He encouraged participants to think beyond sustainability to a process of regenerative development and treat green jobs as more than an opportunity to reduce adverse effects to zero. "It's to turn the arrow the other way, to create meaning and worth, to create well-being."

Keynote speaker Michael Wright, director of health, safety, and environment for the United Steelworkers of America (USW), cautioned that the simplest definitions of green jobs lead to the conclusion that jobs were greener in Victorian London than they are today. "By almost any definition, [green jobs] include jobs that recycle materials that would otherwise be thrown away," he said.

By that measure, the toshers, mudlarks, bone-pickers, and "pure" finders who scoured the mudflats and sewers for refuse and trash had green jobs, "but they were hardly safe, and they were

hardly sustainable." And today's green jobs are no safer or healthier than any other work. If you fall 40 feet to your death, it doesn't matter whether you were installing solar panels on a roof or a smokestack." If a worker suffers lithium poisoning, the effect is the same, whether his or her job involved high-tech batteries or pharmaceutical products.

Still, Mr. Wright stressed that the need to get Americans back to work is a major motivator for green jobs and infrastructure. With many steelworkers on restricted hours or out of work, "the only way we can maintain jobs in this country is through a transformation to a green economy. That's essential to our members' survival and to the long-term survival of members everywhere, not to mention to the long-term survival of the planet."

III.A.2. The Context

Dr. Branche said 146 million workers enter U.S. workplaces every day [BLS 2008a]. By the end of that day, 9,000 are treated in an emergency room for a work-related injury or illness; 200 are hospitalized [CDC 2004]; 5,578 sustain lost-time injuries or illnesses [BLS 2008b]; 565 acquire work-related diseases [Steenland et. al 2003], and 15 die [BLS 2008b].

Each year, said health and safety specialist **John Henshaw**, workplace accidents lead to approximately 5,000 deaths, 3.7 million injuries, 294,000 cases of illness [BLS 2008b], and $128 to $155 billion in costs to the U.S. economy [Schulte 2005]. Those totals are likely underreported, and they exclude the social consequences for families and communities.

"We know we can prevent a lot of injuries and fatalities and incidents in workplaces that are properly designed and properly executed," Mr. Henshaw said. But positive efforts like NIOSH's Prevention through Design initiative, in which extra effort goes into eliminating safety risks in the design stage, must contend with "a lack of a safety culture by the owners, the designers, the contractors, the operators, the work force, and it goes on and on." Green jobs offer an opportunity to change this underlying culture, "but in our efforts to rush to green, we have to be extremely careful not to forget about how to do it correctly."

Paul Renner, J.D., associate director of The Labor Institute, put that culture in perspective with a rendition of his "Joe Chemical Rant," a version of which he had previously posted on YouTube. "This is America, and in America, chemicals have rights," he said. They are entitled to free association with workers, communities, and the environment, regardless of their disruptive, synergistic, or toxic qualities. They have the right to due process of law and to be considered innocent until proven toxic.

"To even be considered toxic you need a body count," Mr. Renner said, noting that chemicals also have the right to avoid self incrimination: "I don't have to tell you anything. I know my rights. They're called trade secrets."

Chemicals have a right to a speedy trial, Mr. Renner said, but trials are rare in an era of "non-regulatory regulation." When a case goes to court, he said, "you have your Miranda. We have our asbestos."

Margaret Quinn, Sc.D., CIH, of the University of Massachusetts-Lowell underscored the scope of the problem, noting that today more than 80,000 chemicals are available commercially with about 1,000 new ones being introduced each year. In 2006, more than 34 million metric tons of chemical substances were produced in or imported into the United States every day. Workers and

the environment are impacted by these chemicals at nearly every step of their production, use, and disposal.

Dr. Michaels argued against a piecemeal approach to chemical regulation, noting that it is not always sufficient to replace a hazardous substance with an alternative that seems safer. The replacement may be too expensive and could turn out to be equally dangerous if it hasn't gone through adequate testing. Although thousands of chemicals are believed to be hazardous, he said OSHA only regulates about 500 of them, often based on science from the 1950s or the 1960s. He listed five key steps for green reform:

- engaging workers in comprehensive workplace health and safety programs
- regulating worker exposure to chemicals
- Prevention through Design principles
- accelerated rulemaking for urgently needed standards, with input from scientists, engineers, academics, workers, and business
- strengthening workers' voices in the workplace

A participant placed the precautionary principle at the heart of the discussion and suggested that governments act as conveners, using a wide dialogue with companies, unions, nongovernment organizations, and the health and safety community. Panelist **Michael Wilson**, Ph.D., M.P.H., agreed that the time is now for active engagement of the OSH community, with chemical production on track to double over the next 24 years and sweeping new policy efforts underway in the United States and abroad.

Peter Binney, PE, vice president and director of sustainable planning at Black & Veatch, said recent regulatory developments in Europe provide a context for discussing the precautionary principle. "It's the way of taking action when we don't know enough yet to clearly establish that a level of a certain chemical is hazardous," he said. "That's a key concept, because it tells us how to make decisions in the absence of full scientific certainty" about a substance that can accumulate for a generation. "But we need to find the balance that allows for growth and stability in the economy—whether jobs, manufacturing, or the provision of services—and in maintaining and expanding infrastructure—such as energy, transportation, and water—while protecting environmental and social values. "Going green" does not mean "doing nothing"; it means managing the footprint of our activities by promoting efficiency and minimizing consumption by using technological advancements and doing things in safer and smarter ways."

Megan Schwarzman, M.D., M.P.H., of the Center for Occupational and Environmental Health, UC Berkeley School of Public Health, listed photovoltaic manufacturing, e-waste recycling, and green building as examples of jobs associated with the green economy that pose many of the same health hazards as their counterparts in other sectors. The health and safety concerns associated with these jobs point to the value of life-cycle thinking in assessing green jobs. She said the photovoltaic manufacturing process relies on hazardous chemicals, flammable liquids, explosives, and corrosive materials, with inputs that are classified around the world as carcinogens or as neurological or reproductive hazards. The industry is expected to grow exponentially and is "based on many substances well known for their hazards that may nevertheless be overlooked in this sector devoted to addressing environmental concerns."

Meanwhile, the disposal of used IT hardware has led to a "global tide of e-waste," with the United States alone producing three million tons per year. Some of that material is recycled, the rest is land filled, but 50%–80% of the "recycled" material is exported to areas such as China, India, and Africa, where unsafe practices lead to multiple severe environmental and health hazards. Despite efforts to control e-waste dumping through the 1989 Basel Convention, she called the handling of e-waste "an illustration that the act of recycling will not address the end-of-life issues for electronics unless the conditions under which they're recycled are vastly improved. It points out that if you want to understand the health and environmental effects of any technology, you really have to look at the whole life cycle."

She added that green building construction—another sector touted for its promise of creating green jobs—can still expose workers to several categories of harmful substances, including volatile organic compounds, which are recognized in the Leadership in Energy and Environmental Design® (LEED) standard, and other chemicals such as phthalates, perfluorinated compounds, halogenated flame retardants, and bisphenol A (BPA), which are not listed. While the LEED standards address aspects of energy use and resource consumption, they do very little to reduce the use of potentially toxic materials.

To deal with the structural problems behind the specific examples, **Dr. Schwarzman** called for policy reforms to address gaps in data, safety, and technology, beginning with a commitment to disclose ingredient and hazard information and share it across the supply chain. "Without those three things, we are missing the tools we need to protect worker health." Michael Wilson agreed that because TSCA does not require chemical producers to generate and disclose hazard information on new or existing chemicals, data gaps have prevented effective identification and regulation of toxic substances; the resulting market has dampened interest in green chemistry by producers, leading to a growing technology gap in green chemistry sciences and technology.

Dr. Quinn called for developing a big picture framework that fully integrates green and safe and that can be used to guide the creation of truly green jobs. "We need to embrace a bigger vision that views green and safe as one and the same. We have divided the way we think about health and safety into 'inside the workplace'—that is, jobs, labor, work—and 'outside the workplace'—that is, the environment, the community, and consumers. When we divide the system of production and use of a chemical or other material in this way, we define our problems and seek solutions within a narrowed scope that limits our ability to see all of the factors that contribute to a problem and that will likely also contribute to its solution. Narrowly solving a health and safety problem often results in risk shifting, meaning we solve the problem for one element of the system simply by shifting the risk to another element. This is what is happening when so-called green jobs are unsafe."

"We need to embrace a bigger vision that green equals safe," she said, recognizing that sustainability is about conserving natural resources and promoting healthy economic development. "We need to design hazards out; to redesign systems of production so that they are nonpolluting, conserving of energy and natural resources, and are safe and healthful for workers, neighbors, and consumers."

Alongside the environmental analysis required to make green jobs safe, several speakers stressed the economic sustainability of green jobs. **Mr. Young** said the discussion was taking place at a

time of historic confluence, with labor and environmental organizations joining together to link environmental initiatives with economic justice.

"We need to put millions of Americans back to work," he said, "but we can't get America working just doing anything." A job is unsustainable if it involves selling homes at inflated value or using stimulus dollars to buy wind turbines manufactured in China then watching the carbon footprint follow the equipment across the Pacific Ocean.

Mr. Binney said a lasting economic recovery will depend on reliable infrastructure. "Our roads, rail systems, dams, power plants, water and wastewater systems, and other infrastructure have a design life to them, and we're getting toward the end of that period for many of these systems," he said. Although the American Recovery and Reinvestment Act of 2009 (Public Law 111–5) provides tens of billions of dollars for energy, water, and transportation investments, he said $2.2 trillion will be needed in the next 5 years to renew America's current infrastructure. "Without that core framework of infrastructure, America's manufactured goods, urban areas, and industrial capacity will not be able to operate effectively and could lose their global competitiveness. The financial implications of that constrained economy can have an adverse effect on governments through reduced revenues and their ability to gain the benefits of the many worthwhile commitments to ecosystem restoration, jobs stability/growth, and worker safety."

Mr. Wright said the combination of economic and environmental imperatives represents a unique opportunity. "We have a chance here, using green jobs as a wedge, to make a quantum leap in workplace protection, and to do that across the board," he said. But "if the new jobs aren't clean, safe, and sustainable, the old ones certainly won't be either," he warned. "If we are just making new products in the same old way, the kind of economic transition we need is not going to happen."

III.A.3. Understanding Hazards: The Drive for Data

Much of the discussion in the plenary sessions (as well as in the breakout sessions, summarized in the next section) highlighted a severe lack of data on the health and safety of different substances and industrial processes. **Dr. Wilson** described this gap as a symptom of a "deeply broken U.S. chemicals policy, particularly TSCA" and suggested two possible paths for improvement: incremental health and safety improvements in green jobs or fundamental changes in chemicals policy, brought about with the active participation of OSH professionals.

Dr. Wilson called for the second path, saying global chemical production is expected to quadruple from 2000 to 2050 and incremental approaches would be insufficient. In the United States, the Toxic Substances Control Act of 2002 is intended to regulate the 83,000 substances in use, he noted; but with no requirements on companies to generate information on chemicals' hazard traits, it is impossible for users, workers, governments, or the general public to distinguish safer substances in the market. The U.S. government therefore lacks the information to identify and prioritize chemicals, and it faces enormous legal and procedural barriers in taking action even on known hazards: since 1976, the Environmental Protection Agency has undertaken formal rule making on only five substances.

Dr. Schwarzman said standard toxicity testing methods used for regulatory purposes have not so far been designed to assess endocrine disruption. Bisphenol A (BPA), for example, would not

be identified as a carcinogen by current criteria, but "emerging evidence suggests it may contribute to the risk of breast and prostate cancer by affecting development in a way that makes these tissues more likely to develop cancer in response to future exposures." Such endocrine disruptors act at much lower doses than standard toxicological testing would detect, and the timing of exposure is critical for developing humans or animals. "For pregnant women, every day is Take Your Child to Work Day," she said, so it is tremendously important to assess the potential impact of exposures to substances that might not be as significant for an adult.

Moreover, when testing is performed on a chemical-by-chemical basis, it can miss the synergistic effects of multiple substances with similar mechanisms. "No one thinks that taking all the medicine in the medicine chest will have the same effect as taking each one individually," she said, "but that's equivalent to what occurs" with chemical exposures both in the workplace and beyond. Recent biomonitoring identified 287 synthetic chemicals and pollutants in umbilical cord blood, a finding that "resonates very strongly with many people, not just workers."

Chip Hughes, Ph.D., director of NIEHS Worker Education and Training Program, said the history of BPA showed the impact of public awareness, even in an atmosphere of little or no regulatory guidance. "When the customer speaks, that can have a profound effect on workers' safety and health."

But **Dr. Wilson** said, while the data on BPA are compelling, it is impossible to know whether BPA exposure in fact constitutes a public or environmental health priority relative to other chemical hazards. "Because we lack a reasonable base of information from producers on the hazards of chemicals in commerce, BPA may just be the one that fell off the apple cart," he said. "We don't know what the whole picture looks like, so we have no choice but to focus on one piece of the jigsaw puzzle when it falls out of the box."

A participant expressed concern about the rapid introduction of nanotechnology. "We live with this right now," he said. "It's being used in multiple applications, but we still don't know whether it will be our next major asbestos-type situation."

Dr. Hughes cited a recent case study on control banding in nanotechnology in which workers and local health professionals used work practice and exposure characterization as a basis for a health and safety plan. "All of this is being done in the absence of any regulatory guidance at all," he said. "It encompassed this paradigm of characterizing unknowns and trying to think about worker protection as a core part of the operation." **Dr. Wilson** said the example still illustrated a shortcoming in national chemicals policy: "We don't require the producers of chemicals or materials to generate and disclose basic information on the hazardous properties of the products they're putting on the market; doing so would greatly inform our policy and regulatory priorities, and it would certainly reduce the existing competitiveness of toxic substances in the market."

III.A.4. Gaps in Policy and Practice

Workshop presenters and participants cited a wide range of specific hazards associated with jobs that might be considered green employment. Many of the examples illustrated gaps in policy or process that run counter to the effort to make green jobs safe.

Mr. Binney said infrastructure projects in the current economic environment are being bid at 20%–40% below engineers' estimates, with the result that delivery schedules are severely compressed, fewer workers are on the job, and project oversight may be less effective. He warned that

increased reliance on public-private partnerships could affect employment practices, contractual relationships, and relationships with insurance providers. "A constrained economy can significantly change the dynamics of the owner-worker relationship and a continuing commitment to worker safety should be maintained even in periods where there could be pressures from increased cost competition, worker turnover, reduced training investments, and faster production rates."

Mr. Henshaw said safety is taking a back seat to the impetus for green products and the concurrent rush to spend stimulus dollars. "Are we covering safety?" he asked. "Have we defined how the money should be spent? It can't be green or sustainable unless it includes health and safety," and until "workers not only go home safe, but they're more productive, more active, and they're increasing their value in society."

A participant said the need for speed in completing infrastructure projects under the American Recovery and Reinvestment Act of 2009 had led to needless workplace risk, injury, and death. At the massive City Center development in Las Vegas, a safety review team found that an exterior skin applied to one of the towers under construction was a requirement to comply with the LEED rating but drove the temperature on the job site up to 105˚F, leading to a couple of ambulance calls for heat stress.

The team also studied a fatal incident where a worker fell off a scaffold. The episode appeared to be behavior related, "but he had been working 12- and 14-hour days, and he was at the end of his shift," the participant reported. "So ask yourself, whose behavior is it" when a foreman is pushing for performance and a contractor is trying to avoid penalties for completing the project late.

A number of speakers stressed the importance of educating members of a new work force who have little or no understanding of health and safety issues. **Mr. Henshaw** cited a 2008 paper that identified a lack of formal health and safety training as one of the barriers to Prevention through Design (PtD) goals [Mann 2008]. Many business people understand the economic impact of workplace hazards and prefer to build PtD into their work processes rather than facing litigation and other consequences when a project goes wrong, he said. But other owners and designers are afraid they will be held liable for poor design or incur higher engineering costs if they adopt a preventive approach.

Even when states are prepared to regulate workplace hazards more effectively, **Dr. Wilson** said gaps in federal policy present a major obstacle. California is establishing a process to identify, prioritize, and take action on chemicals of concern. But due to the gap in data brought about by federal chemicals policy, namely TSCA, "we don't know what chemicals are used in the state, where they're used, for what purpose, by whom, or where they ultimately go, let alone their hazardous properties. This is similar in all other U.S. states." Although EPA Administrator Lisa Jackson recently announced plans to restructure the Toxic Substances Control Act of 2002, "We haven't seen the occupational safety and health community in those discussions. There's an enormous opportunity here for generational change in chemicals policy, but we are risking losing that opportunity because we have not been at the table."

Anthony Bernheim, FAIA, LEED® AP, sustainability principal, AECOM, reminded everyone that the private sector has been acting independently of regulation to promote greener building and practices by introducing various labeling schemes and voluntary standards, and yet workers are still exposed to hazards that those schemes and standards fail to take into account. "The

materials from which a building is constructed contribute to the ambient air quality, which, if poor and polluted with volatile organic compounds, semi volatile organic compounds, inorganic gasses and particulate matter, can lead to worker ill health and, beyond that, to a person's inability to concentrate on their work and on appropriate safety precautions. Thus there is a need to re-engineer materials to make them safer to install and remove; select materials that support good indoor air quality; educate contractors about safe and healthy material installation techniques; and provide ventilation on the construction site during construction to dissipate the pollutants, etc. The problem is that green building standards have gaps in that they don't require all these behaviors."

III.A.5. Regulation and Competitive Advantage

Several speakers noted that the United States faces a competitive disadvantage as its own regulations have not been significantly updated in years, while other regions like the European Union have imposed tougher regulations, for example on toxic substances.

Mr. Hughes said standards must be harmonized across all companies and countries, noting that emerging industries like nanotechnology are developing in the private sector with no government oversight. "Having federal agencies come to the table in some way with the private sector is what we have to figure out how to make happen," he said, even if sound workplace practices are "not something OSHA or EPA can tell you. It's something you figure out on the shop floor."

Mr. Main said global regulations must be scalable and flexible. "If you're operating in China, you can't necessarily go through and say, 'here's the way it's going to be,'" particularly if a company that is accustomed to more intensive regulation is working with a local partner. But **Dr. Wilson** said mushrooming production in China and India will create a new form of jeopardy for the United States.

"Since we don't have a policy structure in place to assess chemicals of concern and take action where we feel we need to, the U.S. risks becoming a dumping ground for materials that are prohibited for use in the EU," he said. For example, pressed wood products containing formaldehyde are banned in the EU and in California but not in other U.S. states, "so we are a large market for pressed wood products made with formaldehyde-based glues," which not surprisingly found their way into the Federal Emergency Management Agency, or FEMA, trailers. If long-overdue regulation of chemicals and products in the United States continues to fall behind the EU, this trend is likely to intensify as production increases.

Dr. Wilson said the United States, unlike the EU, had "paid inadequate attention over the last several years" to the linkages between chemicals policy and green chemistry and had chosen not to engage in long-overdue reforms of TSCA. One result is that the EU is now ahead in this arena and could rapidly outpace the United States in coming years in innovations in green chemistry sciences, technology, and commercial applications. The EU Commission Registration, Evaluation, Authorisation and Restriction of Chemical substances (REACH) regulation, in particular, is already causing companies to scrutinize their chemical and product portfolios and better understand their supply chains (EC 1907/2006) [EU 2006].

"REACH means that workers, communities, and the environment have rights," **Mr. Renner** said. Under the regulation, toxic and other hazardous properties must be disclosed and weighed against the public good, with the result that some chemicals are phased out and innovation in

green chemistry becomes more likely. This raises the question of whether workers and communities in Europe are more deserving than their counterparts in America. "Apparently so," Renner said.

Dr. Wilson said the EU has broken the ice on policies that require transparency from chemical producers for the first time in a generation. Much of the information they provide is driven downstream to users, and the disclosure mechanisms in REACH also provide a basis for informed action by governments.

The absence of similar policies in the United States puts the country at a crossroads, he said. "We have a choice to serve in a regressive role with regard to the EU or to help advance those policies. I think we can do a lot in either direction, depending on what choice we make."

Noting that 10 workers die of occupational exposure to cancer for each one involved in a catastrophic accident, **Paul Schulte**, Ph.D., director, Education and Information Division, NIOSH, said REACH is expected to save $60 billion in worker health benefits. "We'd like to see this issue exposed and some of the benefits garnered by this country."

"We are up against an enormous, untended-to challenge that's on the scale of climate change when it comes to managing industrial chemicals," **Dr. Wilson** said. Solutions will depend on the active participation of labor, governments, and the private sector.

Dr. Schwarzman said comprehensive sharing of health and safety data could eliminate 50% of all cases of workplace asthma, 10,000 cases of chronic obstructive pulmonary disease, and 4,300 cases of cancers per year.

III.A.6. Health and Safety Standards for Green Jobs

Several speakers touched on the philosophical basis and practical applications of a health and safety standard for green jobs.

Dr. Branche noted that social equity is one of the three pillars of sustainable development and that social sustainability must include workers. "The strength of our economy depends on a safe and healthy work force," she said, and that means teaching the market to demand accountability for safety and health.

Mr. Quevedo said the concept of sustainability has been a work in progress since the release of Agenda 21 in the early 1990s. "Sustainability isn't a fad. It isn't a movement. It's an integrated discipline" that brings together different forms of intellectual endeavor to make measurably better business decisions in the face of risk and change.

Sustainability is about making the most of human, natural, and financial capital, but Edward Quevedo said the process begins with people "because we're the decision-makers. As one towering historical figure said, 'we are the deciders.'" People ultimately decide whether to spend natural capital wisely or poorly, use workers' time safely or not, whether to manipulate financial markets or operate in a transparent, accountable manner. "That's what sustainability is."

To begin integrating health and safety concerns with green jobs, **Dr. Branche** stressed the immediate need to:

- define, categorize, and track green jobs;
- evaluate all green jobs, processes, and products for hazards that can cause health and safety risks to workers;
- integrate health and safety, energy efficiency, and environmental protection efforts;
- plan early for prevention;
- incorporate health and safety in green jobs training; and
- include health and safety as a green jobs benchmark.

Mr. Henshaw said a closer alignment between health and safety and green jobs would be achieved by:

- holding owners, investors, contractors, operators, recyclers, and waste handlers accountable for safety and health throughout the product life cycle;
- integrating safety and health into product design, procurement, operations, maintenance, and sourcing;
- involving health and safety professionals in all aspects of the supply and production chain, from initial design and planning through final disposal or recycling; and
- integrating safety and health into the rating, validation, and certification systems for green products.

"Green is health and safety, and it has to deal with the public," **Mr. Henshaw** said. "It can't be green unless it properly considers workers' safety and health. It can't be sustainable unless it properly considers public and worker safety and health throughout the entire product or service life cycle." **Dr. Wright** agreed that health and safety advocates can earn broader support by linking workplace issues with public safety.

Mr. Main said the International Standards Organization's (ISO) 31000, the American National Standards Institute (ANSI) standards on Safety of Machinery ANSI B11.0, the American Society of Safety Engineers (ASSE) Prevention through Design (ASSE) technical report TR-Z790.001–2009 all offer approaches to risk assessment and management, but standards are only one part of the answer. A more comprehensive approach bridges the information gap between the initial design of a device or process and the reality of day-to-day operations. He cited an example of an elevated work platform around a food conveying system that met the standards for work platforms and appeared safe for use. However, understanding all the tasks performed on the equipment identified several additional hazards previously not identified, including fall hazards during cleaning tasks and ergonomic hazards loading materials.

Mike Acott, president of the National Asphalt Paving Association, traced a 16-year effort to use science to achieve economic and operational benefits in his industry. Asphalt paving employs 300,000 workers, and of the 2.5 million miles of paved roads in the United States, 92% are paved with asphalt. "When people talk about the stimulus package, we are the ones who are shovel-ready to do the job," he said.

The industry reclaims 100 million tons of asphalt per year and has worked since 1993 to ventilate the fumes from highway paving machines away from workers, Acott said. Years ago, all the

industry's stakeholders signed a voluntary agreement to introduce a new engineering control system on all highway paving equipment manufactured after 1997 [Mead et al. 1999]. Twelve years later, virtually all the new units are in place, at a cost of less than one cent per ton of material.

More recently, the industry has begun introducing a lower-temperature production process that cuts energy use by 15%–30%, reduces fumes and odor, and permits more recycling and reuse, with corresponding reductions in greenhouse gas emissions. "We've never seen a technology embraced so readily," he said, with 15 states allowing permissive job specifications and hundreds of production plants gearing up for the new process.

However, not all industries are as far down the road toward making green jobs safe. **Dr. Schwarzman** and **Dr. Hughes** both said the U.S. Green Building Council's Leadership in Energy and Environmental Design® (LEED) standard is less than exhaustive in its coverage of health and safety concerns on a building site.

"If we're looking at LEED as a mechanism for reducing occupational risk associated with the use of products, we may not be there yet," **Dr. Schwarzman** said. "We have to think about the entire life cycle and the whole resource process, from manufacturing through product use through disposal. Only in that way will we get at the majority of the chemical hazards posed in workplaces and around the world."

Mr. Bernheim offered that there are alternative standards, such as the Living Building Challenge promoted by the International Living Building Institute, that have more specific requirements around indoor air quality for both worker and occupant than LEED does and that there are at least a score of certifications (including Green Seal Certified, Smart Certified, FSC accredited, Fair Trade Certified, and many Scientific Certification Systems (SCS) labels) that already allow designers to begin selecting better materials for both environmental and worker health.

Dr. Schwarzman and **Dr. Wilson** both cited a statement by students at the Berkeley Center for Green Chemistry as an example of the health and safety standard expected by future generations:

> *We seek a world in which there is open collaboration among the disciplines of chemistry, engineering, policy, business, and environmental and public health. We seek a world in which research toward sustainable products and processes is well-funded and respected. We seek a marketplace in which those chemicals are valued over their less benign counterparts.*
>
> *To us, green chemistry includes all of these things, and its full implementation will require fundamental changes in the way chemistry is practiced and taught.*

Workshop participants stressed the importance of coalition building, to move a health and safety agenda forward. "The first theme I heard is that we need to develop coalitions and coordinate with green organizations, industry, government agencies, and advocacy groups to support our shared goals from a number of different fronts," said **Donna Heidel**, CIH, of NIOSH's Education and Information Division.

III.A.7. Reaching a Varied Audience… and Creating Change

Dr. Michaels said Labor Secretary Hilda Solis had recently announced $55 million in green job grants, to support job training and help workers find jobs in green industries.

Ms. Heidel said each of the breakout groups that met during the workshop talked about disseminating information, assembling case studies and best practices, and developing processes to build safety and health concerns into green jobs. Participants listed workers, engineers, and business leaders, including small businesses, as key target audiences.

But the audience for health and safety education is far wider. Some workshop speakers talked about outreach to establish work forces that have received little or no information in the past, while others discussed new audiences that are just beginning to emerge.

Mr. Quevedo described a project on sustainable management systems and human capital several years ago, involving a large, family-owned winery in California. The researchers began by asking farm workers how to make their work more meaningful, make better use of their skills, and strengthen their relationship to the land. An older worker said this was the first time anyone had asked his opinion or shown concern for his safety on the job. **Mr. Quevedo** recalled how deeply moved he'd been when the worker said someone had finally lived up to the early potential of the farm workers' movement led by Cesar Chavez in the 1960s and 1970s. "I thought there would never be another moment like this," he said.

Dr. Hughes talked about the mix of "burger flippers and nuclear gypsies," who had been called in to decommission and decontaminate the Savannah River Nuclear Plant. For many years, NIEHS has had training programs for workers who were being introduced to "uncontrolled, uncharacterized environments, with a certain unclear roadmap about how their protection would be dealt with."

But he described cleanups like Savannah River, Hurricane Katrina, and the World Trade Center as "a trifecta. We have new industries with new workers in new processes." With an infusion of stimulus funds at Savannah River, "they've hired thousands of people, and that's where the derisive term 'burger flipper' comes from. The other derisive term, 'nuclear gypsy,' comes from this whole work force that lives in a nuclear weapons complex" and migrates from site to site.

The question is, **Dr. Hughes** said, "How [do] we build a safety culture within an operation?" With responsibility for brownfields training, lead remediation, asbestos, and hazardous waste cleanups, the NIEHS program "continues to face the problem that we have new people, young people, untrained people, unskilled people, being put into positions that, from my way of thinking, they're not prepared for."

In NIEHS' brownfields program, a lot of thought and effort have gone into the task of training low-income youth from minority backgrounds to work in environmental remediation. With stimulus projects, however, "we're not really thinking about how we need to train the work force, to communicate information that we in the health professions may know but is not embedded in the work force of the future."

Mr. Main pointed out that solar hot water installations require the skills of a roofer, a plumber, and possibly an electrician in a new situation where any of those specialties might still need to learn how to interact with the others. **Mr. Hatfield** cited solar photovoltaic manufacturing as an area where the processes, hazards, and control options are known, but new customers and vendors will require education. In the breakout sessions, several different sector panels identified new work forces or consumer groups in need of health and safety information.

Ultimately, the need for effective policy, regulation, and education was brought home by a participant who said she represented the families of workers who had been killed in workplace accidents. "I come from a nonprofit where, every year, we read off the names of workers who've been killed in our area," she said. The list contained 177 names last year, "and the families being present brought it home to every single person there."

Dr. Quinn emphasized that integrating occupational and environmental health and safety is not only about preventing negative impacts; it is about creating a positive way forward. For example, redesigning production processes that are safer for workers and conserve energy and natural resources can build economically viable businesses that promote health and environmental quality. And the research, development, and commercialization of safer alternatives can be a force for innovation.

III.B. Recommendations from OSH Practitioners

III.B.1. Construction, Infrastructure, and Repurposing of Materials (Session leader: Matt Gillen)

Jobs and associated risks to construction workers in the green economy

Participants in the two sessions that were focused on *Construction, Infrastructure, and Repurposing of Materials* started out trying to list "green" construction jobs. However, the discussions evolved to discussing how the green economy was encouraging certain types of construction work, such as installation of wind power or solar power, but that in many cases the jobs themselves were not viewed as all that different from other construction work. Some participants suggested that the nature of construction is that each project is broken down into smaller tasks and unit operations that tend to blur unique distinctions. However, several participants suggested that certain "green practices" (e.g., on-site recycling of construction waste) and "green products" (e.g., new types of cements) were likely to play an increasingly important role across many types of jobs and areas of construction. These areas and jobs can be categorized in four ways.

1. **New construction.** Green buildings, many of which in the United States are identified by their pursuit of LEED® certification, are structures that have been constructed using practices that maximize the efficiency with which the buildings and sites use resources (energy, water, and materials) while minimizing building impacts on health and the environment. This is done via design, materials and equipment selection, and particular construction practices. It is intended to consider the entire life cycle of the building. Green LEED®-like projects will provide ongoing opportunities for people already in the construction, architecture, and engineering fields. Engineers and architects may seek certification indicating their expertise in aspects of green design before joining the project teams. However, green construction by itself is not yet a specialized field (most projects pull from available construction crews), and some green practices, such as recycling of construction waste materials, could introduce the potential for additional puncture injuries and musculoskeletal disorders.
2. **Renovation of existing buildings**. Existing buildings use significant amounts of energy and other resources, and retrofitting them to add energy- and water-saving features is an important and growing development. Such work can include weath-

erization upgrades to windows and insulation, installation of solar energy conversion units, biomass-based roofs, low-energy light systems (i.e., compact fluorescent light and light emitting diode), and water collection and treatment systems. One example of a known occupational hazard associated with weatherization is the potential for diisocyanate exposures from application of spray polyurethane foam. This type of insulation product has a very high insulation value and is expected to greatly increase in use. Renovation of older buildings can also involve exposures to in-place hazards such as lead paint and asbestos.

3. **Environmental renovation and restoration.** Brownfield projects are another aspect of the green economy. This is where old manufacturing or otherwise contaminated properties are reclaimed for new use. In the demolition process and in the earth-moving process, workers will be exposed to constituents in those soils and demolished structures. Another green construction job with potential exposure to soils and underground contaminants will be installation of geothermal energy systems.
4. **Green infrastructure.** Some green related construction projects and jobs derive from the need to improve local or national infrastructure. This type of work can range from upgrading old water systems to installing large wind power or solar power installations to developing smart electrical grids to more effectively distributing electric power.

Risks, gaps, and barriers in current practice for integrating OSH into green construction and infrastructure projects

The attendees at first thought that many of the risks that construction workers will face when erecting green buildings are overwhelmingly similar to historical risks, e.g., falls from heights, crush hazards, and electric shock. However, as green construction materials were explored, attendees recognized that some risks might pose unfamiliar chemical exposures to the construction worker. For example, when new composite materials such as fly-ash-based green bricks are drilled or cut, potentially hazardous heavy metals like mercury, arsenic, and chromium, in addition to silica, could be released into the breathing zones of workers.

An example of a disconnect between green construction and worker safety and health that was described in one of the sessions was the effort to protect the integrity of ventilation equipment for building occupants by sealing it during construction. The lack of ventilation during construction increases concentrations of dusts and solvents that the construction worker is exposed to. This was described as meeting the goal of creating a safer building for occupants but at a potential cost of increasing risks to the construction worker.

Participants then discussed the gaps and barriers preventing adequate deployment of OSH knowledge and expertise in the construction sector.

1. **Conflicts between the "drive to green" and the "push for OSH."** The main concern as reflected in the following four examples provided by participants is that environmental concerns drive the process, and with environment as the focus, few heed the voices raising concerns about worker health and safety.

- Project owners write construction contracts with no or minimal requirements for efforts to protect construction workers.
- Caretakers of building standards, such as U.S. Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED®), impose no or minimal requirements for construction worker safety and health [USGBC 2009].
- Mandated environmental activities, such as on-site recycling, are formulated without first exploring potential worker exposure issues.
- Shovel-ready green projects are expected to be built quickly, often before adequate attention is given to the risks to construction workers.

2. **Untapped (and under tapped) synergies between the "drive to green" and the "push for OSH."** There also seems to be a natural, though infrequently tapped, extension of the environmental agenda into the construction world: to add OSH as an integral component, since both aim to protect quality of life. For example, project site health issues would be a logical management requirement for construction of green buildings. Another logical appeal would be to make sure that worker exposure issues are considered during all aspects of a life cycle analysis (supply, fabrication, installation, use, and demolition) for green construction materials and that the life cycle analysis not be restricted to purely environmental issues such as energy consumption. The potential to improve construction safety via linkage with green and sustainable efforts was one of the major areas of agreement among participants. Sustainability was viewed as flawed or incomplete without incorporation of OSH. Safety and health was viewed by some as simply "human asset sustainability." Participants voiced the view that worker safety and health should be placed at least at the same level of importance as energy and environment in sustainability considerations.

3. **Redeploying existing OSH knowledge.** The main gap preventing the deployment of existing OSH knowledge in the construction sector is lack of awareness that there are OSH risks. The participants identified four examples of how that awareness can be increased:

   - List concerns and proper personal protective equipment (PPE) on packaging of construction materials.
   - Develop LEED®-style checklists that specify required activities to minimize OSH risk.
   - Incorporate PtD principles before construction even begins.
   - Perform regular risk-assessments as projects get underway.

4. **Managing the unknown.** Finally, there may be problems associated with green construction that the OSH community is unaware of, largely because of irregular efforts to gather data on worker health and safety both during and after the construction process. Indeed, session participants were concerned about often inadequate attempts to gather actionable information rather than any specific exposure issue. For example, injury and illness reporting may not adequately define or identify the extent of the risks construction workers have faced, and typical attempts to correct the symptoms of problems as they are uncovered may actually mask the systemic causes of risk.

Table 3. Activities Recommended by Construction, Infrastructure, and Repurposing of Materials Workgroup

Activity category	Relative weighting		
	Group 1	Group 2	Combined
Making OSH more compelling	21.7%	24.0%	22.8%
Creating new policies and standards	42.5%	29.0%	36.0%
Promoting "what we know"	35.8%	17.2%	26.9%
Resolving what we don't know	0.0%	29.9%	14.3%

Removing barriers and promoting activities that ensure green construction jobs are safe for workers

Next, the participants listed activities that they believed would close the gaps and remove the barriers identified above. Activities were placed under four distinct categories as described under Methods. At the end of the session, participants were allowed to vote on where strategic priorities should be set to improve safety in the green economy's construction sector.

Specific activities and the relative weightings they were given during voting are described in more detail below. However, looking at the recommendations in total, the construction workgroup consistently recommended that more effort be dedicated to creating new policies and standards (36% average weighting) vs. soft-sell of OSH values (23%), hard-sell (e.g., via training) (27%), and research (14%).

1. **Making OSH more compelling.** Results of the two sessions are summarized in the following table. Participants recommended that primary attention be given to creating standard contract language and planning frameworks facilitating an OSH focus during all phases of construction; the hope was that such language and processes could be promoted and mandated during contract negotiations. There was an equally strong desire to develop an OSH rating system, which could highlight to the community and to other stakeholders the type and success of the safety culture that is actually implemented.
2. **Creating new policies and standards.** Recommendations from the two sessions are summarized in the table below. Both groups felt strongly that the federal government had an opportunity to exert leadership in this area by mandating OSH management in all its construction contracts. There was also a consistent desire to close regulatory gaps that allow OSH management to be delayed or de-emphasized.
3. **Promoting "what we know."** The two sessions identified multiple education and outreach opportunities, some focused on project designers and owners, some on the at-risk population and those who directly manage them, and some on a more general audience to increase perceptions that a safety culture is important and achievable. The attendees also highlighted the value of accreditation and labeling schemes to promote

a safety and a PtD culture. These and additional recommendations for disseminating existing OSH knowledge are summarized below.

4. **Resolving "what we don't know."** The second session also identified and prioritized a list of projects that could be undertaken to improve OSH success in green projects. The favorite recommendation involved a multiple step process to step back and explore the actual synergies between OSH and green and use that finding to create a compelling case to marry the two. Associated with this was a recommendation to develop newer metrics to determine and promote the success of safety programs in the green economy. Other recommendations by this group are summarized below.

Table 4. Making OSH More Compelling in Construction, Infrastructure, and Material Repurposing

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Improve standard contracts to manage OSH risks in more areas of the lifecycle, including fabrication and demolition.	6.7	**Develop an OSH rating system** that highlights for the public the effectiveness of worker protections in place during construction.	10.9
Develop standard process to raise OSH and green issues in construction projects.	5.0	**Develop a holistic pre-project planning framework** where all stakeholders can address OSH risks.	8.1
Develop a program to increase owner and designer commitment/stake in construction worker health and safety.	3.3	**Develop OSH specification language for procurement packages**, protecting workers who manufacture the building and infrastructure components as well as the construction workers who must install it.	4.5
Create a directory for OSH community of sustainable networks, coalitions, and resources.	3.3		
Market Prevention through Design (PtD) plan to the owner/architect/contractor communities.	2.5		
Develop a program just for contractors to increase their motivations and ability to care about construction worker health and safety.	0.8	**Develop a marketing program** focused on those who control construction process, to get them to care about worker health and safety.	0.5

Table 5. Creating New Policies and Standards in Construction, Infrastructure and Material Repurposing

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Expand federal leadership by mandating OSH inclusion in all their contracts.	14.4	**Expand federal leadership** by requiring OSH best practices at federal level.	7.7
Develop an OSH rating system based on setting and agreeing to minimal OSH program requirements.	11.4	**Engage California regulators** to include construction phase OSH in their air quality update.	7.2
Mandate safety requirements at the municipality level.	9.3	**Add OSH metrics to life cycle analysis** models being developed.	6.8
Create an incentive program that can demonstrate how to integrate safety into green jobs.	4.2	**Redefine green** so that it includes worker safety and health and promote that definition endlessly.	4.1
Target new regulations to cover gaps in OSH performance.	3.8	**Modify building permit process** to include OSH requirements.	3.2

Table 6. Promoting "What we Know" in Construction, Infrastructure, and Material Repurposing

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Develop a general marketing and education program highlighting value of safety.	9.7	**Develop guidelines for a holistic preplanning process** that incorporates OSH.	7.2
Educate designers (architects and engineers) about safety issues and their roles.v	6.4	**Educate all construction project stakeholders** (owners, designers) on safety issues with a formally developed outreach program.	5.0
Advocate for clearer identification and guidance for hazardous chemicals used at construction sites.	5.1	**Engage labor/management/ apprenticeship committees** via outreach to increase value they assign to OSH.	3.2

(Continued)

Table 6 (Continued). Promoting "What we Know" in Construction, Infrastructure, and Material Repurposing

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Develop accreditation for PtD projects, i.e., those that incorporate Prevention through Design (PtD) plans and green criteria.	3.0	**Engage mainstream media** to give attention to OSH issues.	1.8
Develop alternative rating systems like SEED instead of LEED.	2.5		
Demystify the PtD process through education and marketing.	2.5		
Sponsor "Safety in Motion" (SIM) sessions at green jobs conferences.	2.1		
Educate legislators about safety issues.	1.3		
Develop recognition system for projects that successfully integrate green and OSH.	1.3		
Develop university and trade school curricula that integrate PtD and green.	0.4		
Create a green guide for construction industry that incorporates OSH, similar to current green guides for health-care industry.	0.4		

Table 7. Resolving "What We Don't Know" in Construction, Infrastructure, and Material Repurposing

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
		Find a hook to marry OSH to green; include developing better metrics for OSH success and better indicators to show and highlight when there is a safety culture on a job site.	10.4
		Promote partnerships (inter-relationships) between trade organizations to identify, research, and resolve common OSH issues.	4.5
		Define what a safety culture and climate is, and then promote it.	4.5
		Create a pilot project in which green and safety risks are equally identified and prioritized, and where experience can be gained to co-manage them.	4.1
		Propose LEED credits to USGBC for managing OSH impact.	4.1
		Disperse technology via bulletins and other communication tools.	0.9
		Test new materials for OSH implications.	0.9
		Research OSH risks in maintenance.	0.5
		Research OSH risks in demolition.	0.0

(Continued)

Table 7 (Continued). Resolving "What We Don't Know" in Construction, Infrastructure, and Material Repurposing

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
		Research OSH risks in hazardous waste cleanup.	0.0
		Research OSH risks in infrastructure and public works projects.	0.0

III.B.2. Manufacturing and Emerging Technologies (Session Leader: Mitchell Blada)

Jobs and associated risks to manufacturing workers in the green economy

Participants in the two sessions that were focused on *Manufacturing and Emerging Technologies* listed a number of jobs where the production of new equipment and materials would likely be ramped up in order to make our lives "greener." The bulk of "green manufacturing jobs" identified during these sessions results from four aspects of a "green economy."

1. **Alternative energy**. To support a move toward non-carbon-based energy production, engineers and workers will be needed to design and manufacture all the components that make up wind turbines, solar panels, batteries, and fuel cells (admittedly, a limited list of alternate energy supplies).
2. **Healthier lives**. To fight disease, increase life span, and make lives more enjoyable, scientists and workers will create new chemicals, including pharmaceuticals and nanoparticles; expand development and implementation of microprocessor-controlled systems; and distribute, install, and promote use of these materials in traditional venues such as hospitals and industrial processes, as well as in homes.
3. **Global impact**. Outsourcing will likely continue and expand the number of persons at risk from exposure to chemicals and devices involved in the manufacture of the items identified above. Outsourcing will not be just to overseas operations but also to contract manufacturing entities located in the United States. The locations where a specific product can be manufactured will change at irregular intervals, and more people will be exposed to multiple components of both classical and green products, without the benefit from long-term experience with these products. Elements of the global supply chain, such as large warehouses and retailers, will also grow in number, and workers not accustomed to manufacturing risks may be exposed to those risks.
4. **Responding to environmental/social stress**. As the global population continues to increase, stress on the environment will increase even in lieu of advances in energy supply and health. Workers will be needed to respond to these stresses in terms of more (and more technologically advanced) water and wastewater treatment facilities and air pollution and carbon dioxide controls. In addition, a growing

service and nongovernment organization sector will arise to respond to social and ecological needs that industry and governments do not address.

Risks, gaps, and barriers in current practice for integrating OSH into green manufacturing and emerging technology jobs

When looking at risks that the workforce in the manufacturing and emerging technology sector will face, there was widespread agreement that most are risks that the OSH community already knows how to minimize; examples include fire and explosions when dealing with flammable vapors and particulates, falls from heights when installing rooftop and elevated equipment, and respiratory and dermal routes of exposure to materials with hazardous constituents. There was also widespread recognition that it may not be easy to preemptively apply OSH solutions to reduce those risks because those who experience them may be unaware of the hazards they face and because organizations have been known to delay OSH expenditures until an accident occurs or somebody forces them to.

Another concern raised was that OSH professionals do not have enough data on chemical bioactivity to manage exposure risks, and it is not just for the newest materials that the green economy will be producing, such as nanoparticles, but also for the bulk of "old-economy," high-production volume chemicals, for these chemicals will continue to be needed and used.

Discussion then turned to identify those things that can promote or delay the deployment of OSH knowledge and expertise in the manufacturing and emerging technology sector.

1. **Conflicts between the "drive to green" and the "push for OSH."** The conflicts that the participants listed are categorized as deriving from three primary sources: business owner perceptions, worker attitudes, and conventional wisdom as reflected in regulator and consumer practices.

Business Owner Perceptions

- Green has a market value, OSH has a market cost.
- OSH may be downplayed when an exciting "green technology" brings along old hazards.
- OSH professionals are not seen as product-oriented and business developers whereas some green professionals are.
- OSH impedes "speed to market" directives. A need for speed often compromises the ability of OSH professionals to adequately assess risks and implement control measures; it also interferes with hazard communication, leading to a lack of transparency.
- Focusing on OSH could lead to green-washing claims, diluting existing green brand values.
- Managing OSH risks could result in a (costly) need to retrofit factories and operations; if you can avoid OSH aspects of green, maybe you can avoid these costs.

- Focusing on OSH could result in a loss of some manufacturing flexibility; manufacture of "green products" could be outsourced overseas, but overseas has less OSH sophistication.
- Small businesses are driving some green marketplace growth, but they tend to be less OSH-savvy.
- Liabilities and penalties are much higher for environmental violations than for OSH violations, indicating the lower value of OSH.
- Investing in OSH may provide long-term benefits, but businesses often need short-term benefits as well to justify their investments.

Worker Attitudes

- Fear that pushing for OSH, unlike a push for green, may lead to job losses (better to be employed and at risk than unemployed).
- New workforce that seems to be getting involved in "green manufacturing" has limited OSH maturity but a more developed green vocabulary.

Conventional Wisdom

- Caring for the environment is modern and sexy; caring about worker health and safety is so 20th century; "didn't we take care of that already?"
- Green is becoming a well-established brand without OSH being in it; why change?
- A lot of green noise already is resulting in confusion as to what really is green; this noise makes it difficult to establish the importance of OSH in green.
- Decision makers typically just shift risks—e.g., replace chlorinated hydrocarbons with hexane as a cleaning solvent—so why be upset?

2. **Untapped (and undertapped) synergies between the "drive to green" and the "push for OSH."** The participants recognized that several changes are required to make a green economy and these changes could be beneficial to the OSH community, especially if OSH practitioners joined forces with the drivers of "green."
   - Push for material substitutions. Include OSH concerns into models that are used to identify greener chemicals and processes, especially life cycle analysis.
   - Increase perceived value of human capital. Align reasons to care about worker health and safety along lines of arguments to protect natural resources.
   - Show value that OSH professionals are already providing. For example, research on chronic toxicity of green chemicals can be applied to make traditional economy jobs safer and greener.
   - Strive for transparency. Green activists should make sure externalities (e.g., costs of operations that are not accounted for on balance-sheets) are at least identified if not quantified, and OSH professionals should make sure the costs regarding worker health and safety are identified (e.g., workers compensation expenses of just the parent corporation do not cover the true cost accumulated throughout the global supply chain).

- Use existing OSH data more effectively. Mine the data and apply it more aggressively; don't necessarily wait to be asked to participate.
- Establish sound management systems. OSH professionals have significant expertise in areas that green professionals can benefit from (e.g., "management of change") [29 CFR 1910.119(l)]. In addition, OSH professionals should make sure they participate in development of "balanced scorecards" and other modern business leader tools where social costs and risks are considered in addition to the financial case when making business decisions. This should result in an integrated management system incorporating quality, environment, and health and safety functions.
- Resolve the certification maze. No one product certification/label system exists that signifies a product has been manufactured in accordance with green/safe principles; labels that do exist are somewhat confusing and highly variable in meaning. Consequently, there is an opportunity to actively participate in creating and promoting a label with an OSH component.

3. **Redeploying existing OSH knowledge**. Participants looked at specific tools used by the OSH community that should be offered as an integral part of the green economy and the barriers to deploying these tools into green workplaces.

Applicable OSH Knowledge

- Management of change—a process to investigate human factors in new green jobs, as well as to implement change more successfully
- Injury/Illness reporting—a robust process to identify and manage risk early
- Cost/benefit analysis—a tool used to show how OSH investments pay off and can be applied to analysis of green jobs as well
- Control banding—a relatively new and powerful tool to manage risks where there are many unknown hazards

Barriers to Deployment

- Insufficient capital deployed to incorporate OSH knowledge and training
- OSH professionals not selling the need for their services to those who may not recognize they have a need
- Inability of OSH community to shift focus where green economy risks may be playing out; e.g., in migrant worker communities

4. **Managing the unknown**. Participants looked at tools that do not adequately identify potential OSH concerns and emphasized a need to make those tools better.
   - Primary risk assessment. To improve efficacy and completeness, responsibility should lie with the manufacturers and be shifted away from government.
   - Life cycle analysis. Tools developed to support the green economy inadequately account for worker impacts throughout the supply chain and thus continue to allow decision makers to avoid taking OSH costs into account when making design and outsourcing decisions.

- Return on Investment (ROI) models. Calculations used to justify investment should include a better accounting for uncertainties in worker health and safety outcomes.
- Risk assessment. Processes to assess risks are not robust enough to account for risks based on multiple unknowns; e.g., can we use control banding to categorize hazards in these circumstances?
- OSH sophistication. The U.S. workforce is losing OSH sophistication, including the ability to recognize and bring to management's attention a potentially undesirable and risky workplace situation.
- Precautionary principle. The United States does not adhere to the precautionary principle; it often waits for risks to play out before it does anything to manage them—i.e., U.S. policy is to manage problems after they become problems, not before.
- Managing unknowns. There is arrogance in believing we can manage unknowns; to overcome that arrogance and become more effective, we must first become more observant, nimble, and humble.

Removing barriers and promoting activities that ensure green manufacturing and emerging technology jobs are safe for workers

Next, the participants listed activities that they believed would close the gaps and remove the barriers identified above. Activities were placed under four distinct categories as described under Methods. At the end of the session, participants were allowed to vote on where strategic priorities should be set to improve safety in the green economy's manufacturing and emerging technology sector.

Specific activities and the relative weightings they were given during voting are described in more detail below. However, looking at the recommendations in total, the manufacturing workgroup consistently recommended that more effort be dedicated to creating new policies and standards (35% average weighting) vs. soft-sell of OSH values (23%), hard-sell (e.g., via training) (22%), and research (21%).

Table 8. Activities Recommended by Manufacturing and Emerging Technologies Workgroup

Activity category	Relative weighting		
	Group 1	Group 2	Combined
Making OSH more compelling	23.5%	21.6%	22.6%
Creating new policies and standards	33.0%	37.0%	34.9%
Promoting "what we know"	23.5%	19.8%	21.7%
Resolving what we don't know	20.1%	21.6%	20.8%

Table 9. Making OSH More Compelling in Manufacturing and Emerging Technologies

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Advocate for formal codes and requirements that would mandate robust risk assessment so that one hazard is not replaced with another.	10.6	**Make OSH more visible**, e.g., by developing a scheme to put OSH metrics onto product labels, possibly via accreditation mechanisms.	10.5
Learn and adapt, specifically how to accept the push for speed without giving up on OSH protections.	6.1	**Promote OSH benefits**, e.g., of Prevention through Design principles early in retrofits of existing facilities that are engaging in green technologies.	6.2
Offer OSH expertise from Management of Change process in manufacturing to those who are tasked to manage risk associated with green technology.	4.5	**Advocate** that states and municipalities seeking green job funds consider OSH implications and requirements of those jobs.	4.3
Offer OSH expertise and viewpoints in development of national chemical security initiatives.	1.1	**Seize opportunities** created by attention being given to everything green to promote a transition to a risk-based assessment approach instead of a hazard based.	0.6
Offer partnerships with oil companies, energy companies and others involved with emerging green technologies, probably via their trade associations, to ensure OSH is addressed.	1.1		

1. **Making OSH more compelling**. Results of the two sessions are summarized in the following table. Participants recommended that primary attention be given to advocacy, efforts to increase visibility, and the offering of OSH expertise to other stakeholders.

2. **Creating new policies and standards.** Recommendations from the two sessions are summarized in the table below. The main thrust from both sessions was that the OHSAS, ISO and ANSI standard process has value and can be expanded to promote better integration and application of OSH into the new economy and the

desire to adopt policies (e.g., like the EU's REACH) that will allow risks to be identified before they are allowed to propagate.

Table 10. Creating New Policies and Standards for Manufacturing and Emerging Technologies

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Create and roll out a management system framework in which environment and OSH concerns are integrated.	6.7	**Adopt precautionary principle** in connection with green technology risk assessments.	12.3
Create a risk assessment requirement or standard practice.	5.6		
Identify and consider incentives, in as broad terms as possible, that will lead people to adopt green behaviors which reap long-term benefits.	5.0	**Create mandates** to ensure that green technology movement incorporates an integrated environmental health and safety management system.	10.5
Adopt EU REACH-like policy in the United States.	5.0		
Fund collection of more data, e.g., conduct toxicity assessments for emerging technologies.	2.2	**Promote safe green products** by developing a federal policy that promotes appropriate (e.g., safer) product substitution in connection with green technology developments.	8.0
Harmonize regulatory penalties and consequences for violating OSH regulations vs. environmental regulations.	2.2		
Create or modify standards (e.g., ANSI Z10) or find another mechanism to incorporate a management system framework in the development and implementation of green technology.	2.2	**Increase data collection and monitoring** of injuries and illnesses.	6.2

(Continued)

Table 10 (Continued). Creating New Policies and Standards for Manufacturing and Emerging Technologies

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Shift responsibilities to manufacturers for risk assessments (and away from government).	2.2	**Develop incentives for small business** to participate safely in green technology movement.	0.0
Make a national commitment to capture data on hazards, risks, controls, learnings as green technology proliferates.	1.7		

3. **Promoting "what we know."** The two sessions agreed that the green movement creates an opening for new training initiatives and that accreditation schemes should be tied to training so that more people can benefit from decades of OSH expertise and advances in OSH science. These and additional recommendations for disseminating existing OSH knowledge are summarized below.

Table 11. Promoting "What we Know" in Manufacturing and Emerging Technologies Sectors

Group 1 recommended activities	% votes cast	Group 2 recommended activities	% votes cast
Develop and promote accreditation criteria for engineers and business professionals that integrates and certifies both OSH and environmental management skills for the green jobs sector.	11.7	**Develop training to retrofit OSH professionals** to deal with green technology risks.	6.2
		Develop outreach and training by OSH professionals to enable U.S. workforce to operate in green technology safely.	4.9
Harness energy from culture change associated with going green for benefit of OSH integration with green jobs (e.g., OSH and green professionals should energetically join as willing partners).	4.5	**Create a basic OSH training program** for workers engaged in green technology.	2.5

(Continued)

Table 11 (Continued). Promoting "What we Know" in Manufacturing and Emerging Technologies Sectors

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Conduct educational campaign to raise awareness that the push for green jobs is simultaneously a push for safe jobs.	3.9	**Create and promote an OSH training program** for high school and vocational/technical school students.	2.5
Apply techniques like control banding to assess/address risks of green technology where hazards and risks are largely unknown.	2.8	**Develop messaging campaign directed to business** and manufacturing companies about positive impact of Prevention through Design principles on green jobs and technology.	1.2
Promote education campaign by environmental professionals that preserving natural resources and preserving human capital are equal goals of the green jobs movement.	0.6	**Capitalize on green movement** by asking OSH professionals to join forces with green movers and infuse OSH into it.	1.2
Elicit help from marketing professionals to counter concern that OSH is boring, not sexy like green, and that it involves consequences to families as well as workers themselves (i.e., protecting workers creates value, not cost).	0.0	**Develop and promote transparency methods** that can inform workers and green buyers as to green product and process hazards.	1.2

4. **Resolving "what we don't know."** Both the morning and afternoon groups proposed interesting research and development projects. The greatest commonality was a frustration that current financial and business management models either do not assign a high enough value (see enough benefits) from their worker's health and safety or they perceive that addressing OSH is too costly. Thus, they recommended projects to demonstrate a value-adding benefit from OSH and to quantify real exposures and risks. These and additional recommended activities are summarized below.

Table 12. Resolving "What We Don't Know" in Manufacturing and Emerging Technologies Sectors

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Develop new toxicity research methods that support speed-to-market practices, and make it available quickly to apply to green technologies as they develop.	5.0	**Develop demonstration project** to show how OSH teams can participate positively in design and development of new processes and technologies.	9.9
Develop business case that shows there is a value to OSH, and that there could be a higher cost if you ignore OSH or shift responsibilities for it elsewhere.	4.5	**Improve surveillance and documentation** of special populations and illnesses.	5.6
Develop cost-benefit analytical tools to support the green movement, including OSH costs/benefits.	3.4	**Research process to document new economy hazards** and see how they differ from old economy hazards.	2.5
Develop baseline OSH data, e.g., by researching jobs and employment in the clean energy sector.	2.8	**Conduct critical review of trade policies** to determine their impact on workers' OSH.	1.9
Develop process or definitions to extend lifecycle analyses in terms of OSH.	1.7	**Formalize technical assistance and R&D knowledge transfer programs** to increase data flow on actual and potential OSH hazards.	1.2
Identify and disclose non-chemical risks associated with green manufacturing and technology, i.e., physical, biological, radiological risks.	1.7	**Research new ROI models** to take into account true costs and true benefits of OSH.	0.6
Identify common chemical risks, i.e., risks that are played out in both environmental and OSH realms.	1.1	**Research "values" modeling methods.**	0.0

III.B.3. Energy, Mining, and Building Operation and Maintenance (Session leader: Pierce Jones, PhD)

Jobs and associated risks to energy sector workers in the green economy

Participants in the two sessions that were focused on Energy, Mining, and Building Operation and Maintenance listed many energy-related jobs that would be created or expanded in a "green economy." This reflects the widespread belief that energy efficiency and sustainable energy production are core elements of a green economy. Jobs were identified by the source of energy involved, either in production or building operation.

1. **Solar energy and home retrofits**. Installation of photovoltaic cells, solar water heaters, green roofs consisting of gardens and biomass materials, and industrial solar collectors is expected to provide many employment opportunities. Retrofit jobs, associated with or as an alternative to improving energy efficiency at each point of use (e.g., a building), will bring even more employment opportunities. Risks in all these cases were believed to largely consist of falls from heights, heat injuries, electric shock, and dermal and air exposure to insulating materials (in the case of insulation). Production of the solar energy collection materials, currently mostly done overseas, may provide additional jobs for U.S. workers. Risks on the production side include potential exposure to toxic chemicals.
2. **Wind energy**. The manufacture, installation, and maintenance of wind turbines will define the bulk of wind energy jobs. Starting with the same risks associated with solar energy, wind energy via turbines adds additional risks from their confined spaces, mechanical (moving) parts, structural integrity concerns, and exposure to weather extremes, especially when installed in hard-to-reach locations such as offshore.
3. **Nuclear energy**. As coal-fired plants are increasingly looked upon with disfavor, nuclear energy production is likely to be expanded as well as uranium mining (with all the standard risks of mining plus the risks of long-term, low-level radiation exposure). On top of that will be an increase in design, construction, and operation of nuclear-power, electric generation plants. How risks in newer operations will differ from older nuclear power plants is not yet clear.
4. **Marine and geothermal energy**. Tapping into the energy of tides, or taking advantage of temperature differentials over the depths of the ocean or geologic strata, will generate additional electricity and jobs within the United States. Besides the electric shock risks seen in other energy sources in this list, workers in marine and geothermal energy production will be exposed to risks from working offshore and working with drilling equipment.
5. **Electric transmission**. After power is generated, it must be transmitted, and one of the big ideas for the green economy is to create smart transmission grids to minimize power loss over the lines. These grids will provide jobs for software engineers as well as for those in the electric trade. Risks begin as listed above but can increase depending on the location of the generating sources and the rights-of-way that the lines will pass through; those that are harder to get to will make rescue efforts more difficult.

6. **Alternative fuels**. Finally, there will be jobs decommissioning old economy, coal-fired power plants; jobs in natural gas drilling and transmission; an increase in coal mining jobs, if coal gasification or coal liquefaction becomes favorable; jobs to drill and sequester CO_2 into deep subterranean structures; and jobs to create biomass-based energy (e.g., cellulose to ethanol, hydrogen production, waste-to-energy, and algae-to-energy). It is unclear how risks in these jobs will differ from risks in today's petroleum refining and coal mining/combustion productions.

Risks, gaps, and barriers in current practice for integrating OSH into green energy, mining, and building operations and maintenance

The attendees overwhelmingly looked at the "rush to green" as being pursued at the expense of worker safety and health concerns, which require additional time and resources to address adequately. As detailed below, focusing on this conflict was easier than looking for opportunities to overcome them.

1. **Conflicts between the "drive to green" and the "push for OSH."** Many examples of how and why OSH is given secondary consideration to green were provided.
   - The desired speed to get green energy into the marketplace often does not allow adequate time for licensing and OSH training.
   - Developing adequate OSH practices after identifying risks takes longer time than procurement agents can wait; thus, OSH often follows installation and only occasionally precedes it.
   - Because a variety of green energy systems are available, it has been difficult to establish consistent OSH standards across all of them, resulting in lack of standards, occasional confusion, and dropping of OSH to a secondary consideration.
   - The "drive to green" is emotional (concern for my future) and economic. OSH, on the other hand, is typically regulatory driven and supported by a different emotional driver (concern for people I don't know). Thus green often has the stronger motivators.
   - Much of the investments in green energy and building operations are being handled in the "do-it-yourself" market, where there is little push or pull for formal safety guidance.
   - In LEED® projects, points are assigned to the welfare of workers in all green building aspects, including energy production. Thus, those who pursue LEED® certification have little incentive to invest more time in providing better levels of OSH protection.
   - People don't believe there could be unintended consequences of green energy.
   - The United States relies on hazard evaluation models that do not address a lot of worker safety and health concerns (e.g., environmental impact statements) as opposed to the European Union where its models (e.g., REACH) look at impacts on workers as well as others throughout a product's life cycle.
   - Consumers, even green consumers, do not generally look at the risks of a product or project in all aspects of its life cycle. They especially ignore recycling and decommissioning costs, which can make some green projects look more attractive today than they would be in the future.

2. **Untapped (and undertapped) synergies between the "drive to green" and the "push for OSH."** Participants felt that contracting and the development of business cases for green are two areas where synergies could develop. Whenever a requirement exists to pursue a green objective, such as energy efficiency, additional requirements could evolve, such as a requirement for a measurable safety management system or for applying Prevention through Design (PtD) principles. And the federal government could take a lead in doing this. Also, as the business case for green continues to be developed, an opportunity equally exists to make sure the business case looks at all OSH impacts; when green is also safe, improved OSH could make green look, not just desirable, but for many, mandatory.
3. **Redeploying existing OSH knowledge**. Participants recognized the need to provide OSH training to those who currently downplay it (e.g., practitioners of LEED®) and to share best practices from highly successful OSH practices, such as PtD, with the leaders of companies and agencies that have strategic responsibility to pursue green energy and resources.
4. **Managing the unknown**. Finally, participants felt that fear of the unknown should not necessarily stop the move to green, even when dealing with OSH unknowns, but recognized that a 60% solution to resolving the unknowns, as they come up, could be a good start.

Removing barriers and promoting activities that ensure green energy sector jobs are safe for workers

Next, the participants listed activities that they believed would close the gaps and remove the barriers identified above. Activities were placed under four distinct categories as described under Methods. At the end of the session, participants were allowed to vote on where strategic priorities should be set to improve safety in the green economy's energy, mining, and building operation and maintenance sectors.

Specific activities and the relative weightings they were given during voting are described in more detail below. However, looking at the recommendations in total, the energy workgroup split their recommended priorities between creating new policies and standards (28% average weighting) and making OSH more compelling (26%). Options to train others on OSH values and procedures and to perform research to investigate the unknowns were rated lower in importance (22% and 24%, respectively).

Table 13. Activities Recommended by Energy, Mining, and Building Operation and Maintenance Workgroup

Activity category	Relative weighting		
	Group 1	Group 2	Combined
Making OSH more compelling	30.6%	21.1%	26.2%
Creating new policies and standards	26.9%	30.3%	28.5%
Promoting "what we know"	19.4%	24.6%	21.9%
Resolving what we don't know	23.1%	23.9%	23.5%

1. **Making OSH more compelling**. Results of the two sessions are summarized in the following table. Participants recommended that OSH professionals make a more visible and widely available case as to why data collection and monitoring are important when investigating OSH risks. Also, OSH professionals should highlight the best practices available so small businesses, like the home installers, don't have to fear the cost or novelty of inventing them for themselves. In addition, community colleges could provide appropriate venues for making compelling OSH pitches to the most at-risk communities as part of their normal curriculum.

Table 14. Making OSH More Compelling in Energy, Mining, and Building Operation and Maintenance

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Conduct data collection and monitoring to inform risk assessments.	16.9	**Develop and promote best practices** for small businesses on the safe way of implementing each of the green technologies and on the PtD process.	16.9
Partner with community colleges to make OSH a standard part of some education programs.	5.6		
Develop model language for procurement contracts so that purchases require a risk assessment.	4.4	**Increase awareness of need for consistent manufacturing standard codes** for wind and solar turbines.	3.5
Add performance requirements on worker health and safety to contracts.	3.1	**Establish codes** to make it easier to track green jobs.	0.7
Build closer partnership with building code enforcers perhaps via better training of them.	0.6		
Adopt green certifications for the OSH cause.	0.0		

2. **Creating new policies and standards**. Policy and standard recommendations from the two energy focus groups are summarized in the table below. Each made a strong case for federal action to improve the climate for protecting workers. One group discussed the need for an executive order requiring safety through design to be part of every federally funded green project. The other group discussed the two federal agencies responsible for safety and energy, NIOSH and DOE, should coordinate and then promote a similar message of the importance of safety in energy supply, transmission, and use. The groups also suggested a number of new requirements be placed on engineers and contractors via licensing, building codes, contracts, and building certifications so that OSH becomes a more conscious aspect of each energy-related project.

Table 15. Creating New Policies and Standards in Energy, Mining, and Building Operation and Maintenance

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Promote federal coordination, especially between DOE and NIOSH, of the deployment of green energy technologies; address conflicting missions of these agencies.	6.9	**Promote/demand an executive order** mandating safety in design for federally funded green energy and building projects.	14.8
Add a safety knowledge test to licensing requirements for professional engineers and contractors.	6.3	**Develop building codes** for wind tower and solar building installations.	7.7
Add OSH criteria to green certifications.	6.3	**Establish industrial classification codes and leading indicators** that can be used in researching injuries and fatalities in the green energy and building realm.	2.8
Advocate for risk assessment mandates via language in manufacturing agreements for green energy and building components.	5.6	**Push for consistent standards** in new industries like wind and solar with life cycle-based benchmarks in design, manufacture, maintenance, power distribution, and component recycling.	2.1
Conduct gap analysis—Are current standards for OSH in federal contracts adequate?	3.8	**Confront issues arising from foreign manufacture** of wind turbines where there are lower standards than in the United States.	1.4
Develop OSHA compliance guide—Develop and distribute.	0.0	**Promote more NIOSH involvement** with development of building codes and OSHA federal regulations.	1.4
Investigate building codes, especially the time it takes to put them into practice.	0.0	**Develop mandates (regulations)** on running of some green energy devices, on particulate matter, emissions, idle time, etc.	0.0

3. **Promoting "what we know."** The recommendation with the most weight was to help nonprofits tap into an existing fund to train green energy workers in safe practices. After that, a number of proposals were discussed, and many of them were recurring themes expressed in the prior two series of recommendations: promote the risk assessment process, focus better training on the engineer/designer/owner communities, utilize community colleges and building inspectors to further support and enforce the safety message, and develop specific guides to distribute to all the at-risk communities. These and additional recommendations for disseminating existing OSH knowledge are summarized below.

Table 16. Promoting "What we Know" in Energy, Mining, and Building Operation and Maintenance

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Require risk assessments for manufacturing of components used in this sector.	5.6	**Guide nonprofits to apply to use Susan Harwood Grants** for training workers.	9.9
Promote quick training, i.e., figure out how to make safety training less onerous and time consuming, while maintaining or improving its efficacy.	5.0	**Develop better training curriculum** for architects, engineers, owners. Show them how tasks that appear similar have different OSH risks; create case studies that show how green energy created safely has a market value higher than may be perceived up front.	6.3
Incorporate OSH in community colleges as a standard part of retraining programs.	4.4	**Develop training guide** specifically for wind energy jobs where risks are unique.	2.8
Identify hazards in this new industry and populations needing training, then tailor training for both.	2.5	**Develop guidance and standards** for installation and maintenance of wind and solar energy systems.	2.1
Train building code enforcers in regulations, e.g., on hydrogen fuel stations.	1.9	**Promote marketing to general public** and to owners. Possibly engage broadcast media like "Myths and Mythbusters" to explore "Green Economy—Dirty Jobs?"	2.1
Understand and address cultural issues preventing alternative energy adoption.	0.0	**Identify hazards confronting these new jobs** and develop training for them.	1.4

(Continued)

Table 16 (Continued). Promoting "What we Know" in Energy, Mining, and Building Operation and Maintenance

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Create forum in which best practices can be shared and small businesses can share experiences.	0.0	**Partner with retailers** to help make consumer home improvements safer.	0.0
Pursue green certifications as a vehicle for OSH training.	0.0		

4. **Resolving "what we don't know."** The research recommendations also revisited many of the recommendations made for practice, policy, and outreach, indicating that maybe there are only a few tasks that need to be undertaken to improve OSH results in the energy and building operation sector. For example, the importance of workplace data collection and monitoring was again highlighted, as was the need for NIOSH and DOE to coordinate their activities and for a concentrated focus on small business needs. But there were a few new recommendations as well, especially to identify the types of incentives that can motivate workers to change their behaviors and the type of financial cases that can change owners' behaviors regarding worker safety. Other recommendations by this group are summarized below.

Table 17. Resolving "What We Don't Know" in Construction, Infrastructure, and Material Repurposing

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Coordinate the implementation of existing NIOSH and other research into DOE, especially on green technology deployment.	6.9	**Collect injury, illness and fatality data** at green job sites.	8.5
Initiate research on hazards related to green initiatives (chemicals, processes, techniques).	5.0	**Study what incentives are most effective** in driving implementation of OSH practices in green jobs and processes.	6.3
Identify and help manage risks to small business from green technology.	5.0	**Research "What makes a compelling business case?"** Is there a level of risk control or ROI that should be strived for?	2.8

(Continued)

Table 17 (Continued). Resolving "What We Don't Know" in Construction, Infrastructure, and Material Repurposing

Group 1 recommended activities	% votes cast	Group 2 recommended activities	% votes cast
Demonstrate how a 60% solution now can provide immediate OSH benefits rather than waiting for a lengthy research study to be completed before implementing anything.	4.4	**Research to identify similarities** between green jobs and similar industrial jobs.	2.1
Conduct behavioral analysis—Who is most likely to secure changes in worker behavior?	1.3	**Research building codes** on wind and solar installations to develop a better standard.	1.4
Develop new partnerships for research, i.e., academia (e.g., UMass College of Natural Resources and Environment), biomass specialists, DOE, NIOSH.	0.6	**Identify and promote best OSH practices** in green industries.	1.4
Formulate new ROI models that better incorporate OSH components.	0.0	**Apply Prevention through Design** process to solar energy systems and work on the electrical grid.	0.7
		Research hazards that training programs should be geared to address.	0.7
		Identify leading indicators (positive feedback signals) to determine if OSH interventions are working.	0.0

III.B.4. Agriculture, Forestry, and Fishing (Session leader: Richard Hegg)

Jobs and associated risks to agriculture, forestry, and fishing workers in the green economy

Participants in the one session that was focused on *Agriculture, Forestry, and Fishing (AFF)* listed several jobs that would be created or affected by the "green economy." The push for sustainability in food and fiber production involves the application of green chemistry to fertilization and pest control practices by collecting and returning more biomass to the soils, by reducing reliance on mechanized collection methodologies, by growing and harvesting new crops (such as algae) for new uses (such as biodiesel), and by being more selective in the harvesting process to allow the supporting ecosystems (fisheries, forests) better opportunities for recovery. Risks to the health

and safety of AFF workers were likely to change as they are exposed to new chemicals, to the explosive and flammable nature of some biomass lifecycle output, to repetitive motion as labor is substituted for machinery, and to higher pressure to produce in shorter harvesting seasons.

Risks, Gaps, and Barriers in Current Practice for Integrating OSH into Green Agriculture, Forestry, and Fishing Practices

Participants discussed the gaps and barriers preventing adequate deployment of OSH knowledge and expertise in the AFF sector.

1. **Conflicts between the "drive to green" and the "push for OSH."** The participants listed several examples of where a green practice increases OSH risks.

Table 18. Examples Where Green Practice Increases OSH Risks in the Agriculture, Forestry, and Fishing Sector

Green practice	Antagonistic effect on OSH
Collection of biomass	Increased exposures to physical hazards and biohazards
Shorter fishing windows	Increased risks from weather, time, pressure
Organic agriculture	Ergonomics and Hazard Communication
Green chemicals	Unknown risks
Ethanol production	Greater explosion risks
De-mechanization	Lower wages and less healthcare coverage

2. **Untapped (and undertapped) synergies between the "drive to green"** and the "push for OSH." The participants looked for opportunities to borrow from the momentum that the push for green AFF products and processes has created and to transfer some of that momentum to a desire for better worker experiences.

Table 19. Opportunities for OSH in the Agriculture, Forestry, and Fishing Sector

Green practice	Synergistic effect on OSH
Reduced use of pesticides	Reduced exposure to highly toxic materials
Organic farming	Increased jobs/biomass refineries
Urban agriculture	Reduced transportation exposures

3. **Redeploying existing OSH knowledge**. Many OSH risks in the AFF sector are generally recognized, but knowledge for how to manage those risks is not widely distributed. Areas where the sector can benefit from currently available expertise include the following:

- biomass management: distillation process safety management
- agriculture: chemical hazard education
- small scale pulp wood: experience with structural timber OSH
- redeploy risk and hazard assessment methodology in new AFF venues to identify specific hazards and enforce existing regulations

4. **Managing the unknown**. Finally, the impact of green on worker OSH is unknown for some changes in the AFF economy. For example, will computerized technology improve conditions for workers or increase OSH adverse effects? Participants discussed the need for getting involved early in the rollout of green AFF practices; e.g., strategically locate smaller biomass production facilities where OSH risks can be more effectively reduced and managed. But the most important need they identified was to improve data collection and monitoring even in hard-to-reach populations—such as, the migrant worker community—so that sentinel OSH events could be tracked and addressed.

Removing barriers and promoting activities that ensure green agriculture, forestry, and fishing jobs are safe for workers

Next, the participants listed activities that they believed would close the gaps and remove the barriers identified above. Activities were brainstormed and eight were listed without regard to category. Categories were assigned at the end of the session.

The bulk of recommendations centered on expanding known practices to at-risk communities (43%) and collecting new data or translating it in new ways so that new risks can be identified (46%).

Table 20. Activities Recommended by Agriculture, Forestry, and Fishing Workgroup

Activity category	Response distribution
Making OSH more compelling	14.9%
Creating new policies and standards	3.5%
Promoting "what we know"	**43.0%**
Resolving what we don't know	**45.6%**

Specific recommended activities. Results of this one session are summarized in the following table. The two most important activities that participants recommended for follow-up, garnering nearly 50% of all votes cast, were (1) to engage AFF workers, particularly migrant farm workers, in assessing risks in their jobs and devising solutions, and (2) to engage in formal research to develop baseline exposure assessments and ascertain occupational safety issues in each category.

Table 21. Removing Barriers, Promoting Activities to make green Agriculture, Forestry and Fishing Jobs Safe

Making OSH more compelling	% Votes cast	Creating new policies and standards	% Votes cast
Create a marketing campaign for OSH using green as a platform.	14.9	Include occupational injury and illness component in existing health records.	3.5
Promoting what we know	**% Votes cast**	**Resolving what we don't know**	**% Votes cast**
Engage AFF workers (e.g., migrant farm workers) in assessing risks, making changes, and finding solutions.	26.3	Develop baselines of exposures for each industry.	22.8
Develop index of green chemicals and associated exposure risks.	11.4	Use migrant health clinics and agriculture extension services for sentinel events notification.	14.0
Tailor communications for foreign-born workers.	2.6	Research best means of communication and translation of information for each industry.	4.4

III.B.5. Transportation (Session leader: Max Kiefer)

Jobs and associated risks to transportation workers in the green economy

One session focused on the *Transportation* sector. Participants discussed how the green economy would affect transportation workers directly in the types of vehicles available and in the potential modifications of equipment and indirectly in the types of fuels and cargo that would be involved.

1. **Vehicle type and design**. The green economy in the Transportation sector includes the manufacture, operation, and maintenance of hybrid cars (electric/gas combination), electric cars, cars and buses fueled with liquefied natural gas (LNG), trucks with improved aerodynamics and lower weight, and possibly even bicycles and scooters. Increases in funding to develop and expand public transportation—including light rail, high-speed rail, street cars, and even fuel-efficient water transportation (ferries and freighters)—are anticipated. Finally, an increase in demand for jobs to retrofit trucks with more efficient cooling systems, energy collectors, and improved aerodynamic shapes is expected. Risks

from manufacture of these vehicles and vessels may be similar to classical manufacturing, but risks to drivers and pilots may be different and possibly unanticipated. As an example, a push to remove step rails from trucks to reduce air friction could lead to more slips and falls, and better cooling systems can lead to an increase in hood height, which, along with changes in placement of mirrors to improve aerodynamics, could reduce driver vision leading to increased accident risk. An emphasis on higher speeds, such as in rail transport, and increased reliance on lighter-weight vehicles, including two-wheel vehicles, could increase the risk of accidents and higher severity of injuries should there be an accident. Investment and emphasis on the green economy must be coupled with expanded efforts to include occupational safety in all aspects of design and implementation and an increased focus on reducing the likelihood of accidents.

2. **Fuels and cargo**. To support green transportation, new fuel and energy delivery stations will be required, each with specific new risks like electric shock (plug-in stations) or explosion (LNG stations). Nano-sized catalysts, like cesium oxide in fuel cells, could raise new exposure concerns; the fuel cells also can increase explosion risks due to H_2 release. Finally, to support other aspects of the green economy, transporters will be carrying new materials to job sites. Some (e.g., components of wind turbines) could pose transport risks as a result of their size, and others, like new green chemicals, may increase risks because only a paucity of information is available regarding exposure risks and other hazards associated with their transport and transfer.
3. **Pipelines**. Participants briefly discussed the hazards associated with pipelines that are used to transport fuel. New pipelines are being constructed and installed due to increased fuel demand. New fuels in existing and new pipelines could pose risks of exposure to pipeline workers and emergency responders in the event of a leak due to the potential for breaches (e.g., improper seals).

Risks, gaps, and barriers in current practice for integrating OSH into green transportation practices

The rapidity of the development of green projects, often by smaller start-up companies, is a major concern as it is difficult to ensure safety and health is addressed during the design stage; this can result in placing OSH in catch-up mode.

1. **Conflicts between the "drive to green" and the "push for OSH."** Several examples were provided of how a green innovation could benefit the environment but also adversely impact the transportation worker.
    - Smaller vehicles improve fuel efficiency but are generally less safe when in accidents. Historically, in the United States, driver desire for safety contributed to the move to larger cars.
    - Conflicting priorities occur because of historical splits in regulatory responsibilities: Environmental issues often take precedence over efforts to protect worker health and safety.
    - New technologies are developed and implemented quickly, often before learning how to safely manage and operate them.

- Tires that promote fuel efficiency by reducing normal friction also reduce the traction needed to maneuver in dangerous situations.
- Insulation removal from truck cabs to reduce weight can increase driver exposure to higher noise levels.
- New materials are being transported by various means, but insurers may not insure the loads when they recognize that risks of exposure to these materials are unknown. A disconnect exists between green and OSH in the marketplace; e.g., restricting availability of financial tools normally available to manage the consequences of known risks.

2. **Untapped (and undertapped) synergies between the "drive to green" and the "push for OSH."** If mass transit is favored in the green economy, a reduction in vehicular miles could result in a decrease in transportation-related fatalities. And if walking and biking become more popular, then increased physical activity could result in a healthier public. OSH professionals can and should support these green efforts.

The EPA SmartWay Transport program, which emphasizes fuel efficiency in company truck fleets, also reduces driver exposure to exhaust because of their required idling strategies. By emphasizing proper speed and scheduling, the likelihood of an on-the-road accident is diminished.

In addition, some changes in vehicle design of hybrids could reduce ergonomic risks for mechanics. For example, the massive batteries used in hybrids are too heavy to lift, and therefore mechanics are forced to use mechanical lifts.

3. **Redeploying existing OSH knowledge**. OSH professionals often evaluate safety risks after a new technology is implemented. Deploying anti-collision technologies in new ways can reduce accidents and, when used in situations like rail transport, can also relieve dispatchers' workloads. Management safety programs and effective implementation of a safety culture are existing and proven methods for reducing accidents and improving the health of a workforce. These programs can be equally successful for addressing green initiatives.
4. **Managing the unknown**. Novel technologies, unanticipated hazards, and unintended consequences are significant challenges when dealing with the green technology initiative. For example, changes in fuel composition could result in unanticipated exposure risks and subsequent health effects. The professional OSH researcher can help evaluate these technologies, conduct research, and examine data to identify potential problems at an early stage.

Removing barriers and promoting activities that ensure green transportation jobs are safe for workers

Next, the participants listed activities that they believed would close the gaps and remove the barriers identified above. Activities were placed under four distinct categories as described under Methods. At the end of the session, participants were allowed to vote on where strategic priorities should be set to improve safety in the green economy's transportation sector.

Specific activities and the relative weightings they were given during voting are described in more detail below. However, looking at the recommendations in total, the transportation workgroup thought more effort should be put into research (31% average weighting) than creating new policies and standards (24%), making OSH more compelling (23%), and outreach and education (21%).

Table 22. Activities Recommended by Transportation Workgroup

Activity category	Relative weighting
Making OSH more compelling	23.4%
Creating new policies and standards	24.1%
Promoting "what we know"	21.3%
Resolving what we don't know	31.2%

1. **Making OSH more compelling**. Results of the one session are summarized in the following table. The overwhelming choice here was to become more active in getting in front of the at-risk populations, making the communications more persuasive and less laden with jargon, and getting transportation workers more involved in identifying and caring about the risks they face.

Table 23. Making OSH More Compelling in Transportation

Recommended activities	% Votes cast
Actively identify and disseminate safety information for at-risk populations.	7.8
Communicate health research more effectively.	7.8
Engage workers in identifying and managing their safety risks.	5.7
Seek higher levels of corporate commitment to health and safety of all their employees.	1.4
Improve safety coverage in operating manuals for vehicles.	0.7
Add a safety rating to eco-report cards for cars.	0.0

2. **Creating new policies and standards**. Recommendations in this category are summarized below. The overwhelming desire was for the federal government to demonstrate its commitment to OSH by, as the primary example, tying all green grants and stimulus-funded projects to a requirement that the projects be carried out with safety in mind. Another concern highlighted by the participants was that regulatory agencies

do not have all the tools they need to protect the health and safety of workers, especially in the transportation sector, and a request was made that those gaps in regulatory OSH standards be closed.

Table 24. Creating New Policies and Standards in Transportation

Recommended activities	% Votes cast
Use government grants or stimulus funding to prioritize OSH green initiatives.	13.5
Close regulatory gaps where identified risks are not covered by existing health and safety standards.	5.0
Put research into practice, i.e., spreading anti-collision technology.	2.8
Conduct training for new materials and wastes whenever given to a hauler.	1.4
Review jurisdictions of regulatory agencies so safety issues do not fall through the cracks.	0.7
Require general fleet safety training.	0.7

3. **Promoting "what we know."** While the desire to make OSH more compelling led to recommendations for OSH professionals in this sector to be bolder in getting in front of at-risk audiences, this section raised a complementary recommendation: to tell stories, specifically case studies, when in front of those audiences. And while at it, expand the appeal for safer transportation to those who can help make transportation safer, such as the engineers and mechanics.

Table 25. Promoting "What we Know" in Transportation

Recommended activities	% Votes cast
Build case studies around the management of transportation risks; e.g., compelling reasons, ROI, technical and organizational solutions.	8.5
Add transportation case studies to educational curricula in safety engineering and in trade programs.	5.7

(Continued)

Table 25 (Continued). Promoting "What we Know" in Transportation

Activity category	Response distribution
Promote assurance reviews with the motto, "Just because it's green, doesn't mean it's safe."	5.0
Add transportation safety guidance to the Emergency Response Incident Command System.	1.4
Reach out to immigrant communities and offer safety support programs.	0.7
Train drivers/truckers on handling and segregating new hazardous materials, especially for truckers who may haul hazmat once a year.	0.0
Ask corporations to promote transportation safety before they start greening their fleet, i.e., green does not have to equate to safe.	0.0

4. **Resolving "what we don't know."** Ten recommendations were put forward for consideration by the transportation group. The highest priority was assigned to looking at all health and safety implications of truck design and to begin collecting surveillance data from the trucking community, especially the small business trucker, to see if there are patterns of injury or illness that could foretell existence of some risky design or practice, and then develop outreach to begin eliminating those risks. In addition, participants recognized that their expertise lies in road-based transportation, and therefore a need exists to look deeply into rail, maritime, and air transport to identify equally important risks that are begging for intervention.

Table 26. Resolving "What We Don't Know" in Transportation

Recommended activities	% Votes cast
Research on designing trucks, specifically health and safety implications (e.g., insulation and noise of truck).	7.1
Perform surveillance and generate "green-truck" OSH data; identify early indicators of OSH risk.	7.1
Reach out to small businesses to help investigate their issues and support them.	7.1
Evaluate rail/maritime/air transport risks.	5.0

(Continued)

Table 26 (Continued). Resolving "What We Don't Know" in Transportation

Activity category	Response distribution
Research how eco-driving promotes safety. Is it more dangerous? How do speed limits affect pace of work?	1.4
Research "vibration issues." Is there less vibration with new efficient cars?	0.7
Research fuel conservation effects on OSH. Does conserving fuel provide health and safety benefits?	0.7
Research safety issues with bicycle use. Are more people using bicycles? Does it lead to more accidents?	0.7
Research new ways to communicate hazards.	0.7
Research baseline training and skills that new workers are bringing into the transportation sector.	0.7

III.B.6. Waste Management and Recycling (Session Leader: Susan Eppes)

Jobs and associated risks to waste management and recycling workers in the green economy

One aspect of green is supposed to be a reduction in waste generation and disposal. But the two sessions held to look at worker risks in the Waste Management and Recycling sectors recognized that the processes of waste generation and disposal change in character as the economy greens and only sometimes result in reduced waste quantities.

Because of the diversity of wastes identified, the types of jobs and risks depend on whether the workers manage a specific set of wastes (e.g., those who work in industry or those who support a narrow industrial sector) or whether they run processes that manage a wide variety of wastes (e.g., municipal workers and those who run the nonspecific waste management companies).

1. Managing specific wastes.

Medical waste: A green economy does not directly increase risks to medical waste generators and handlers. However, in this modern time, widespread use of antimicrobial agents is creating strains of multidrug resistant bacteria, and the fast-paced and global nature of modern commerce has contributed to the rapid spread of viral threats from remote corners of the world. These changes have put healthcare waste workers at particular risk because of their frequent exposure to sharps and other potentially infectious waste materials. Medical waste workers may also be exposed regularly to hazardous chemicals like mercury and physical hazards like radiation from diagnostic equipment.

Chemical plant waste: Managing scrap and waste by-products of modern chemical production brings a risk of exposure to chemicals to waste management workers, some in nanoparticle form, as well as ongoing risks of fire, explosion, and release of hazardous vapors from incompatible materials mixing and reacting.

Nuclear waste: As nuclear energy expands to offset carbon emissions, a corresponding rise can be expected in the volume of nuclear waste materials and, with that, all the risks inherent to radiation exposure. Because these materials pose such a high risk, they are managed in confined spaces, which create additional safety concerns for the nuclear waste manager.

Electronic waste: Mountains of discarded computers, computer monitors, cell phones, and circuit boards from other modern equipment and toys are growing in volume and are more often being segregated and handled separately from the general waste stream. Workers who take this equipment apart and try to recover precious metal components from the circuit boards and batteries and workers who stockpile metal casings for their scrap value have ergonomic risks during material handling. These workers also can be exposed to chemicals in the components they are disassembling and stockpiling such as mercury in old CRT screens and lithium from the batteries.

2. **Operating general waste management processes**. In the jobs described below, physical and chemical risks are inherent to the operation of the processes themselves. But on top of that, the potential exists for exposure to a multitude of wastes with unique biological and chemical hazards. Such jobs may increase in number due to a greening economy as communities demand that less wastes be land filled and more be handled through treatment, sorting, and, wherever possible, reuse, recycling, or repurposing.

Household Trash Collection: There is a move for households to segregate more of their wastes into general categories so that plastics, glass, and paper can be recycled; vegetative waste can be composted; and the material that remains can be land-filled or incinerated. Many haulers who collect these wastes are, like their old economy counterparts, still at risk from inattentive drivers, from lifting heavy containers, from crushing via the compactor, and from exposure to improperly disposed hazardous materials in the communities they serve. Luckily, the green economy also includes attempts to make these jobs safer for workers through the increased use of collection trucks that have automated arms and compactors, thus reducing the need for the workers to directly contact the wastes, the compactor, and other traffic during collection.

Single-stream Sorting: It used to be that households were asked to segregate their various recyclable materials, which then allowed haulers to just collect material and transport it directly to the appropriate materials recovery facility. However, in the green economy, recyclables are increasingly being collected as a single-stream process, which seems to actually increase recycling volumes and requires new, more highly mechanized sorting lines. In these processes, fewer people are required to hand sort materials and thus have reduced exposure to physical hazards. But mechanized equipment requires maintenance to correct or prevent upset conditions, and this increased maintenance activity carries a higher risk of injury. Risks include greater exposure to noise; flying debris (due to use of magnets); improperly recycled materials such as propane tanks, pool chemicals, and aerosol cans; and bioactive contaminants (pharmaceuticals, infectious agents, and solvents).

Household Hazardous and Bulk Waste: Workers at household hazardous waste collection events and for new start-up businesses that collect and extract value from bulk household wastes, including old appliances, are exposed to risks from traffic and from ergonomic hazards. They also have potentially higher exposures to chemical hazards, complicated by the fact that many hazardous materials are not easily identified at first glance.

Maintenance/Janitorial/Housekeeping: Many of the hazards described for the old economy trash hauler are retained by green economy maintenance, janitorial, and housekeeping staffs. On top of that are risks from electrocution, from shards of broken glass contacting eyes and other unprotected body parts, and from exposure to new materials and other risks the maintenance staff may not have been made aware of. These workers are also increasingly exposed to "green cleaning chemicals" some of which are green because they have fewer petroleum-based components, not because they are safer for the workers who use them. And classical risks, such as exposure to sharps from diabetic needles, still remain.

Construction and Demolition: Many workers in this field are day laborers and small businesses with little formal training in safety and health protection. They are regularly exposed to hazardous materials, diesel exhaust, flying debris, wet drywall, mold, and mildew.

Scrap Metal Recycling: Greening leads to more throughput at scrap metal recycling facilities. The workers who perform the recycling are exposed to ergonomic risks, traffic risks, fumes from cutting and torching, flying debris, and moving equipment. As prices paid for some scrap materials increase, such as has happened with copper, there is also a rush to collect as much of that material as possible during demolition and extraction with less regard for safety of that process.

Emergency Responders/Remediation: Protecting oneself from unknown hazards is the first step in every emergency response and remediation case. Facing the unknown and finding out more about it is the second step. But in certain incidents, EMTs, fire fighters, police, and Hazmat teams must act before all information they seek is available. To help prevent serious injury when an unknown exposes itself as dangerous, the workers are trained to establish and maintain emergency egress mechanisms. Other risks these workers face include use of heavy machinery and selection and use of proper PPE.

Wastewater Treatment: These workers have always been exposed to microbial risks, to whatever people put down the drain including flammable/explosive liquids and toxic chemicals, and to hazards from chemicals and mechanical equipment used in the treatment process itself. Recent news indicates that wastewater treatment workers may also be exposed to pharmaceuticals found in high concentrations in wastewaters. In addition, a push for cleaner water may lead to the addition of new wastewater treatment processes in order to polish the effluents and bring them closer to drinking water quality. The chemicals and energy used in such tertiary processes could further increase the risks faced by the wastewater treatment operator.

Risks, gaps, and barriers in current practice for integrating OSH into green waste management and recycling practices

The workgroups then explored the various gaps and barriers that make it difficult to integrate more or better OSH practices into green waste management practices.

1. **Conflicts between the "drive to green" and the "push for OSH."** The conflicts that the participants listed derive from three primary sources: regulatory gaps, market forces, and false advertising.

Regulatory Gaps

- A mismatch exists between environmental and OSH regulations. Pro-environment activity is often required without equal requirements to protect the workers involved.
- Municipalities do not follow federal OSH regulations.
- Environmental regulations have a cradle-to-grave framework; OSH does not.
- Measurements of carbon footprints, which are being required more often, do not take into account the toxicity of processes that generate them; e.g., lowering a carbon footprint may increase exposure risks to workers.

Market Forces

- Green has a monetary value, and thus the pressure to get it to market fast, results in shorter production lifecycles.
- The market value of OSH for workers is not as high as the market value of green products, and the attention paid to OSH reflects these market conditions (i.e., energy efficiency is promoted above worker health).
- A market desire for more green products is often developed independent of the concerns for the safety and health of workers.

False Advertising

- Some materials that municipalities require be recycled do not have a market value. These materials are collected and processed anyway, exposing those workers to hazards without providing any real environmental (recycling) benefit and without letting the community know those materials will just be land-filled.
- Recycled materials have little, if any, value in the commodity market, and therefore little money is available to sustain OSH activities for the workers who feed those markets.

2. **Untapped (and undertapped) synergies between the "drive to green" and the "push for OSH."** The participants recognized that some pushes leading to greener waste management practices have also been good for the health and safety of its workers. The challenge is to expand those mutual benefits.
   - Automation in waste collection reduces ergonomic risks to those workers.
   - Alternative fuel garbage trucks can reduce worker exposures to hazardous fumes and emissions.
   - Increased recycling can reduce raw material extraction and reduce risks and exposures in those worker communities.
   - Use of less hazardous materials in products and processes should result in less hazardous materials in the waste stream.
   - Capture of landfill gases reduces emissions and risks to the communities around landfills.
   - Competition between those who promote environmental management systems like ISO 14001 and those who promote safety management systems like ANSI Z10 leads to improvements in both.

- When green means consumer friendly, it should be easy to make sure it is also worker friendly.

3. **Redeploying existing OSH knowledge**. Participants identified several areas where existing OSH experience and expertise could make the jobs in waste management and recycling safer.
   - Experience in making manufacturing processes safer should be transferred to the waste management industry, thus providing similar benefits.
   - Experience with devising and implementing database and software systems to track injury and illness data and to complete root-cause analyses should also be useful in waste management.
   - Existing database systems that have data needed to understand and address safety issues in this industry should be "repurposed" for OSH outcomes.
   - New automation technologies can be applied in other waste management functions. Although it might lead to a reduction in certain types of jobs, it could make the jobs that remain safer.
   - OSH professionals have developed education models that work.
   - Deploying OSH knowledge needs to turn from old technology (PowerPoint) and embrace new technologies (You Tube and other social media).

4. **Managing the unknown**. A number of unknowns were identified that are begging for research and remediation dollars in order to make the industry safer.

   - Cradle-to-cradle thinking instead of cradle-to-grave changes the function of, and risks to, the waste manager, and this needs to be explored holistically.
   - For many green economy materials, a paucity of data on exposure risks or compatibility issues makes it harder for OSH professionals to develop protective schemes.
   - Medicines are finding their way into solid waste streams, and information is lacking as to how they behave or degrade in both landfills and in incineration.
   - Identify and close the regulatory gaps that keep some waste management and recycling workers at higher risk compared to other workers in the society.
   - PtD must do a better job at looking at risks to the waste management worker who supports a process, not just the process workers.
   - Plan before implementing; for example, the larger containers used for automated trash collection are difficult to handle and create ergonomic concerns.
   - Traditional risk assessment models may not apply to the waste management industry. Risks from exposure to unknown materials in multiple ways may need to be assessed with new models.
   - E-wastes: what we know may not pose the only risks of handling waste electronic equipment.
   - Investigate charging fees to users of waste management and recycling services to create incentives to reduce the risks that workers see: "When you pay, you pay attention."

- Explore whether ROI is still a valid driver for projects in waste management and recycling. The dynamic marketplace often invalidates assumptions made when projects are first evaluated.

Removing barriers and promoting activities that insure green waste management and recycling jobs are safe for workers

Next, the participants listed activities that they believed would close the gaps and remove the barriers identified above. Activities were placed under four distinct categories as described under Methods. At the end of the session, participants were allowed to vote on where strategic priorities should be set to improve safety in the green economy's waste management and recycling sector.

Specific activities and the relative weightings derived from the vote counts are described in more detail in subsections that follow. However, looking at the recommendations in total, the waste management and recycling workgroups came up with distinctly different priorities: the morning session preferred new policies and standards and the afternoon session preferred outreach and education. Overall, education and outreach gained the combined groups priority (with a 29% average weighting) vs. creation of policies and standards (26%), soft-sell of OSH values (23%), and research (22%).

Table 27. Activities Recommended by Waste Management and Recycling Workgroup

Activity category	Relative weighting		
	Group 1	Group 2	Combined
Making OSH more compelling	20.6%	25.9%	23.3%
Creating new policies and standards	31.4%	21.3%	26.2%
Promoting "what we know"	23.5%	33.3%	28.6%
Resolving what we don't know	24.5%	19.4%	21.9%

1. **Making OSH more compelling.** Results of the two sessions are summarized in the following table. Participants recommended that primary attention be given to increasing incentives, like taxes, for investing in the safety of waste management workers and then increasing connectivity and raising awareness that OSH professionals are prepared and capable of making a difference in the workplace.
2. **Creating new policies and standards**. Recommendations from the two sessions are summarized in the table below. The main thrust from both sessions was to require that health and safety be a priority in the waste management industry and to eliminate funds if it is not.
3. **Promoting "what we know."** The two sessions both tended to focus on education of the public so that they care more and know better their role in protecting the workers in this industry. Participants also recognized a need for better systems required to collect

and disseminate information on the health and safety risks and solution facing this community. These and additional recommendations for disseminating existing OSH knowledge are summarized below.

Table 28. Making OSH More Compelling in Waste Management and Recycling

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Raise awareness and availability of information on successful OSH programs, specifically Prevention through Design (PtD), job hazard assessments, and exposure assessments.	7.0	**Provide tax incentives** for making recycling safer for the workers involved.	10.4
		Use universities to develop connection/sharing centers for workers' safety and health.	7.3
Develop Web sites for sharing information and best practices.	5.3	**Promote training** for proper material handling.	3.1
		Share best practices more easily.	3.1
Put health and safety language in recycling contracts and government grant awards.	3.5	**Develop more programs to educate drivers** about hazards on the road.	2.1
		Promote getting more energy from waste, increasing financial drivers to dedicate to OSH protection.	2.1
Make the case that OSH consideration is a necessary component of the product's life cycle assessments.	1.8	**Promote information sharing via modern tools**, e.g., Google, Bing, and YouTube.	1.0
Promote cradle-to-cradle management of products and its mandate to care about workers at end of this cycle.	0.9	**Develop more worker friendly OSH training programs** (instead of sit-down sessions at the end of a midnight to 8AM shift).	0.0

4. **Resolving "what we don't know."** Participants recognized that workers in waste management and recycling have not benefited from many job hazard assessments, from consistent injury and illness data collection and monitoring, or from sharing best practices. These and additional recommended activities are summarized below.

Table 29. Creating New Policies and Standards for Waste Management and Recycling

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Put health and safety language in federal and municipal recycling grants and contracts.	10.5	**Require a safety and health program** in any federally funded venture, before money is released.	9.4
Collect data and monitor occupational injuries and illnesses in recycling and waste management industries.	7.0	**Create standard disposal guidelines** that include a strong OSH component.	7.3
Integrate OSHA and EPA exposure standards into one.	7.0	**Provide tax incentives** to make recycling more financially viable.	4.2
Incorporate OSH standards into green recycling and waste management contracts.	2.6	**Promote better enforcement** of safety and health regulations for public employees.	2.1
Evaluate impact of tax policy on green vs. safe behaviors.	0.9	**Advocate for requirements to minimize packaging** that reduces quantity of materials to be handled in waste stream.	1.0
Modify current cradle-to-grave laws to take into account cradle-to-cradle thinking.	0.0	**Develop regulations on use of post consumer recycled content in packaging** to increase market for recycled materials.	0.0
Ask OSHA and Bureau of Labor Statistics to look at the recycling industry.	0.0		

Table 30. Promoting "What we Know" in Waste Management and Recycling

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Educate public about collection workers and other jobs and their risks in trash/recycling processes.	10.4	**Develop and fund community-specific green outreach**; offer process safety assessments covering recycling and trash policy, yard and food wastes, etc.	12.3
Educate public about products and what happens when they enter the waste stream, e.g., good and bad, impact on workers.	6.3	**Develop stories and educate public** via local news and pictorials about trash recycling vehicle workers and drivers.	11.4
Develop worker rights training.	4.2	**Develop communication best practices Web sites** that local governments and municipalities can access.	7.9
Develop systems for information sharing to pass a knowledge base to a new generation.	3.1		
Educate public about externalities, including social costs of waste and waste management, and show how these costs come back as a real cost to society.	1.0		
Develop a mentoring program; safety culture trickles down.	0.0		

Table 31. Resolving "What We Don't Know" in Waste Management and Recycling

Group 1 recommended activities	% Votes cast	Group 2 recommended activities	% Votes cast
Develop new methodologies to perform better job hazard analyses and exposure assessments, accompanied by data collection and monitoring for injuries and illness.	10.5	**Develop new best practices for recycling.**	7.3
Research safer products and mechanisms to promote cradle-to-cradle management, e.g., separation after use and return to supplier.	5.3	**Research technologies to reduce/eliminate worker exposures.**	5.2
Develop demonstration projects, e.g., how to avoid driving accidents.	4.4	**Improve surveillance and medical records**, e.g., scope, format, availability.	4.2
Research source reduction programs. What is really needed to keep some materials out of general waste stream and to handle them safely?	1.8	**Perform exposure assessments** for waste management and recycling industry.	3.1
Improve facility designs in anticipation of unexpected hazards and handling them better.	0.0	**Involve academia in this research.**	2.1
Improve analysis methods of root cause so investigators can gain better understanding of the scope of OSH problems.	0.0		
Develop information sharing databases that allow better surveillance of all occupations, including temp, self-employed, and day laborers, etc.	0.0		
Perform economic and behavior analysis. Find out what it is that motivates change.	0.0		

IV. PRIORITIZED RECOMMENDATIONS

Each workgroup leader presented to the combined audience eight recommendations for which their groups had given the highest support. Thus, each workgroup presented two "Practice" recommendations (how to make OSH more compelling), two "Leadership" recommendations (what policies and standards need to be strengthened), two "Education" recommendations (how to promote what we know), and two "Research" recommendations (how to resolve what we don't know). Each audience member then assigned their own prioritization on each recommendation, with 1 being lowest priority and 5 being highest priority.

When all priority scores were averaged, the audience seemed to be recommending that OSH professionals need to assume more leadership and that the leadership can then be backed up with investment in research, improved practices, and education.

Table 32. Prioritization of Recommendation Types

Type of recommendation	Average ranking for top priorities
Leadership	4.03
Research	3.76
Practice	3.72
Education	3.68

Similarly, the combined audience believed that the recommendations made by the construction and energy sectors also deserved higher prioritization, perhaps reflecting that green investment via ARRA funding and other mechanisms also seem to focus on construction processes and energy delivery.

Table 33. Prioritization by Sectors

Sectors	Average ranking for top priorities
Construction/Infrastructure/Repurposing	4.07
Energy, Mining, and Building Operation and Maintenance	3.85
Agriculture, Forestry, and Fishing	3.79
Transportation	3.72
Manufacturing/Emerging Technology	3.68
Waste Management	3.68

When looking at the top 24 priorities overall (i.e., the top 50% whose average score exceeded 3.75), it is also clear that there are overlaps in these top recommendations and that they refer to many of the same approaches.

Table 34. Top 24 Overall Priorities

Rank	Work group	Category	List items	Rating
1	Waste	Leadership	Include worker health and safety requirements in federal grants and contracts.	4.49
2	Energy, Mining	Leadership	Promote consistent OHS codes for wind/solar and other green energy construction, e.g., turbine towers.	4.38
3	Construction	Leadership	Include OSH into green and sustainable standards as they are being updated.	4.38
4	Construction	Leadership	Promote federal sustainability efforts to include OSH in procurement and construction.	4.37
5	Transportation	Leadership	Ensure OSH is in green initiatives via government grants.	4.31
6	Construction	Practice	Integrate OSH into green elements of contracts and specifications.	4.25
7	AFF	Practice	Develop index of green chemicals and exposure risks.	4.18
8	Energy, Mining	Practice	Establish best practices and PtD processes for green energy categories emphasis on small business.	4.13
9	Construction	Research	Develop, validate, and disseminate a LEED®-like safety and health rating system.	4.06
10	Waste	Research	Research for safer products (cradle-to-cradle, life cycle analysis) by industry/academia.	4.03
11	Energy, Mining	Research	Conduct surveillance and hazards research on green job sites with emphasis on small businesses.	4.02

(Continued)

Table 34 (Continued). Top 24 Overall Priorities

Rank	Work group	Category	List items	Rating
12	Waste	Research	Investigate better exposure assessment (job hazard analysis) through improved research methodologies.	3.99
13	AFF	Leadership	Include occupational injury and illness tracking component in health records.	3.99
14	Manufacturing	Education	Train new U.S. workforce to operate green technologies safely.	3.98
15	Construction	Research	Develop a life-cycle assessment tool that includes OSH.	3.98
16	Construction	Education	Educate and emphasize the importance of using upstream thinking (planning, preventing, controlling) as the primary approach to integrating OSH into sustainability.	3.96
17	Manufacturing	Education	Develop/promote OSH training for engineers/business professionals.	3.95
18	Transportation	Leadership	Address regulatory gaps.	3.94
19	Construction	Education	Develop and disseminate the basic case (and hook) for why OSH is crucial to sustainability.	3.93
20	AFF	Education	Engage workers/AFF communities in assessment of job changes, risks, and solutions.	3.92
21	Manufacturing	Leadership	Establish integrated environmental health and safety management system that includes formalized risk assessment and management of change policy.	3.86
22	Waste	Leadership	Include OSH surveillance and standardization of federal disposal recycling guidelines, including the integration of OSHA/EPA standards, in federal grants and contracts.	3.85

(Continued)

Table 34 (Continued). Top 24 Overall Priorities

Rank	Work group	Category	List items	Rating
23	AFF	Research	Develop a baseline of exposures for agriculture, forestry, and fishing.	3.78
24	Transportation	Practice	Identify and disseminate information and include worker involvement.	3.76

By looking for common themes in each of these high priority recommendations, we conclude that there are seven approaches that OSH professionals recommend be taken to make worker safety and health an integral part of the green economy.

Table 35. Top Recommended Themes

Rank	Work group	Category
1	Make OSH a priority by leveraging the power government and industry already have, be it via contracts or grant authority.	#1,4,5,6,22
2	Integrate OSH data collection and monitoring into codes and standards of practice that already have wide support, so that improved OSH protections also becomes standard practice.	#2,3,9,21
3	Improve the data collection process to identify and understand OSH risks and use that data to promote OSH investment more effectively.	#8,11,13,20,22,23,24
4	Create better methods, better standard references that can be used by OSH professionals to better protect workers.	#7,8,10,12,15
5	Invest more time and resources to train exposed populations and those who may be unaware they are creating risks.	#14,16,17,24
6	Fix broken regulations.	#18
7	Conduct market research to create new motivators that will inspire workers and owners to make OSH a priority that cannot be ignored.	#19

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