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SESSION III

Climate Change and the Circular Economy: How Green Chemistry Connects

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Jon Smieja, Steelcase
Sally Edwards, University of Massachusetts Lowell *(moderator)*

This session explored the connections between green chemistry, climate change, and the circular economy to identify the need for, and opportunities to, bring green chemistry into these discussions. Dr, Edwards opened the session with a primer on these issues and emphasized the following points to set the context for the subsequent panel discussion:

- *Green chemistry solutions hold promise as an important adaptation strategy to lessen the impacts of climate change on the health of the environment and humans.* A 2013 International workshop convened through the Society for Environmental Toxicology and Chemistry (SETAC) identified multiple ways that climate change and toxic chemicals interact in negative ways that are greater than additive effects.
- *A circular economy will not succeed with a contaminated stream of materials targeted for reuse.* Principles of the circular economy such as "waste is food'" point to the critical importance of designing out chemicals of concern and the role for green chemistry in developing benign materials and chemicals. Customers and the public need to be confident in the quality of recyclable material. If this confidence is lacking, the market will demand virgin materials and the attempt to create a circular economy will fail.

The panelists represent companies that are engaged in different types of product manufacture and therefore face different challenges within a circular economy. Novozymes primarily uses "biological nutrients" (materials that are not harmful to living systems after human use and can be safely returned to nature) and HP, Inc. and Steelcase primarily use "technical nutrients" (polymers or minerals that have the potential to be securely reused in a continuous industrial cycle). The panelists

discussed the connections between green chemistry, climate change, and the circular economy.

KEY TAKEAWAYS

Opportunities for Safer Chemicals and Products:

- Green chemistry innovations that reduce the toxicity of products and increase their potential as inputs for new products at end of life.
- Increased transparency of supply chain information that allows manufacturers to more easily select high quality/benign materials.
- New, innovative bio-based chemicals and materials for industrial processes that provide restorative as well as non-hazardous properties.
- Improved systems for reverse logistics.
- A sufficient inventory of restorative and renewable materials and energy.

Key Drivers for Safer Chemicals and Products:

- HP, Inc. has adopted the following definition of a circular economy: "Keeping materials in use for the longest period of time at the highest state of value."
- Novozymes' business model applies biological processes to industrial processes and is directly connected to the circular economy principle of restoration. The company collects data from life-cycle analyses to demonstrate restorative benefits.
- Steelcase and HP, Inc. both incorporate "product as service" capacities in their business models. This approach changes design incentives because the companies will get their products back for re-use/re-manufacture. It provides additional incentives to use innovative and safer chemicals and materials.

Challenges for Implementation/Lessons Learned:

- Business models depend on the paradigm that the only way to make money is to "sell more stuff." Moving towards a circular economy requires embracing different business growth models (e.g., adding service components).
- Customer preferences for the newest trend.
- Lack of economies of scale in the biomaterials area, and necessary supplies of energy from renewable sources.