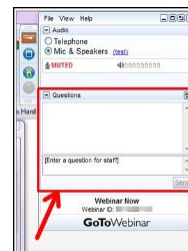
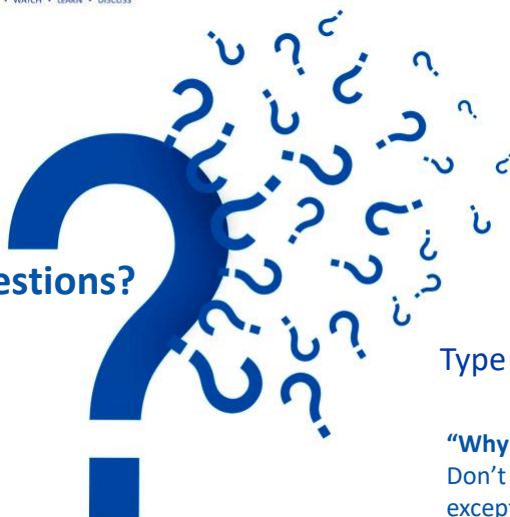




Have Questions?



Type them into questions box!

**“Why am I muted?”**

Don't worry. Everyone is muted except the presenter and host. Thank you and enjoy the show.

Contact ACS Webinars® at [acswebinars@acs.org](mailto:acswebinars@acs.org)

1



@AmericanChemicalSociety



@AmerChemSociety



@AmerChemSociety



<https://www.linkedin.com/company/american-chemical-society>

Contact ACS Webinars® at [acswebinars@acs.org](mailto:acswebinars@acs.org)

2

## Check out the ACS Webinar Library!

*An ACS member exclusive benefit*



Hundreds of presentations from the best and brightest minds that chemistry has to offer are available to you on-demand. The Library is divided into 6 different sections to help you more easily find what you are searching.

### Professional Development

[▶ View the Collection](#)

Learn how to write better abstracts, deliver more engaging presentations, and network to your next dream job. Brush up on your soft skills and set a new career path by mastering what can not be taught in the lab.

### Technology & Innovation

[▶ View the Collection](#)

From renewable fuels to creating the materials for the technology of tomorrow, chemistry plays a pivotal role in advancing our world. Meet the chemists that are building a better world and see how their science is making it happen.

### Drug Design and Delivery

[▶ View the Collection](#)

The Drug Design Delivery Series has built a collection of the top minds in the field to explain the mechanics of drug discovery. Discover the latest research, receive an overview on different fields of study, and gain insight on how to possibly overcome your own med chem roadblocks.

### Culinary Chemistry

[▶ View the Collection](#)

Why does food taste better when it is grilled or what molecular compounds make a great wine? Discover the delectable science of your favorite food and drink and don't forget to come back for a second helping.

### Popular Chemistry

[▶ View the Collection](#)

Feeling burdened by all that molecular weight? Listen to experts expound on the amazing side of current hot science topics. Discover the chemistry of rockets, how viruses have affected human history, or the molecular breakdown of a hangover.

### Business & Entrepreneurship

[▶ View the Collection](#)

How do ideas make it from the lab to the real world? Discover the ins and outs of the chemical industry whether you are looking to start a business or desire a priceless industry-wide perspective.

<https://www.acs.org/content/acs/en/acs-webinars/videos.html>

3



## ACS Webinars®

CLICK • WATCH • LEARN • DISCUSS



**Learn from the best and brightest minds in chemistry!** Hundreds of webinars on diverse topics presented by experts in the chemical sciences and enterprise.

**Edited Recordings** are an exclusive ACS member benefit and are made available once the recording has been edited and posted.

**Live Broadcasts** of ACS Webinars® continue to be available to the general public several times a week generally from 2-3pm ET!

A **collection of the best recordings** from the ACS Webinars Library will occasionally be rebroadcast to highlight the value of the content.

[www.acs.org/acswebinars](http://www.acs.org/acswebinars)

4

# Advance YOUR CAREER

ChemIDP™



ChemIDP.org

# Discover ACS PUBLICATIONS

Publishing Resources



publish.acs.org

# Connect WITH CHEMISTS AND OTHER SCIENCE PROFESSIONALS

CAS SciFinder Future Leaders



171 alumni, 35 countries  
and over 120 institutions

acs campus.acs.org/resources



## From ACS Industry Member Programs

### ◆ Industry Matters Newsletter

ACS Member-only weekly newsletter with exclusive interviews with industry leaders and insights to advance your career.

Preview & Subscribe: [acs.org/indnews](https://acs.org/indnews)



Connect, collaborate, and stay informed about the trends leading chemical innovation

Join: [bit.ly/ACSinnovationhub](https://bit.ly/ACSinnovationhub)

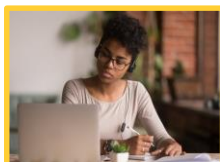


## ACS Career Navigator: Your Home for Career Services



Whether you are just starting your journey, transitioning jobs, or looking to brush up or learn new skills, the **ACS Career Navigator** has the resources to point you in the right direction.

We have a collection of career resources to support you during this global pandemic:



Professional  
Education



Virtual Career  
Consultants



ACS Leadership  
Development System



Career Navigator LIVE!



ChemIDP



College to Career



ACS Webinars



Virtual Classrooms

Visit [www.ACS.org/COVID19-Network](http://www.ACS.org/COVID19-Network) to learn more!

7

## Join us in our efforts to increase the diversity of chemistry.



Valued donors like you have sustained ACS educational programs that are welcoming students from diverse backgrounds into our profession.

[www.acs.org/donate](http://www.acs.org/donate)



ACS Office of Philanthropy  
Chemistry for Life®

8

## A Career Planning Tool For Chemical Scientists



**ChemIDP** is an Individual Development Plan designed specifically for graduate students and postdoctoral scholars in the chemical sciences. Through immersive, self-paced activities, users explore potential careers, determine specific skills needed for success, and develop plans to achieve professional goals. **ChemIDP** tracks user progress and input, providing tips and strategies to complete goals and guide career exploration.

<https://chemidp.acs.org>

9

## ACS Department of Diversity Programs



*Advancing ACS's Core Value of Diversity, Inclusion & Respect*

We believe in the strength of diversity in all its forms, because inclusion of and respect for diverse people, experiences, and ideas lead to superior solutions to world challenges and advances chemistry as a global, multidisciplinary science.

### Contact Us:

[https://app.suggestionox.com/r/DI\\_R](https://app.suggestionox.com/r/DI_R)

[Diversity@acs.org](mailto:Diversity@acs.org)



[acsvoices.podbean.com/](https://www.acsvoices.podbean.com/)



[www.acs.org/diversity](http://www.acs.org/diversity)

10



**25<sup>th</sup> Annual Green Chemistry & Engineering Conference**  
Sustainable Production to Advance the Circular Economy

**VIRTUAL CONFERENCE**  
June 14-18, 2021

**REGISTRATION IS OPEN**

 **ACS GCI**  
Chemistry for Life®

**gcande.org**

<https://www.gcande.org>

11

**Register Today!**

 **ACS** Green Chemistry Institute  
Chemistry for Life®



B. Frank Gupton

Eunice Heath

Gregg Beckham

Amy Prieto

Meagan Mauter

Jun Huang

Jeremy  
Luterbacher

- Daily Keynotes
- 40+ sessions over 5 days exploring *Sustainable Production to Advance the Circular Economy*
- Networking opportunities, live discussions and more!

<https://www.gcande.org>

12

## GC&E Fridays



Workshops and technical sessions presented on Fridays leading up to the GC&E Conference week. Included in conference registration.

- **May 21:** Communications Workshop
- **May 28:** Careers in Green Chemistry & Engineering that Advance the Circular Economy
- **June 4:** Toxicology for Chemists Workshop
- **June 11:** Influencing Green Chemistry in Pharma and Beyond

---

<https://www.gcande.org>

13

## Grants for Green Chemistry Research in Pharma



### Apply by May 15:

- Solvent Minimization in Flow Chemistry – (\$50k)
- Technology-Enabled Late-Stage Functionalization (LSF) of Pharmaceuticals – (\$50k)
- Greener Peptide and Peptide Conjugate Synthesis – (\$50k)
- Increasing the Breadth and Utility of Enzymes in Pharma Manufacturing – (\$50k)
- Ignition Grant Program for Green Chemistry and Engineering Research – (\$25k; multiple available)

---

<https://www.acsgcipr.org/advancing-research>

14



## Solving the Plastics Problem Through Chemistry

Federal Research and Technology Programs



Date: Wednesday, April 28, 2021 @ 2-3:30pm ET

Speakers: Bruce Garrett, U.S. Department of Energy / Christina Payne, National Science Foundation / Kathryn Beers, National Institute of Standards and Technology

Moderator: Angela Wilson, 2021 ACS President Elect

[Register for Free!](#)

### What You Will Learn:

- The Federal research funding priorities and opportunities related to the chemical formulation, recycling, and upcycling of plastics
- How these Federal agencies are working with industry to set new standards, move toward a circular economy, and improve life-cycle analysis tools
- What are some possible future directions and plans under a new administration

Co-produced with: ACS Committee on Science

Organized by: Teresa Fryberger, National Academy of Sciences (retired) and Young-Shin Jun, Washington University in St. Louis

## How to Survive a Life in Chemistry in a Post-COVID-19 World



Date: Wednesday, May 5, 2021 @ 2-3pm ET

Speaker: Joe Martino, American Chemical Society

Moderator: Tom Halleran, American Chemical Society

[Register for Free!](#)

### What You Will Learn:

- How to approach networking and work after COVID-19, both in person and virtually highlighting virtual tools and how to re-think in-person networking for a post-pandemic world
- What was impacted by COVID-19 in the past year, focusing on industry and academia, and how that will impact the future
- How the workforce is gearing up to a return to in-person work that will be slightly different than before

Co-produced with: ACS Careers

## How Industry is Driving Sustainability Through Innovation



Date: Wednesday, May 12, 2021 @ 2-3pm ET

Speakers: Peter Eckes, BASF / Gayle Schueller, 3M / Bob Maughon, SABIC

Moderator: Rebekah Paul, American Chemical Society

[Register for Free!](#)

### What You Will Learn:

- The role of the chemical industry in driving sustainability
- How sustainable innovations can benefit the consumer, the chemical industry and the environment
- Opportunities for the next generation in the chemical industry

Co-produced with: ACS Industry Member Programs

[www.acs.org/acswebinars](http://www.acs.org/acswebinars)

15

CHEMISTS CELEBRATE EARTH WEEK

ACS Green Chemistry Institute

ACS Chemistry for Life®

# THE HIDDEN IMPACT

## TAKING A LIFE CYCLE VIEW



**FREE Webinar** | TODAY at 2pm ET



THIS ACS WEBINAR WILL BEGIN SHORTLY . . .

16





## The Hidden Impact: Taking a Life Cycle View



**RICH HELLING**  
Global Expertise Principal,  
Dow Chemical



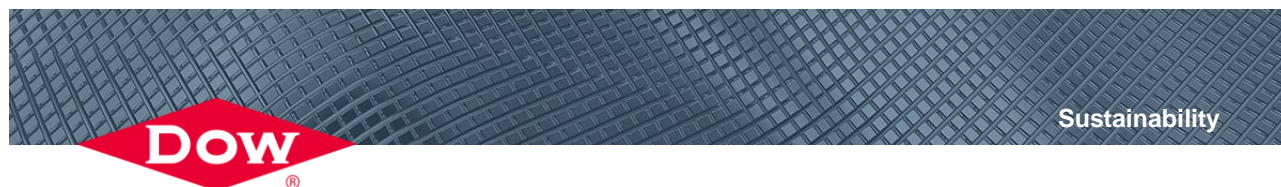
**DAVID CONSTABLE**  
Science Director, Green Chemistry Institute,  
American Chemical Society

*Presentation slides are available now! The edited recording will be made available as soon as possible.*

[www.acs.org/acswebinars](http://www.acs.org/acswebinars)

*This ACS Webinar is co-produced with ACS Green Chemistry Institute and the ACS Committee on Community Activities for the Chemists Celebrate Earth Week campaign*

17



## The Hidden Impacts: Taking a Life Cycle View

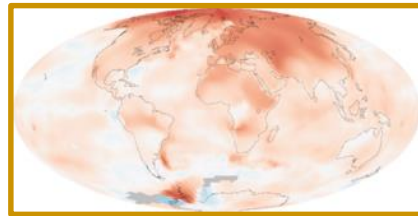
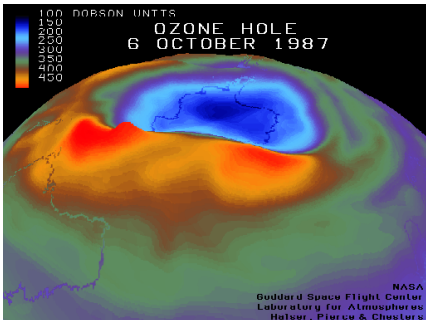
Rich Helling  
22 April 2021

Seek **Together**<sup>™</sup>

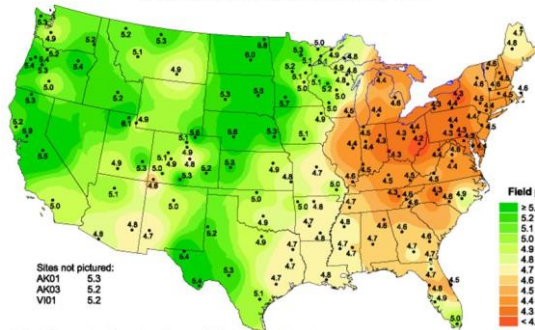
18



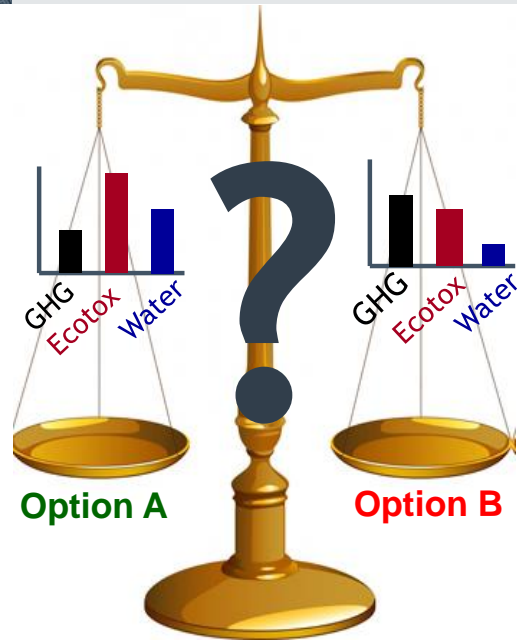
# Environmental Challenges



Hydrogen ion concentration as pH from measurements made at the field laboratories, 1999



**Life Cycle Assessment (LCA) provides environmental insights for decisions**



21

## **Audience Survey Question**

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT



**The most common answer in LCA is:**

- Climate change impact is the most important
- About 2 kg CO<sub>2</sub>eq/kg
- Reusable is always better
- It depends



*\* If your answer differs greatly from the choices above tell us in the chat!*

22

# Life Cycle Assessment

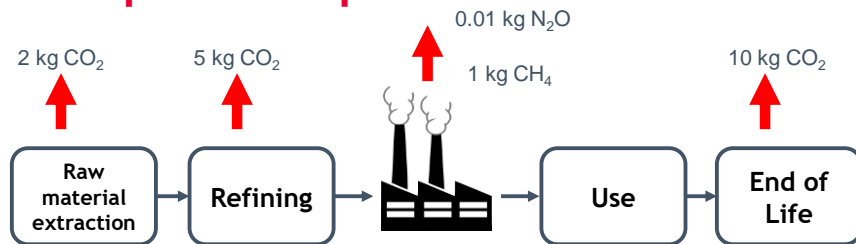


$$\text{Potential Environmental Impact} = \sum_{\substack{\text{all stages} \\ \text{all species}}} \text{Mass, energy} \times \text{Characterization Factor}$$



23

# Simple carbon footprint example

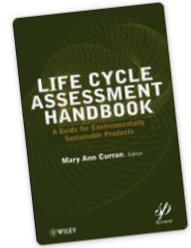


Characterization Factors (Global Warming Potential)		Stage	Emissions	Characterization Factor (CF)	Emissions x CF = GWP
GHG	GWP (kg CO <sub>2</sub> -eq/kg GHG)	Raw Mat's	2 kg CO <sub>2</sub>	1	2
CO <sub>2</sub>	1	Refining	5 kg CO <sub>2</sub>	1	5
CH <sub>4</sub>	30	Manu-facturing	1 kg CH <sub>4</sub>	30	30
N <sub>2</sub> O	298		0.01 kg N <sub>2</sub> O	298	3
		EOL	10	1	10
TOTAL life cycle GHG emissions (GWP)					50 kg CO <sub>2</sub> -eq



24

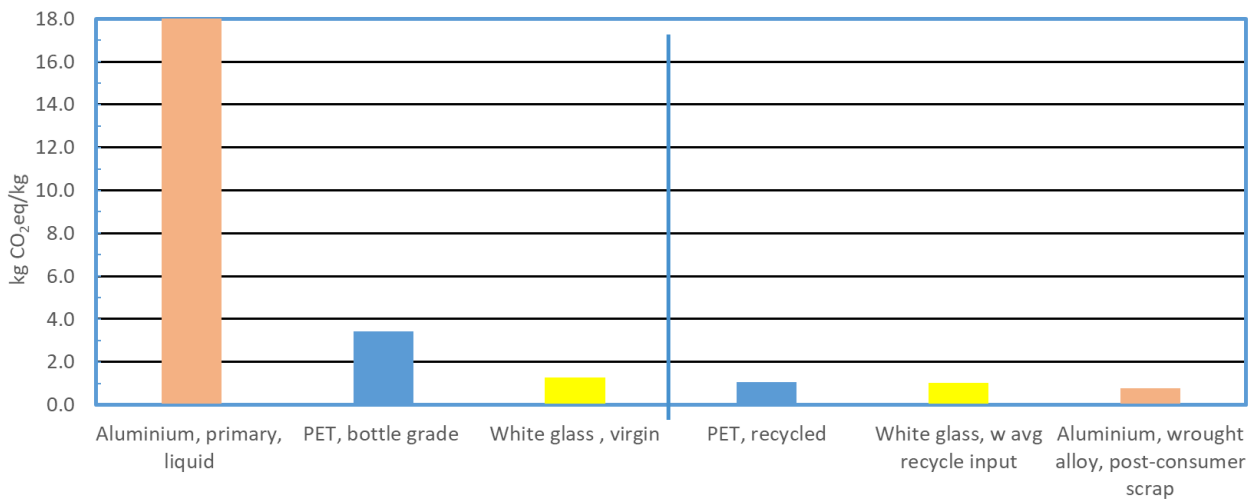
## LCA started with Coke



vs.

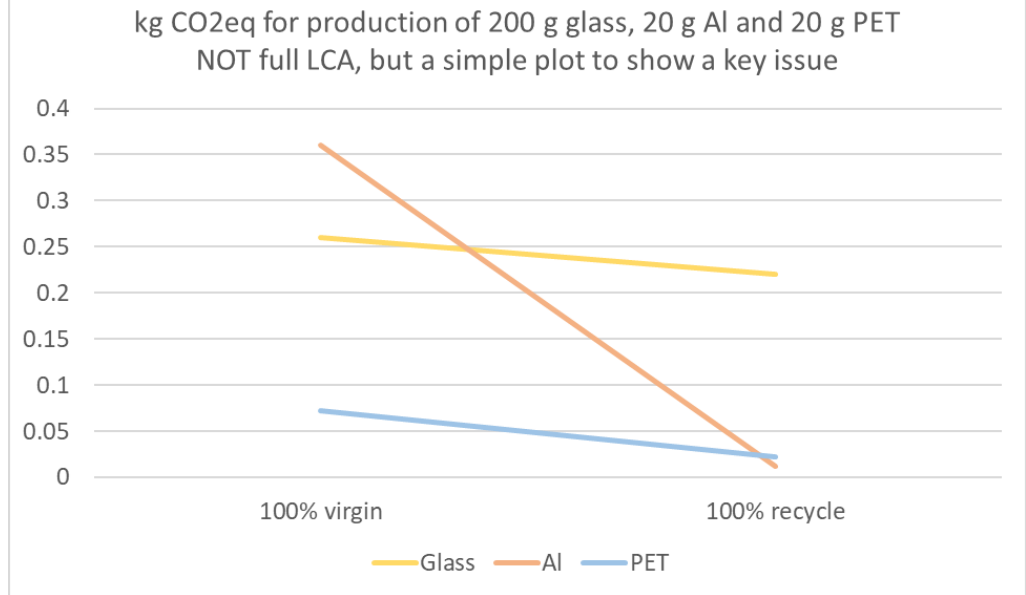


Carbon footprints of common bottle materials are lower for recycled materials, **per kg**



Source: ecoinvent, v 3.6

**For plausible masses per bottle, the “best” material depends on recycle rate**



27

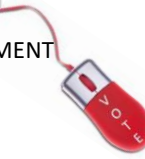
## Plastic Circularity



28

## Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT



Location of circular processes from waste depend strongly on location. **Which of these my be the least dependent on location?**

- Grid power
- Alternative fate of the waste
- Transportation modes and distances
- Process technology



*\* If your answer differs greatly from the choices above tell us in the chat!*

29

**Consider systems that do these two things:**



**Make plastic**

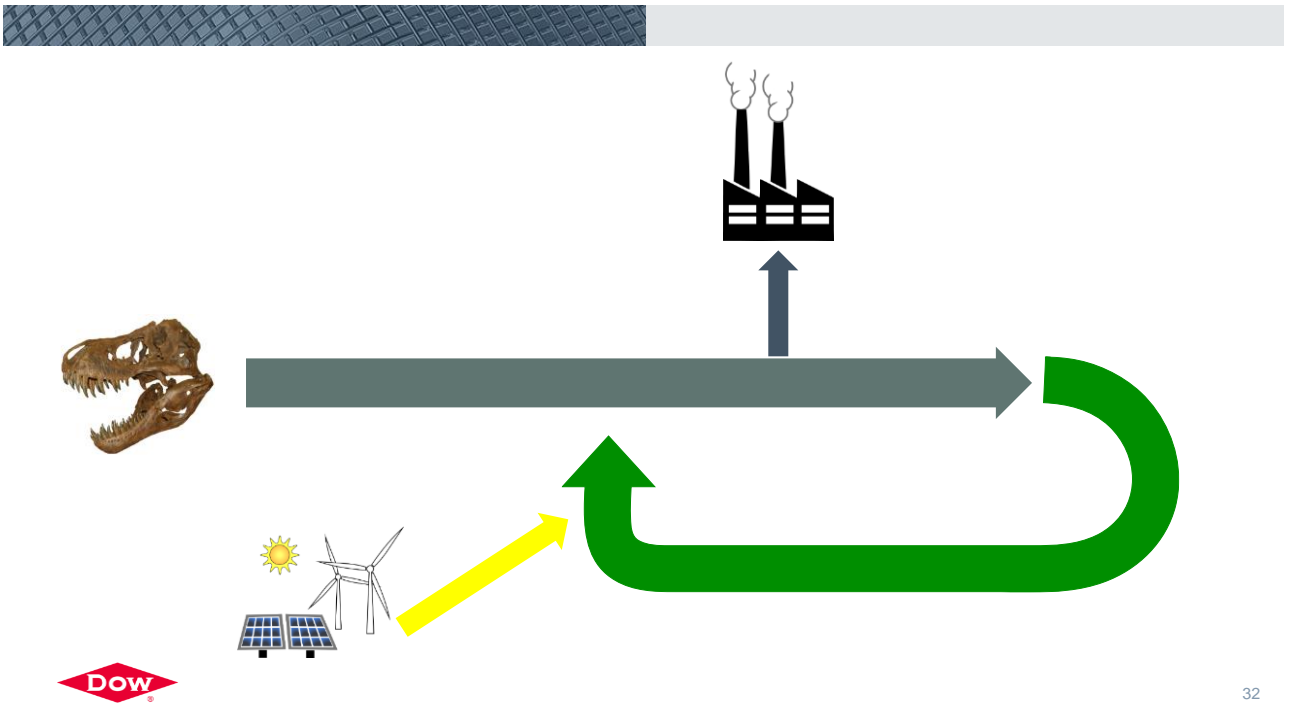
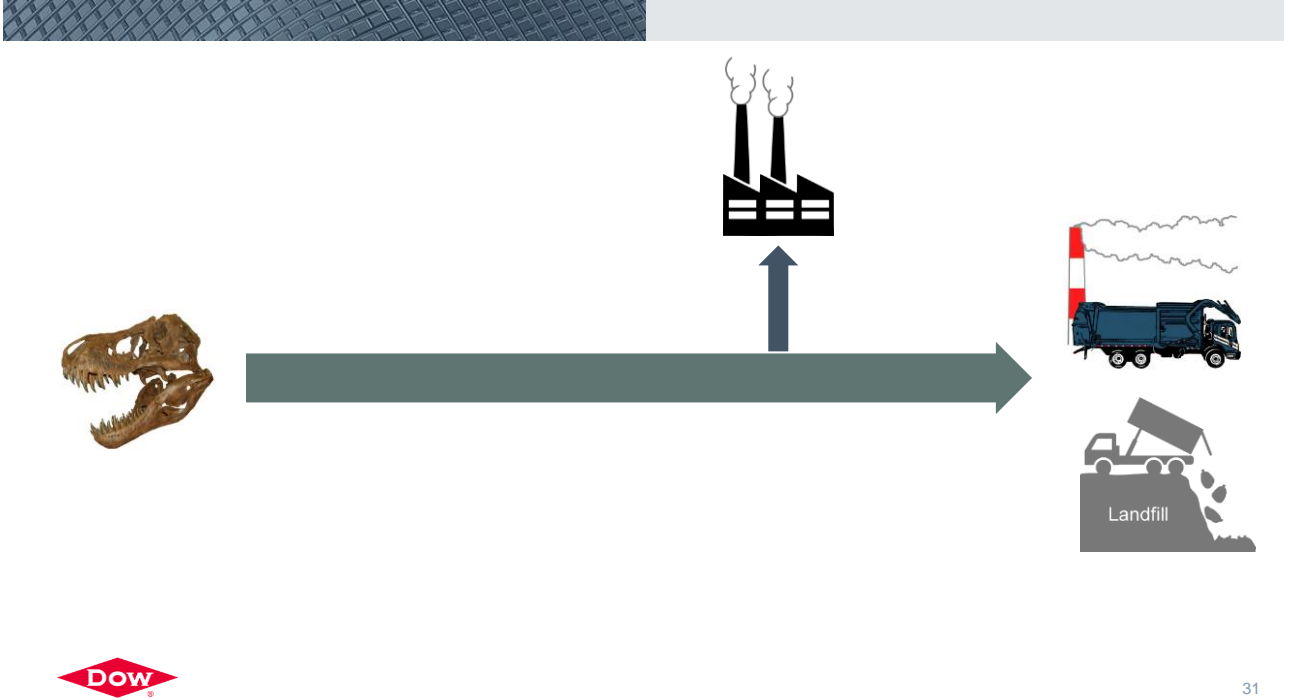
**AND**



**Use/treat waste plastic**



30





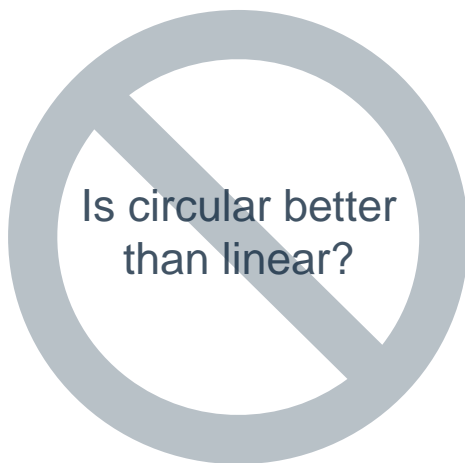
## Where (or when!) in the world is the circular option better for GHG

	Use coal power	Use green power
Avoid burying waste	- -	- +
Avoid burning waste	- +	+ +



33

## The real question for LCA



Under what conditions is circular better than linear?

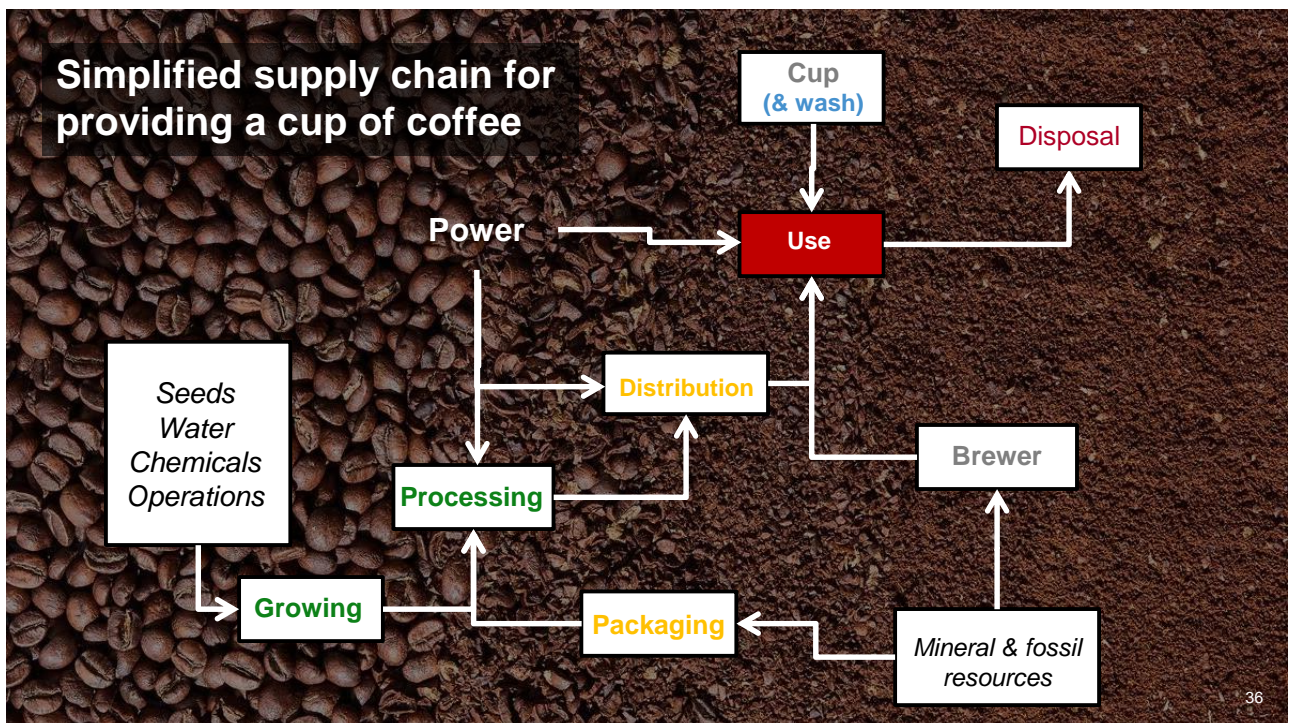


34

# A short story about coffee...



35



36

## Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT



### Which of these is least important in the LCA of home-brewed coffee?

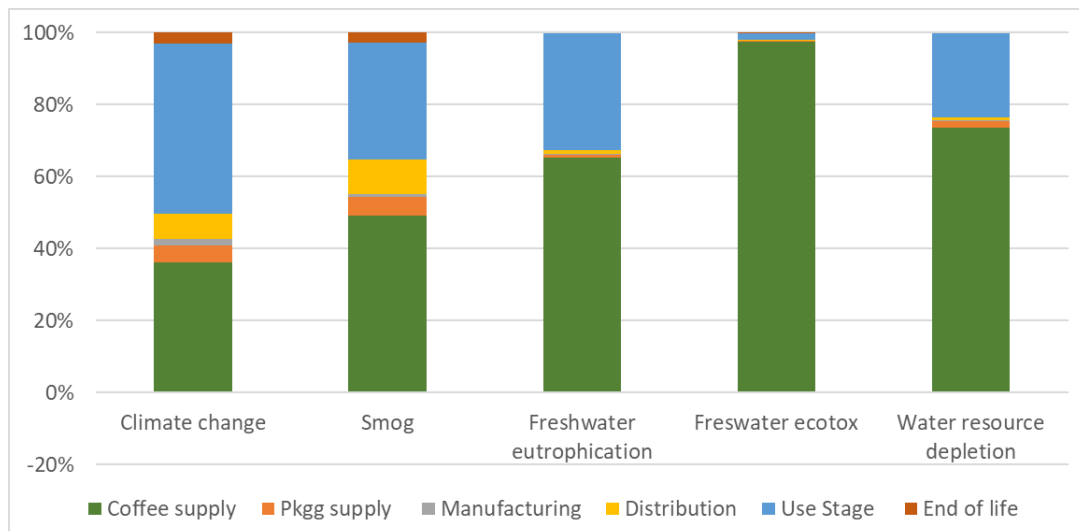
- Coffee supply chain
- Using a dishwasher
- Disposal of the filter, grounds and packaging
- Everything is important



*\* If your answer differs greatly from the choices above tell us in the chat!*

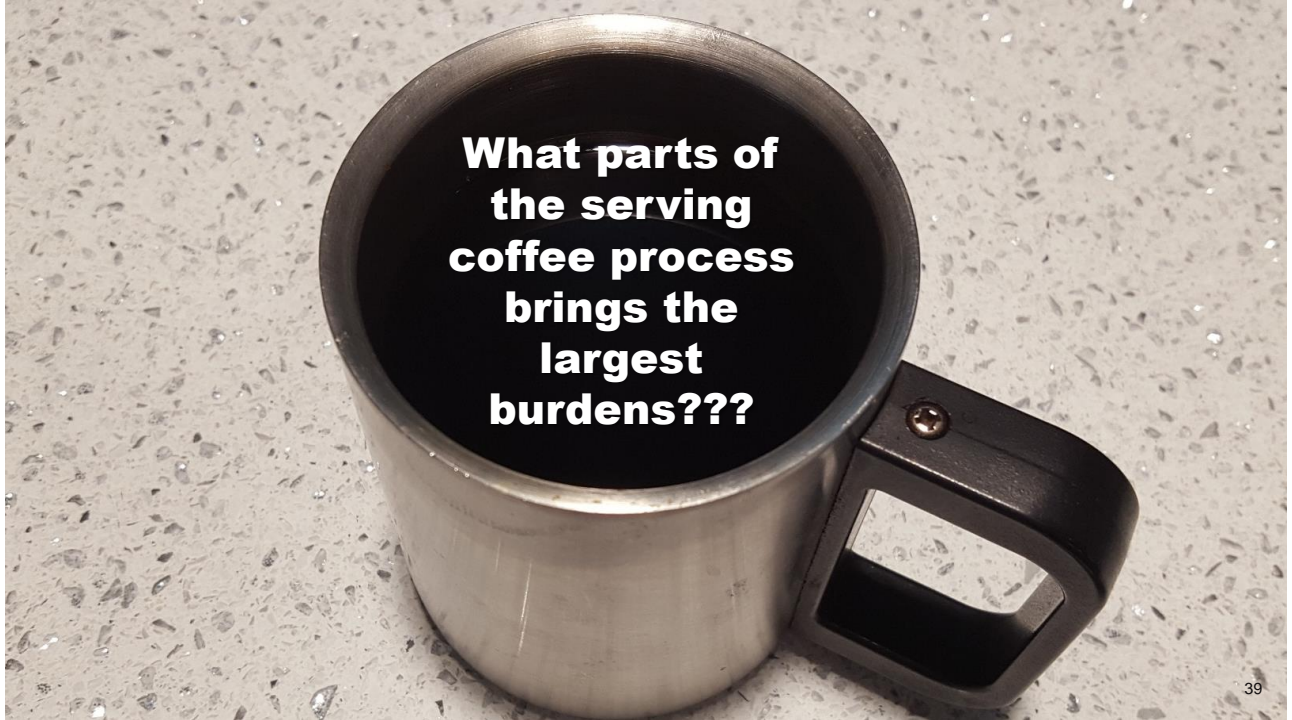
37

### Major impact sources for cup of coffee are supply & use



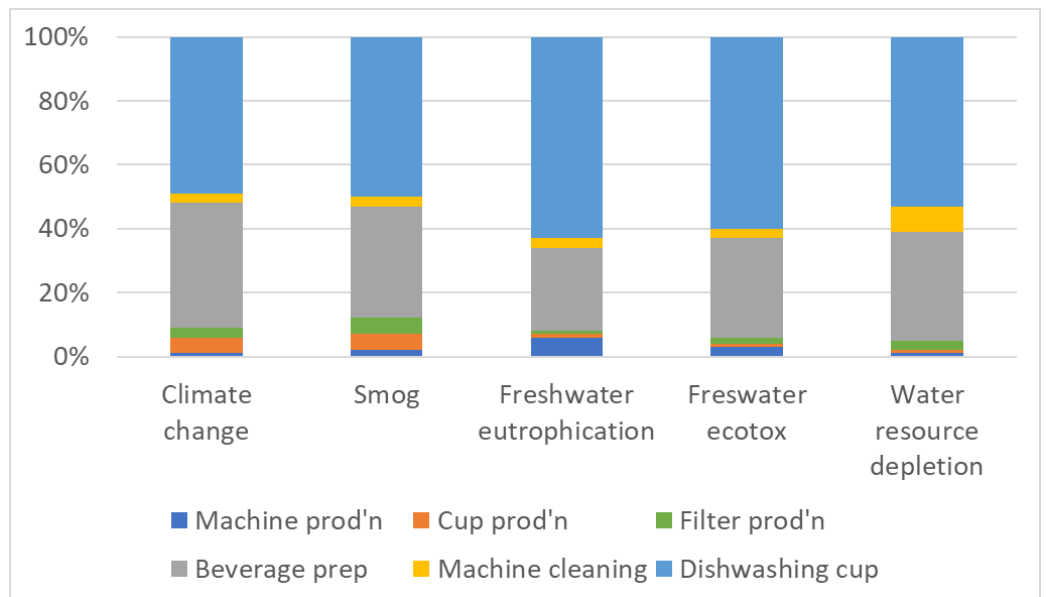
Reference: "PEF coffee screening report in the context of the EU Product Environmental Footprint Category Rules (PEFCR) Pilots", Technical Secretariat, December 10, 2015

38



39

**Most of the use-phase burdens come from washing the reusable ceramic cup!**



40



## How about a single use cup?

“Where there is statistical difference, results almost entirely favor reusable cups in the USA.”

*Number of uses required for ceramic mug to be better than single use polystyrene cup for climate change*

Where & what kind of DW	2004 average DW	2013 Energy Star DW	2013 Best Available DW
California	110	90	70
Michigan	Never	360	100

## What if you drive to get your coffee?



43

## Insights on coffee & cups

- If you make it – use it!
- Re-use your reusable cup.
- Don't go out of your way to get it



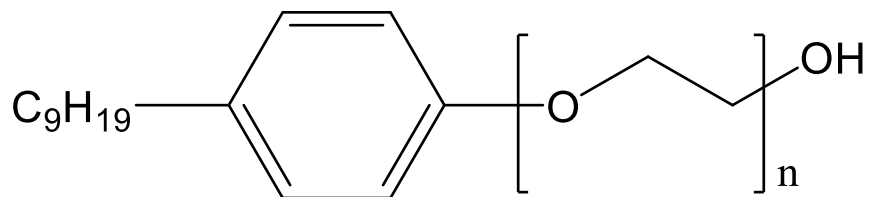
44

# An improved surfactant



45

## Nonylphenol has known ecotoxicity

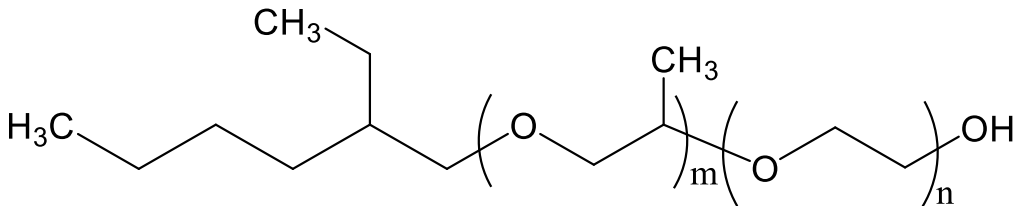


TERGITOL™ NP-9 Surfactant

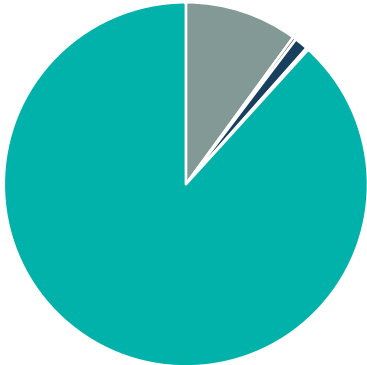


46

# Innovation without nonylphenol: ECOSURF™ EH-9 Surfactant



# Dow test formulation for laundry detergents

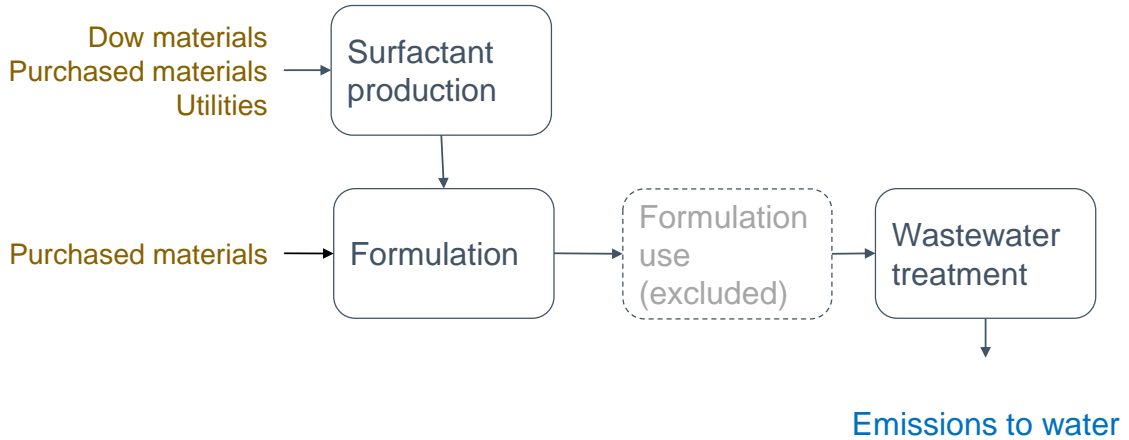


- Anionic surfactant (LAS)
- Dow nonionic surfactant
- Water
- Rheological modifier (CMC)
- Fragrance

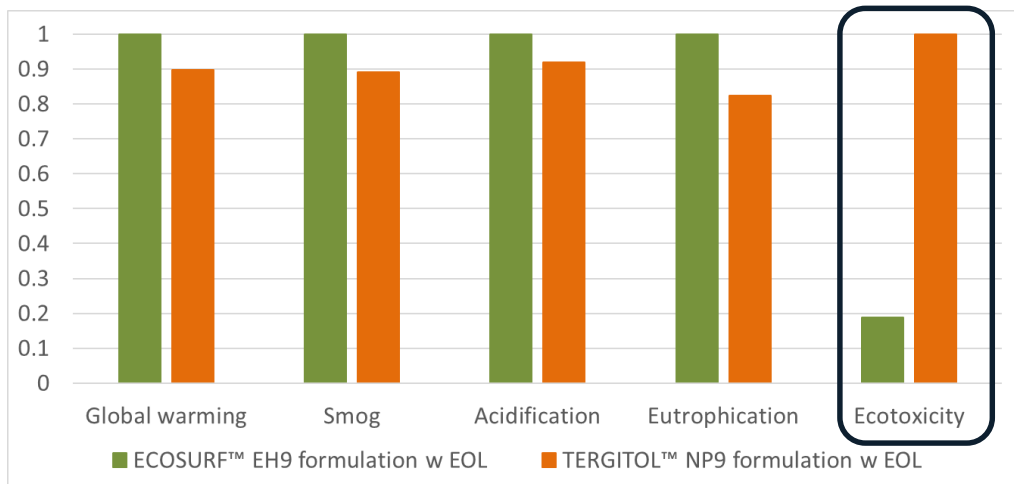




## Analysis boundaries



## TERGITOL™ NP-9 formulation has largest ecotox impact; all other TRACI categories higher for ECOSURF™ EH-9



**LCA results are part of making an informed choice**

**PRICE**

**PERFORMANCE**

**SOCIAL ISSUES**

**QUANTIFICATION  
OF RISK**



51



<https://epic.gsfc.nasa.gov/>

**25<sup>th</sup> Annual Green Chemistry & Engineering Conference**

*Sustainable Production to Advance the Circular Economy*

**VIRTUAL CONFERENCE**  
June 14-18, 2021

**REGISTRATION IS OPEN**

 **ACS GCI**  
Chemistry for Life<sup>®</sup>

**gcande.org**

<https://www.gcande.org>

53

**Register Today!**

 **ACS** Green Chemistry Institute  
Chemistry for Life<sup>®</sup>



B. Frank Gupton

Eunice Heath

Gregg Beckham

Amy Prieto

Meagan Mauter

Jun Huang

Jeremy  
Luterbacher

- Daily Keynotes
- 40+ sessions over 5 days exploring *Sustainable Production to Advance the Circular Economy*
- Networking opportunities, live discussions and more!

<https://www.gcande.org>

54

CHEMISTS CELEBRATE EARTH WEEK ACS Green Chemistry Institute

ACS Chemistry for Life®

# THE HIDDEN IMPACT

## TAKING A LIFE CYCLE VIEW



**FREE Webinar** | TODAY at 2pm ET



ACS Webinars®  
CLICK • WATCH • LEARN • DISCUSS

ASK YOUR QUESTIONS AND MAKE YOUR COMMENTS IN THE QUESTIONS PANEL NOW! 55



### The Hidden Impact: Taking a Life Cycle View



**RICH HELLING**  
Global Expertise Principal,  
Dow Chemical



**DAVID CONSTABLE**  
Science Director, Green Chemistry Institute,  
American Chemical Society

*Presentation slides are available now! The edited recording will be made available as soon as possible.*

[www.acs.org/acswebinars](http://www.acs.org/acswebinars)

*This ACS Webinar is co-produced with ACS Green Chemistry Institute and the ACS Committee on Community Activities for the Chemists Celebrate Earth Week campaign*

56



## Solving the Plastics Problem Through Chemistry

Federal Research and Technology Programs



Date: Wednesday, April 28, 2021 @ 2-3:30pm ET

Speakers: Bruce Garrett, U.S. Department of Energy / Christina Payne, National Science Foundation / Kathryn Beers, National Institute of Standards and Technology

Moderator: Angela Wilson, 2021 ACS President Elect

[Register for Free!](#)

### What You Will Learn:

- The Federal research funding priorities and opportunities related to the chemical formulation, recycling, and upcycling of plastics
- How these Federal agencies are working with industry to set new standards, move toward a circular economy, and improve life-cycle analysis tools
- What are some possible future directions and plans under a new administration

Co-produced with: ACS Committee on Science

Organized by: Teresa Fryberger, National Academy of Sciences (retired) and Young-Shin Jun, Washington University in St. Louis

## How to Survive a Life in Chemistry in a Post-COVID-19 World



Date: Wednesday, May 5, 2021 @ 2-3pm ET

Speaker: Joe Martino, American Chemical Society

Moderator: Tom Halleran, American Chemical Society

[Register for Free!](#)

### What You Will Learn:

- How to approach networking and work after COVID-19, both in person and virtually highlighting virtual tools and how to re-think in-person networking for a post-pandemic world
- What was impacted by COVID-19 in the past year, focusing on industry and academia, and how that will impact the future
- How the workforce is gearing up to a return to in-person work that will be slightly different than before

Co-produced with: ACS Careers

## How Industry is Driving Sustainability Through Innovation



Date: Wednesday, May 12, 2021 @ 2-3pm ET

Speakers: Peter Eckes, BASF / Gayle Schueller, 3M / Bob Maughon, SABIC

Moderator: Rebekah Paul, American Chemical Society

[Register for Free!](#)

### What You Will Learn:

- The role of the chemical industry in driving sustainability
- How sustainable innovations can benefit the consumer, the chemical industry and the environment
- Opportunities for the next generation in the chemical industry

Co-produced with: ACS Industry Member Programs

[www.acs.org/acswebinars](http://www.acs.org/acswebinars)

57



**Learn from the best and brightest minds in chemistry!** Hundreds of webinars on diverse topics presented by experts in the chemical sciences and enterprise.

**Edited Recordings** are an exclusive ACS member benefit and are made available once the recording has been edited and posted.

**Live Broadcasts** of ACS Webinars® continue to be available to the general public several times a week generally from 2-3pm ET!

A **collection of the best recordings** from the ACS Webinars Library will occasionally be rebroadcast to highlight the value of the content.

[www.acs.org/acswebinars](http://www.acs.org/acswebinars)

58



ACS Webinars® does not endorse any products or services. The views expressed in this presentation are those of the presenter and do not necessarily reflect the views or policies of the American Chemical Society.



Contact ACS Webinars® at [acswebinars@acs.org](mailto:acswebinars@acs.org)

59



## Solving the Plastics Problem Through Chemistry

Federal Research and Technology Programs



Date: Wednesday, April 28, 2021 @ 2-3:30pm ET

Speakers: Bruce Garrett, U.S. Department of Energy / Christina Payne, National Science Foundation / Kathryn Beers, National Institute of Standards and Technology

Moderator: Angela Wilson, 2021 ACS President Elect

[Register for Free!](#)

### What You Will Learn:

- The Federal research funding priorities and opportunities related to the chemical formulation, recycling, and upcycling of plastics
- How these Federal agencies are working with industry to set new standards, move toward a circular economy, and improve life-cycle analysis tools
- What are some possible future directions and plans under a new administration

Co-produced with: ACS Committee on Science

Organized by: Teresa Fryberger, National Academy of Sciences (retired) and Young-Shin Jun, Washington University in St. Louis

## How to Survive a Life in Chemistry in a Post-COVID-19 World



Date: Wednesday, May 5, 2021 @ 2-3pm ET

Speaker: Joe Martino, American Chemical Society

Moderator: Tom Halleran, American Chemical Society

[Register for Free!](#)

### What You Will Learn:

- How to approach networking and work after COVID-19, both in person and virtually highlighting virtual tools and how to re-think in-person networking for a post-pandemic world
- What was impacted by COVID-19 in the past year, focusing on industry and academia, and how that will impact the future
- How the workforce is gearing up to a return to in-person work that will be slightly different than before

Co-produced with: ACS Careers

## How Industry is Driving Sustainability Through Innovation



Date: Wednesday, May 12, 2021 @ 2-3pm ET

Speakers: Peter Eckes, BASF / Gayle Schueller, 3M / Bob Maughon, SABIC

Moderator: Rebekah Paul, American Chemical Society

[Register for Free!](#)

### What You Will Learn:

- The role of the chemical industry in driving sustainability
- How sustainable innovations can benefit the consumer, the chemical industry and the environment
- Opportunities for the next generation in the chemical industry

Co-produced with: ACS Industry Member Programs

[www.acs.org/acswebinars](http://www.acs.org/acswebinars)

60