



ACS Green Student Chapter Activity: How to Organize a Workshop or Conference

Table of Contents

Introduction.....	2
Green Chemistry Definition.....	3
Audience, Venue, Scheduling.....	4
Volunteers and Amenities.....	5
Making a Budget, Attracting Sponsors, Finding Funds....	6
Inviting Speakers, Going Beyond the Lecture.....	7-8
Workshop Guidelines.....	9
Advertising and Communication.....	10-11
Keeping the Focus on Chemistry.....	12
Practical Checklist.....	13
Submitting a Green Activity to ACS.....	14
Additional Information about Green Chemistry.....	15-19

This guide is produced by the ACS Green Chemistry Institute®
www.acs.org/greenchemistry | gci@acs.org | (202) 872-6102

Chemistry can bring people together. Hosting a workshop or conference is a lot of work but there's hardly a better way to spread the word.

Alternatively, your ACS student chapter can attend a green chemistry workshop, conference, or lecture hosted by another organization. Students from the University of Texas at Tyler attended the ACS National Meeting and went to several green chemistry lectures covering a range of material from greener syntheses to waste reduction.

In either case, participating in a green chemistry event brings together innovators, researchers and entrepreneurs while introducing others to an important subject. It might seem overwhelming at first but with a little time and organization, hosting your own is not as challenging as it first appears. Of course, don't be afraid to ask for help! In combination with tips from a few other ACS student chapter guides, you'll be prepared to host a smooth, successful, and productive event.

Sustainable and green chemistry in simple terms is just a different way of thinking about how chemistry and chemical engineering can be done. Over the years different principles have been proposed that can be used when thinking about the design, development and implementation of chemical products and processes. These principles enable scientists and engineers to protect and benefit the economy, people, and the planet by finding creative and innovative ways to reduce waste, conserve energy, and discover replacements for hazardous substances.

It's important to note that the scope of these green chemistry and engineering principles go beyond concerns over hazards from chemical toxicity and include energy conservation and waste reduction, as well as life cycle considerations such as the use of more sustainable or renewable feedstocks and designing for end of life or the final disposition of the product.

By incorporating sustainable and green chemistry into your student chapter's activities you can:

- Become a spokesperson on your campus for sustainability and the solutions chemistry can bring through green chemistry
- Start a movement of sustainability across your campus and in the community
- Make a difference through chemistry
- Have a positive impact on human health, the environment & the future
- Improve the "image" of chemistry

Chapters who engage in at least three green chemistry outreach and educational activities during the school year are eligible to win a Green Chemistry Student Chapter Award.

Green Chemistry Themes to Consider¹

It is better to:

Prevent waste than to treat or clean up waste after it is formed

Minimize the amount of materials used in the production of a product

Use and generate substances that are not toxic

Use less energy

Use renewable materials when it makes technical and economic sense

Design materials that degrade to innocuous products at the end of their usable life

¹ Middlecamp, Catherine, ed. *Chemistry in Context: Applying Chemistry to Society*. 8th ed. New York: McGraw Hill, 2014. Print

Who is the Target Audience/Who's Invited?

- Decide whether the event is for your university only, the surrounding community, or a wider area (i.e. open to anyone, broadly advertised)
- Will there be materials of interest to non-chemists? If you're hoping to attract an interdisciplinary audience consider inviting lecturers from various fields, like economics or public policy.

Choosing a Venue

- Make reservations early – this will solidify a date and location from the get-go.
- While a conference center may seem ideal it might also be costly. Classrooms provide individual seats, technology for presenters, and are located near one another. Consider having the event in a college or university building. Lecture halls can be used for larger events or keynote speakers. In addition, a cafeteria on campus is a convenient lunch suggestion: it's nearby for guests and won't break your bank.
- If several rooms are holding talks simultaneously, be sure there are signs indicating who the speaker is and the title of their lecture.
- Make sure it's clear where exactly the event is being held, even if it's a room number in an academic building. Provide a map online or in print if necessary and consider having volunteers direct guests from the parking lot. Putting up signs never hurts!

Creating a Schedule (for yourself and others)

- Make a calendar early on to decide how much time is needed to prepare for the event – this includes making reservations, applying for funds, advertising, getting sponsors and arranging speakers. If you're hosting the event in the spring, planning must begin in the fall.
- Assign tasks to individuals or teams within your student chapter. Communication is key, but breaking down the planning into committees can reduce anxiety while increasing organization.
- Include breaks, make sure things don't overlap, schedule various types of activities like a poster competition or workshop so it's not too repetitious
- Avoid major holidays, campus events and examination periods (midterms and finals)
- Choose an inclement weather/reschedule date. Be sure to notify attendees as soon as possible if there is a cancellation for any reason.
- Also make a schedule (printed or online) for attendees and communicate throughout the event so participants know what's going on and the event feels organized.

Scheduling Volunteers

- Even for a small event, a schedule should be made so that volunteers are assigned practical tasks and locations. Make sure the expectations are clear even if it's as small as a reminder to be friendly and welcoming to guests.
- Designate a meeting location and point of contact in case there is a problem.
- Volunteer responsibilities might include monitoring sessions for technical difficulties, putting up signs, greeting attendees, running a booth, providing directions, assisting with parking, and standing by to answer questions.
- Be sure to thank volunteers (consider giving them a small gift or card in appreciation or at least covering their lunch expenses if the event is off campus).

What's being provided?

- Make sure there are enough chairs, podiums, refreshments, signs, and volunteers. Ask attendees how they're doing during the event to help gauge if anything else is needed. Make sure any food provided includes a special-diet option such as gluten-free and vegetarian.
- If the event is taking place on campus, your chapter might consider giving tours. Select one or two volunteers to lead scheduled campus tours.
- Decide early on if it's in your budget to provide accommodation for guests. Make sure it's clear whether or not this cost is included in the conference/workshop registration fee.
- Ask speakers/facilitators what technology they'll need for presenting. Be realistic with them about whether or not it can be provided.

Creating a Budget

- Expect the unexpected
- First decide what your budget is and stick to it – don't try to arrange everything and find the money later.
- A significant part of the cost will be refreshments including any meals, coffee or snack breaks, and bottles of water.
- The venue and any speaking fees will also be high on the list of expenses.
- If accommodation or transportation is being provided for presenters or attendees, include that in the budget.
- The cost of the conference won't necessarily come out of the chemistry department's pocket: sponsors, registration fees, and anything sold at the event can help cover the expenses. A university department likely specializes in event planning. Definitely consult them for funding and advertising opportunities. They may even provide volunteer assistance, venue, and catering recommendations.
- There may be a cost associated with marketing, such as mailing materials, printing fees, or website set-up. Of course, the amount of printed material should be limited to minimize waste.

Tips for getting sponsors:

- Do your research and make sure the sponsor's values are in line with what's being presented at the conference. If a company agrees to sponsor but demonstrates a lack of interest in green chemistry consider carefully whether or not to continue contact.
- Brainstorm some potential sponsors then go to their websites. Do those companies sponsor similar events?
- Is the company's target audience related to the audience of your event? Try to find a sponsor that will be interested in what you're doing, not just the other way around.
- If a sponsoring business wants to have a representative give a lecture, discuss their potential topic. Have them send you an outline of their talk if possible to ensure that it's not just a promotional speech.
- Ask the sponsor what they expect such as signs with their company logo.
- Always send a thank you note!

Fundraising/Existing Funds

University grants and the department budget may have money available for student projects. Ask faculty members and browse your school's website for opportunities to apply. There are about a million different ways to fundraise on campus. A few common ones include a bake or craft sale, raffle, or car wash. You may be required to notify your university or college

when and where you plan to hold a fundraiser. There may be an organization on campus, such as student government, that allocates money for student organized events.

Speakers – Inviting faculty and external guests

- Be sure that anyone speaking at your workshop or conference understands the purpose of the event. Have them send you an outline of their presentation, their PowerPoint, etc. so your student chapter can make sure it aligns with the goals of the conference.
- Try to find speakers who are invested in the topics that members of your student chapter find compelling – everyone will feel more invested.
- See the ACS Green Student Chapter Guide on inviting a speaker for more tips and information.
- Provide nametags for speakers (and possibly for all registrants, if it's feasible with your budget)

Additional Activities

Changing up the pace of the conference with poster sessions, awards, booths, and networking opportunities can help keep audience members focused during the talks and engaged throughout the day.

Sponsor booths and vendors

- Depending on the scale of the event, your chapter may consider having information or sales booths. Ask potential sponsors if this is something they would be interested in.
- This is also a revenue opportunity for your student chapter to help cover the costs of the conference or workshop. What green chemistry-themed items might be available for sale?

Survey/Evaluation

- Getting feedback on an event is critical – it shows attendees that you care about them and will help you make future conferences and workshops better. Evaluations should include questions about what was liked and disliked as well as ask for information on who the respondent is so your chapter will have a better understanding of what demographics (students, academics, businesspeople, etc.) attended the event.

Presenting Student/University Research

If faculty members or students at your college or university have research relevant to green chemistry, ask them to present at a poster session during the conference or workshop. If your budget allows, provide an award for the best poster (judged by a panel, perhaps with separate categories for faculty, graduate, and undergraduate presentations). Even if those with posters are giving a talk, this gives them

an opportunity to interact one-on-one with attendees and provide more details than they'd likely be able to give in a more general lecture.

- Be sure the expectations are defined for those who sign up for the research presentation through email or on the website.
- Confirm who is presenting and on what topics a few days before the event.
- A poster session can coincide with a break where the booths/vendors are operating. They are meant to be informal.

Demonstrations

- Green chemistry demonstrations help draw a crowd and change up the pace from a series of talks. See the ACS Green Student Chapter Guide on demonstrations for more tips and information.

Networking Opportunities

- An informal socializing/networking opportunity may be appealing to attendees. This can be something like an extended coffee break, a welcome breakfast, or a reception.

[To Table of Contents](#)

Workshop Guidelines

Workshops have the potential to be very productive and influential events either as a part of conference or as standalone activities. There are a few important things to remember when hosting a workshop.

- The purpose of the workshop must be clear to those planning and attending it. Decide on a theme and goals for participants in the early stages of planning. How will your workshop affect perceptions about green chemistry, encourage the application of green chemistry principles, and what practical knowledge will attendees take away?
- Just as with the conference, decide who the workshop is aimed at. Do you need to provide a basic introduction to green chemistry? Are there many non-scientists? Make sure the material is not so technical people get lost or bored.
- Make a separate schedule for the workshop, including several breaks. People need to be comfortable in order to pay attention, so make sure they have the opportunity to use the restroom or get water or food. Additionally, don't make the workshop longer than it needs to be (ensure it is no more than eight hours – four or five hours is a good length, including breaks). Communicate the schedule to participants as the workshop proceeds so it feels as organized as it looks on paper.
- What kinds of activities will be part of the workshop? Small group discussions? Team problem solving and solution sharing? Games? Example problems using green chemistry metrics? The aim is to have attendees leave feeling that they're walking away with something useful whether that's a practical skill, new contacts, or a different approach for solving real-time challenges.
- When choosing the location for the workshop, consider what would be the most useful for communication among attendees. Round tables encourage interactions, for example.
- Workshops are intended to be more intimate than conferences as well as more hands-on. Advertise the workshop as widely as the conference to attract attendees, but consider pairing it with a short application so your student chapter can be selective if necessary.
- Who will facilitate the workshop? Communication with those teaching/leading workshop sessions is crucial to making sure they're on the same page as your student chapter in terms of goals for learning outcomes, focus areas, and even the scheduling. If the workshop is part of a conference invite someone who is giving a talk to be a workshop facilitator.
- Activities can be as simple as having participants write down things they will change in their labs, raising their hands in affirmation of a question, or sharing an idea with the person sitting to their left. Facilitators in a workshop should aim to guide, rather than dominate, the conversation.

- Try to conclude the workshop on a positive note: green chemistry is about ingenuity, innovation, and challenging ourselves to reinvent chemical processes to design a better world.

Tips on Advertising

Who will come to the conference or workshop if no one knows about it? One of the most important parts of hosting an event is advertising. Here are a few tips for getting better attendance when designing posters or spreading the word online.

1. Remember, you will know who you're inviting and why better than anyone looking at your flyers, posters, or probably even in attendance. Sometimes it's best to take a step back when you're very familiar with the project. Think of how undergraduates, professors, high school teachers, etc. who have never heard of green chemistry would perceive advertisements and tailor your message around the perceptions of the intended audience. Do some research to find out what they are most likely to care about and adjust the program to fit their needs.
2. Always approach advertising in a way that is SIMPLE, DIRECT, and RELEVANT. You don't need a sassy/witty marketing push. Stick true to your message and the purpose of the conference or workshop. People can instantly sense authenticity so try and be as clear as possible.
3. Make sure you have information access points for your programsuch as a Facebook page, Tumblror WordPress sites to give a more behind-the-scenes look. Also try to get your own URL and make it as short as possible for advertisements. Consider including features such as area maps, a schedule, and information about the speakers.
4. If you have an online presence, make sure all the facts are straightforward and easy to find. A simple page with about (time, date, place, description) and contact information should suffice. Find a tech-savvy friend to help you set up a website if you want to but aren't sure how. There are a number of fairly simple drag and drop webpage builders.
5. Be sure to include any information about registration dates clearly on advertisements and webpages. Carefully proofread any marketing materials to make sure that the dates, times, and locations are correct.
6. If the scope of your event includes a wide community, consider running ads in the local newspaper or on the radio – the greater the outreach, the greater the likelihood of attracting participants. Is there a similar conference where your event might be mentioned? Making contact with other members of the sustainability community is helpful because you already know they're interested in the subject.

Getting people to sign up, registration

- Advertise early, advertise often! Other colleges and universities are a great place to start.
- The more people you invite, the more will come. Plan your venue, budget, food, etc. accordingly!
- Contact your institution's media, marketing, or communications department. They will likely want to promote your event as well, since it will bring publicity to the school itself. This will save your student chapter time and money while providing additional promotional resources.
- Have people registered well in advance so catering, transportation and accommodation (if necessary) can be sorted out. Taking payment in advance will help ensure that those who've signed up actually turn up.

Social Media: How to get people to talk about your event.

- Let everyone attending know if you have a Twitter handle, Facebook page, etc. They won't mention the event on social media platforms if they don't know what's been created.
- Include social media information on nametags, session signs, or have t-shirts made for the event.
- If there is an ACS student chapter booth, suggest that those who stop by check out the event's social media page(s).
- Feel free to mention the American Chemical Society (@AmerChemSociety, <https://www.facebook.com/AmericanChemicalSociety>) or the Green Chemistry Institute's (@ACSGCI, <https://www.facebook.com/ACSGreenChemistryInstitute>) social media pages.

Is the conference/workshop part of a larger campus or community event?

If possible, consider hosting your green chemistry conference or workshop in conjunction with a pre-existing theme such as Earth Day or if your college or university has something like a sustainability lecture series. This will help promote your event and attract attendees.

Keeping the Focus on Chemistry

Members of your student chapter should have a meeting to discuss what topics are appropriate for the conference or workshop. Remember, this is for green *chemistry*, which it is important to distinguish from sustainability and environmental friendliness. So what's the difference?

Initiatives such as recycling, using less paper, and cleaning up litter are examples of general sustainability projects which are focused on the need to slow global warming, reduce carbon dioxide emissions, etc. many of which have been popularized and there's a good level of awareness surrounding them. It's easy to get these kinds of activities confused with green chemistry because in certain respects they overlap significantly. It is essential, however, to make a distinction between the two.

The manufacture of goods – everything from cars to paint to pesticides – involves chemical processes. “Green Chemistry” was developed as a way to re-thinking past and current processes, many of which posed significant risk to human health and safety or the environment. Green Chemistry takes into consideration the effects of a chemical through its entire “life” from the time it is extracted from the earth to what happens after it is disposed of as waste. This includes the risks involved in its transportation, effects when it enters wastewater, and potential harm caused to those who are working with it. Green chemistry is also a way in which businesses can reduce their expenses by spending less money on waste treatment and using fewer chemicals in general. Some green chemists consider there to be [twelve](#) guiding principles for greener chemistry while others feel the scope is much broader. A few key ideas in green chemistry are to prevent waste instead of treating or cleaning it, use as few materials as possible, make and use non-toxic substances, reduce energy use, take advantage of renewable materials, and design things to be harmless even when they reach the end of their useful life.

Although a goal of green chemistry is to create more sustainable practices it's a specific area of the sustainability movement. For example, recycling plastic is a great sustainability practice. However, a green chemist might consider designing plastic that is more biodegradable, doesn't require non-renewable petroleum or contain potentially harmful chemicals like BPA, or how to improve the efficiency of the recycling process itself. Another example of a sustainability project would be “going electronic” for a newsletter to reduce paper. A green chemist might consider how to reduce the environmental impact of the paper production process such as eliminating the use of bleach as a whitener or how to re-use chemicals that become waste during the paper production process.

Although sustainability will inevitably come up during a green chemistry workshop or conference, it should not be the focal point. Make sure speakers understand the difference as well. What chemical processes, innovations, or challenges will they talk about?

Checklist

- Select a date, time, location, and theme**
- Contact university Event Planning or similar department**
- Create a budget**
- Reserve a venue**
- Contact potential presenters/facilitators**
- Schedule speakers (accommodation, transportation, times)**
- Advertise**
- Registration**
- Contact Catering Services (if using)**
- Review scheduled presentations/talks**
- Find volunteers**
- Confirm reservations and speakers**

Submitting Your Green Student Chapter Activity

Once your ACS student chapter has completed a green activity it's time to fill out the student report with details about what's been done. Feel free to send along photographs or a mention of your work in the university or college news. Let us know how many people attended your event, what topics were covered, whether or not your student chapter plans on hosting another conference or workshop.

See [this webpage](#) for information on deadlines, submission requirements, and the report form.

[To Table of Contents](#)

Want to Know More about Green Chemistry?

If you're feeling unsure about what green chemistry is, how it applies to you, or why it's worth having a conference about, below are some examples of green chemistry in everyday life and resources where you can become familiar with the basic concepts.

Websites:

The [ACS Green Chemistry Institute Beyond Benign](#)

The [Berkeley Center for Green Chemistry Green Chemistry Initiative](#) at the University of Toronto

A list of textbooks and lab manuals with a green chemistry focus can be found [here](#).

Everyday Examples of Green Chemistry ²

Below are some interesting examples of how green chemistry affects everyone.

- *Have you ever had your clothes dry-cleaned?*³
 - Dry Cleaning: dry-cleaning processes have conventionally used the chemical perchloroethylene (perc). Several organizations have stated that perc is a hazardous substance to human health. The International Agency for Research on Cancer (IARC) concluded that perc is a “probable human carcinogen” meaning it is likely to cause cancer in addition to its short term effects like dermatitis. Workers in a dry-cleaning facility can be exposed to perc in a number of ways from cleaning the machine to simply loading clothing.⁴ In addition, perc is categorized as a hazardous air pollutant by the U.S. EPA's Clean Air Act and it may contaminate groundwater when it is disposed.⁵
 - *Applying green chemistry to this situation has resulted in a markedly improved process using liquid carbon dioxide – a substance that is essentially non-toxic and is equally effective at removing grease and dirt from fabric. This simple innovation of replacing a hazardous chemical for a benign one is a perfect example of green chemistry at work in everyday life.*
- *Do you own something involving a computer chip?*

² <http://www.acs.org/content/acs/en/greenchemistry/what-is-green-chemistry/examples.html>

³ Ryan, M. (ed.), Tinneland, M. (ed.) (2002) *Introduction to Green Chemistry*, American Chemical Society: U.S.A. pp.23-29

⁴ <https://www.osha.gov/dsg/guidance/perc.html>

⁵ <http://yosemite.epa.gov/opa/admpress.nsf/0/e99fd55271ce029f852579a000624956>

- Have you ever considered what goes into making a smartphone, computer, or television work? As technology progresses so does our consumption of endangered elements: the 44 critical materials which will soon face supply limitations. These limitations can stem from factors such as geographic concentration, political motivations, regulatory laws, or consumer demand. Some green chemists are researching more abundant alternatives, more efficient syntheses where alternatives are not found, diversifying the supply and better recycling and recovery programs for these scarce materials. A smartphone, for example, usually contains over 80 elements, many of which are considered “endangered,” for everything from the touch screen (dysprosium, europium, etc.) to the color display (yttrium, terbium, and more). To manufacture computer chips, many chemicals, large amounts of water, and energy are required. In a study conducted in 2003, the industrial estimate of chemicals and fossil fuels required to make a computer chip was a 630:1 ratio! That means it takes 630 times the weight of the chip in source materials just to make one chip! Compare that to the 2:1 ratio for the manufacture of an automobile. This is an example of very poor atom economy. Scientists at the Los Alamos National Laboratory have [developed a process](#) that uses supercritical carbon dioxide in one of the steps of chip preparation, and it significantly reduces the quantities of chemicals, energy, and water needed to produce chips. Richard Wool, director of the Affordable Composites from Renewable Sources (ACRES) program at the University of Delaware, found [a way to use chicken feathers](#) to make computer chips! The protein, keratin, in the feathers was used to make a fiber form that is both light and tough enough to withstand mechanical and thermal stresses. The result is feather-based printed circuit board that actually works at twice the speed of traditional circuit boards. Although this technology is still in the works for commercial purposes, the research has led to other uses of [feathers as source material](#), including for biofuel.
- *Who owns clothes? By the looks of it, all of you!*
 - Micro-organisms are everywhere, even in our clothes. They cause odors, wearing, and color changes to fabrics in textiles. To reduce the number and effects of micro-organisms on our clothes, antimicrobial textiles have been developed. Unfortunately, some of these synthetic agents have toxic effects on humans. For example, silver antimicrobial agents have caused dermatitis, some synthetic dyes have been found to cause cancer, and still others like zinc pyrithione are mildly neurotoxic. Not only are these compounds harmful to humans, they are often not biodegradable and the waste created by their manufacture is difficult to treat and sometimes become ineffective over time. *Green chemistry approaches have created benign antimicrobial textile solutions. These include materials called biopolymers that are made from a huge variety of renewable materials found in nature such as chitosan from crustaceans and fungi, cyclodextrin from starch, and alginate from brown sea weeds. Antimicrobial agents*

*made from these ingredients are less harmful to the environment, have lower toxicity, are renewable, and still highly functional.*⁶

- *Have you ever eaten food?*
- Many people are surprised to learn that even what they eat is a product of chemical design. Decaffeination and the production of flavors are just two examples of food-industry processes that green chemistry principles have been applied to with success. Decaffeination of coffee beans using dichloromethane, a suspected carcinogen, was the accepted process for about 70 years. However, greener methods have been developed and applied on an industrial scale. The [Swiss water process](#) and the use of supercritical CO₂ are both the result of green chemical innovation. The Swiss water process uses water, green bean extract and a difference of caffeine concentrations. No harmful solvents are used and very little waste is produced as the water is easily recycled. Decaffeination by supercritical CO₂ is also a safer and more environmentally friendly method because it is a very low-waste process using a relatively non-toxic substance; the carbon dioxide is recycled throughout the process and the caffeine solution produced is sold to other manufacturers.⁷
- Consider everything vanilla-flavored you've ever eaten or vanilla-scented candles, soaps, and more that you've used. The production of synthetic vanillin, the main flavor component of natural vanilla extract, has undergone several changes through industry attempts to improve efficiency, reduce waste, and increase the quality as demand grows at a faster rate than vanilla bean production. In the 1930's, ligninsulfonates (organic material from wood pulp production) became the conventional starting material for vanillin production but were eventually replaced by a petrochemical starting material due to the large amounts of waste created through the wood-production by-product process⁸. New research has found that vanillin molecules can be collected and purified using ionic solvents which are often greener than the solvents they replace (less volatile) and can be derived from renewable resources unlike petrochemicals⁹. Although this synthesis is still in development the pathway towards greener production is being paved.
- *Have you ever used plastic?*
 - Several companies have been working to develop plastics that are made from renewable, biodegradable sources.
 - [NatureWorks](#) of Minnetonka, Minnesota, makes food containers from a polymer called polylactic acid branded as Ingeo. The scientists at NatureWorks discovered a method where microorganisms convert cornstarch into a resin that is just as strong as the rigid petroleum-based plastic currently used for containers such as

⁶ Shahid-ul-Islam, Shahid, M., Mohammad, F. Green chemistry approaches to develop antimicrobial textiles based on sustainable biopolymers – a review. *Ind. Eng. Chem. Res.* 2013, 52, 5245-5260.

⁷ Jimenez-Gonzalez, C., Constable, D. J. C. (2011) *Green Chemistry and Engineering: A Practical Design Approach*. Hoboken, New Jersey: John Wiley & Sons, Inc.

⁸ Calvo-Flores, F.G., Dobado, J.A. Lignin as a renewable raw material, *Chem Sus Chem.*, 2010, 3, 1227-1235.

<http://onlinelibrary.wiley.com/enhanced/doi/10.1002/cssc.201000157/>

⁹ <http://www.sciencedirect.com/science/article/pii/S1383586610002789>

water bottles and yogurt pots. The company is working toward sourcing the raw material from agricultural waste.

- BASF developed a compostable polyester film that called "[Ecoflex®](#)." They are making and marketing fully biodegradable bags, "Ecovio®," made of this film along with cassava starch and calcium carbonate. Certified by the Biodegradable Products Institute, the bags completely disintegrate into water, CO₂, and biomass in industrial composting systems. The bags are tear-resistant, puncture-resistant, waterproof, printable and elastic. Using these bags in the place of conventional plastic bags, kitchen and yard waste will quickly degrade in municipal composting systems.
- *Have you ever taken a medication?*
 - Merck and Codexis developed a second-generation green synthesis of sitagliptin, the active ingredient in Januvia™, a treatment for type 2 diabetes. This collaboration led to an [enzymatic process](#) that reduces waste, improves yield and safety, and eliminates the need for a metal catalyst. Early research suggests that the new biocatalysts will be useful in manufacturing other drugs as well.
 - Originally sold under the brand name Zocor®, the drug, Simvastatin, is a leading prescription for treating high cholesterol. The traditional multistep method to make this medication used large amounts of hazardous reagents and produced a large amount of toxic waste in the process. Professor Yi Tang, of the University of California, [created a synthesis](#) using an engineered enzyme and a low-cost feedstock. Codexis, a biocatalysis company, optimized both the enzyme and the chemical process. The result greatly reduces hazard and waste, is cost-effective, and meets the needs of customers.
- *Have you ever painted something?*
 - Oil-based "alkyd" paints give off large amounts of volatile organic compounds (VOCs). These volatile compounds evaporate from the paint as it dries and cures and many have one or more environmental impacts.
 - Procter & Gamble and Cook Composites and Polymers created a mixture of soya oil and sugar that replaces fossil-fuel-derived paint resins and solvents, cutting hazardous volatiles by 50 percent. Chempol® MPS paint formulations use these biobased Sefose® oils to replace petroleum-based solvents and create paint that is safer to use and produces less toxic waste.
 - Sherwin-Williams developed water-based acrylic alkyd paints with low VOCs that can be made from recycled soda bottle plastic (PET), acrylics, and soybean oil. These paints combine the performance benefits of alkyds and low VOC content of acrylics. In 2010, Sherwin-Williams manufactured enough of these new paints to eliminate over 800,000 pounds, or 362,874 kilograms of VOCs.