American Chemical Society AMA: I'm David Constable, Director of the ACS Green Chemistry Institute. Ask Me Anything about green and/or sustainable chemistry.

AmerChemSocietyAMA [1] and r/Science AMAs[1]

[1]Affiliation not available

April 17, 2023

Abstract

Hi Reddit! Since I introduced myself in the ACS AMA last year (http://redd.it/3fqnqo) , I'll only say that I'm the Director of the American Chemical Society's Green Chemistry Institute where we work to catalyze and enable the implementation of green chemistry and engineering throughout the global chemistry enterprise. At the moment we're getting ready for the 20th Annual Green Chemistry & Engineering Conference, held in Portland, OR June 14-16 (http://www.gcande.org/) and I hope you can join us for what is shaping up to be a great Conference.. So, feel free to ask me anything about the current and future states of sustainable and green chemistry and engineering. Like last year, feel free to ask me anything about how sustainable and green chemistry is implemented in industry, or how you can apply it in your research, or what challenges you're encountering in your work as you work to implement it. I will be back at 11 am ET to answer your questions, Ask me Anything!

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REDDIT

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AMERCHEMSOCIETYAMA R/SCIENCE

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One of the problems with the state of renewable energy is the storage and transportation of energy from areas high in solar, wind or geothermal energy to areas with high population densities.

Is there any kind of viably solution that you can see solving this problem in the future? (Preferably something that's not 20 years away.)

JimBroke

Hi Jim, thanks for a great question. The short answer is no, I don't see a viable solution on the horizon, but a range of potential opportunities.

In my opinion, there are no easy answers here. I'm a big fan of one politically unacceptable answer which is distributed energy generation along with massive changes to how the grid is managed. Beyond that, I think you need to distinguish between transportation energy, high intensity uses (petrochemical/chemical manufacturing, for example), and living space heating/cooling. For each of these, there are a range of potential solutions. For high-intensity uses, combined heat and power at point of use based on natural gas is probably going to be with us for the foreseeable future. Certain regions will be able to take advantage of wind or solar as they are already, but that's not a panacea.

I could go on, but transmission of energy from point of generation to use always entails a loss of a lot of energy without many viable solutions at this point in time. That's why I think distributed energy generation at point of use is the best way to go. We are wed to large scale utilities, and as long as we are, the options are more limited.

DJCC

How do you see grindstone chemistry as a future viable alternative for organic syntheses? Do you think it will become common in the future?

EpiclyYummy

Hi there - Interesting name!

I would say that there is a future for mechanochemistry/grindstone chemistry, but like any different way of processing or manufacturing, it will take time for it to be adopted and used. With these sorts of innovations, you will see a small start-up/green field manufacturing plant being built using the technology for a particular application because it is economically viable.

DJCC

For alternative energies, I've noticed a sharp increase in biomass fuels (please correct me if I'm using incorrect terms, I am just getting started as a freshman). Between mosses, willow, and other fast-growing plants, it seems like this may be a new way for creating an alternative fuel source. How do you think this will compare to more "well-known" alternative fuel sources like solar, wind, and biofuels from oil wastes (like vegetable oil, canola oil, etc)? Do you see it gaining popularity to the same level, in terms of popularity and efficiency?

I hope this is clear. I'm on my phone, so it's a bit difficult. Let me know if I need to try to explain my thoughts better.

ImLudzy

Hi, thanks for your question. Transportation fuels are an enormously difficult area for us to come to terms with as a society. For the foreseeable future, petroleum/fossil carbon will remain the main source of transportation fuels. When you start computing the land mass required to support the production of fuels from agriculture, you will see that this is not viable with current technology. While there is currently an enormous amount of research going into bio-based fuels derived from agricultural biomass, municipal solid wastes, algae, cyanobacteria and other micro-organisms, etc., we are still not at a point where these sources are sufficient or derived sustainably.

Over time, I do think you will see an increase in our ability to make use of a variety of technologies for transportation, but this will be a slow evolution over the next generation. I would expect a variety of solutions gaining in efficiency and as a result, in popularity. However, all of these options have sustainability challenges; there is no panacea, yet.

DJCC

How do you feel about nuclear energy compared to others like solar, wind, etc.?

iwanttoplayit

Well, I have great hopes that eventually we'll figure out how to do fusion, although that is a lot like peak oil, we were supposed to see it before the year 2000 came along.

I think that we don't have a lot of choices around energy generation and at some point, we will likely have to start building more nuclear fission plants to meet society's needs for energy. We also have to figure out what we're going to do with nuclear waste. The U.S. has a real problem with what to do with the nuclear fission waste, mostly low level. We also are not into fast-breeder reactors, so uranium becomes an issue.

Bottom line for me is that I am not a fan of nuclear, but I don't see a lot of options. There are significant sustainability challenges with any kind of energy generation and you "trade" impacts depending on which option you choose.

DJCC

Has the oil industry done anything to try to impede your research?

LakeyPoo

Hi, thanks for your question. Short answer is no, but they certainly are not at the head of the line to fund green chemistry research, either.

DJCC

What is your view on patents on basic spieces and elements?

There is a lot going on with bio-enginering these days. On the field of seeds, there is alot controversy in Europe about handing out patents for basic spieces. Do you think patents on such can actualy block new inventions or better enriched spieces?

ThaFizzy

Hi thanks for your question. Not sure I understand it completely, but what I will say is that I am a huge fan of synthetic biology as a means of creating alternative chemical feedstocks and for performing important chemical transformations.

The use of modern genetic engineering techniques to alter plants and animals for food is enormously controversial and largely misunderstood by the general population.

Patenting seeds and similar organisms, I think, presents some barriers, but like most IP, there are lots of clever people who manage to get around the patents. DJCC

ACS member here, recent college grad. I work in the industrial cleaning industry and have experienced the trend of phasing out NP-9s and phosphates in auto dish. What do you think the compound or family of chemicals to be phased out of industrial chemicals will be? Also, love your work and what you're doing, keep it up.

freshlikeuhhn21

Thanks for being a member! And thanks for your question and compliment, I do appreciate it!

So, I would look to the EU and REACH for signals about chemicals that are likely to come under pressure in the near- to mid-term.

There are a variety of chemicals in cleaning products that are known to be problematic - chelants, surfactants (as you mentioned), preservatives, fragrances, etc. The ACS GCI Formulator's Roundtable published a paper in the ACS J of Sustainable Chemistry and Engineering last year identifying these compound classes and talking about R&D needs. I would recommend that you have a look and since you're in the cleaning products industry, you may want to check out the Formulator's RT web page on the ACS GCI web site. DJCC

David- What is the current state of renewables chemical market to produce ethylene and naphtha?

What are the major barriers?

How can those be overcome to make green chemicals economical?

Gus_Bodeen

Hi Gus, thanks for your great question. Boy, I could write a book on this one. Ironic that ethylene was originally produced from ethanol in the early part of the 20th century. Then, with the advent of cheap petroleum feedstocks, ethylene was produced from ethane, and that continues to dominate, especially with the ready availability of ethane from fracking fluids. But, I digress.

I know that in Brazil, there was a JV between Dow and Braschem, I think, that was dehydrating ethanol (sugarcane) to make ethylene. You can check that out. In general, this is not being widely pursued, once again, because ethane from fracking is so abundant.

As far as naphtha is concerned, I would say that I'm not a fan of trying to replicate naphtha, BTX, or similar fractions from bio-derived sources. While this would make them "drop-in" replacements, I would argue that we need to make use of the molecules that are readily available from biomass and convert these to different kinds of building blocks. A great example of this strategy is the use of bio-derived succinic acid (Myriant, BioAmber, etc.) as a route to BDO and other specialty chemicals.

Barriers to broader implementation of bio-derived chemicals are significant. Any displacement chemical or technology faces these kinds of barriers that are deeply routed in the supply chain for chemicals. Re-capitalization, changes to manufacturing processes, resistance to changing suppliers (qualified vendors with whom a company has a pre-existing relationship), changeover costs, etc., etc.

In many respects, green, bio-based and renewable chemicals are, from a life cycle cost perspective, already economical or they won't be on the market. Commodity chemicals are not where one should look for replacements until petroleum and fracking fluids become more expensive, so the action for the foreseeable future is on the specialties side. DJCC

What is your take on the adoption of "green" plastics?

From my observations plant based fillers seem to be used more than entirely bio-degradable polymers.

carbonnanotube

Hi - thanks for your question. My answer to this could go in several different directions. One line would take me down the path of what you may mean by "green" plastics? The other would be to focus on your observation about plasticizers or other chemical property modifiers added to the basic polymer to achieve some kind of performance characteristic.

Polylactic Acid or PLA is probably the most cited polymer that is considered to be "greener" than other polymers because it is compostable, as long as that compost pile gets to the right temperature. There's a lot of PLA made these days, and from volume perspective, probably more than the fillers, but I don't have the facts and data at hand; it's just a guess.

Getting back to "green" plastics - are you defining "green" as one that is biodegradable? That's a fairly limited definition, if so. If you are referring to some of the efforts to produce the "plant bottle," i.e., a significant portion of the monomers (building blocks) of the polymer may be bio-based while the other part is still petrochemically sourced, so not so "green."

So, the short answer is, we have a ways to go to get to "greener" plastics. DJCC

Dr. Constable, AIChE member (not ACS, sorry...) and graduate researcher here. Thanks for doing this AMA.

When I started graduate school and took on a sustainable chemistry and biocatalysis research project, I was highly motivated because I really (perhaps naively) believed that my project had the potential to make an immediate difference in the world - we were certainly had high-volume targets in mind. But it's been three years, and due to the nature of bio-related work, progress is slow and it feels likely that I'll make such a minor step forward that funding will not be renewed and the project will die - possibly even serving as a red flag and warding off other researchers who might have otherwise looked into working on my particular problem.

So the question is, for myself and others in similar positions: how can we stay motivated and make our work more impactful in the time that we have remaining?

As an aside, I love the ACS Webinars!

Dear Redditors, if any of you are interested in learning about chemistry, how it works, or how it impacts our daily lives, check out the...

FREE ACS Webinars video series on Youtube!
verticalfuzz

Hi there - thanks for your great question. Sorry you're not an ACS member, but I'm a member of AIChE, too, so we have that in common. I'll try not to hold ACS membership against you...;-) Thanks for the ACS Webinar plug - they are a great value and resource, that's for sure!

Now to the answer... There are no guarantees in research, whether it is sustainable/green or otherwise, and sometimes, what you hoped was a great idea just doesn't pan out. Actually, the overwhelming majority of research falls into that category, especially, in my opinion, in the green/sustainable chemistry area. Now, I'm not yelling, but emphasizing an important point: IF IT WAS EASY, MORE PEOPLE WOULD BE DOING THIS TYPE OF CHEMISTRY OR CHEMICAL ENGINEERING RESEARCH! But, it's not easy; it's really hard, and it's very important, even if it ends in failure!

To do this, you have to be intrinsically motivated and optimistic to stay motivated because it is hard and there are many people who are going to be naysayers. Ask yourself what kind of world do you want to leave behind? Hopefully the answer to that is a better one and you'll find great motivation in being a part of making that happen.

In the time you have remaining, think about the next great idea, how you would build upon and improve upon what you've done, and take the time to reflect on what you've learned. Take all the best with you into the future.

DJCC

What do you see as the biggest hurdle when it comes to patenting new types of green and/or sustainable chemistry? Have you encountered any particular issues and how would one become an expert witness whose purview would include new technologies like these?

gryshim

Hi - thanks for your question. Short answer is that I have not seen any more or less difficulty in patenting green and/or sustainable chemistries, chemicals, or processes. We are actually looking to better understand patents in green and sustainable chemistry and that is actually more challenging

than you might think, simply because people don't use those terms when submitting a patent.

I'm not exactly sure what you have in mind that would require expert witness - it would depend on the innovation, and I suspect that you would have to be an expert in one particular area or another, just as you always have to be. You would not receive a patent based on your innovation being green, greener or more sustainable.

DJCC

Do you find that academic research or private industry is more open to and enthusiastic about green chemistry initiatives?

AlpheusWinterborn

Hi, thanks for your question.

It has been my experience that academic research institutions are overwhelmingly populated with scientists who are adamantly against or at best, dismissive of sustainable and green chemistry-related research. Industry is by far the biggest adopters of greener, more sustainable approaches to chemistry and chemistry research.

Considering that both NIH and NSF, both big funders of academic research are in the case of NIH not the least engaged, and in the case of NSF, only forced into it legislatively, this is not surprising. Researchers will follow the funding, won't they?

DJCC

Do you feel like sustainable technologies will suffice with the damage we know we have done to the environment? Let alone the damage we don't know...

trash-berd

Hi there - thanks for your question. This is actually a lot harder to answer than it may seem at first blush and there are a variety of ways I could answer it. I agree that the environment is highly stressed and I openly express my concern that we are at or perhaps past a tipping point where there is certainly irreversible damage that has been done. This doesn't mean that life won't continue, but it may mean that we will not be able to return to the way things were previously, but to something different. That different state may or may not be terribly desirable.

A second thought is that true sustainability, in my opinion, should contain a restorative aspect to it. That is to say, reverse some of the damage we've caused. There are two big problems with this, however. One is human population growth continues to exacerbate any stresses. The second is that, as you point out, there's an awful lot we don't know about how things work in the environment, and we don't know, what we don't know.

DJCC

Hi Dr. Constable,

My question is about the people side of making green chemisty work - how do you convince industry to adopt green strategies?

It's difficult to change attitudes, especially in industry where there can be an aversion to risks that

change brings. How do you deal with the naysayers?

superhelical

Hi - thanks for your great question. The longer I was in industry, the more interested I became in human change management. You are absolutely correct that it is difficult to change attitudes, beliefs, values, opinions, etc. no matter if you are in industry, academia, government, or wherever you work and live. A majority of humans are very risk adverse; some say that's a remnant of not wanting to get eaten by something bigger than us like a lion, tiger or bear...

But, I digress. You have to take a long-term view and be patiently diplomatic and optimistic. Eventually people retire, they move on, etc. and an opportunity presents itself to move things forward. Always be ready, looking for those opportunities, and take advantage of them when they do arise, because it doesn't often happen.

There will always be naysayers; the skill to learn is how to respond in a way that they don't stand in the way. Change is scary to most because people fear losing something in the process. Always show how they will gain from the change you are trying to bring about.

DJCC