

Genetically Engineered Algae Public Engagement Strategies: A Stakeholder Workshop Report

1 Introduction

On October 27, 2016, a diverse group of stakeholder leaders assembled on the campus of Arizona State University (ASU) in Tempe, AZ for a facilitated discussion of how best to engage broader public audiences in the governance of genetically engineered (GE) algae. The workshop was organized and facilitated by the **Expert and Citizen Assessment of Science and Technology (ECAST) Network** (<https://ecastnetwork.org>), a network of researchers and practitioners dedicated to exploring hybrid strategies for engaging diverse audiences in science policy and technology assessment. The workshop was funded by the United States Environmental Protection Agency (EPA), with additional in-kind support provided by ASU's School for the Future of Innovation in Society (<https://sfis.asu.edu>) and Office of Knowledge Enterprise Development (<https://research.asu.edu/>); the Keystone Policy Center (<https://www.keystone.org>); and North Carolina State University's Genetic Engineering and Society Center (<https://research.ncsu.edu/ges/>). The workshop followed an open public meeting convened by the EPA regarding revisions to their guidelines for GE algae under the Toxic Substances Control Act (TSCA).

This report¹ describes the motivation and purpose of the workshop, summarizes the content of presentations and discussions, and offers suggestions for future strategies of public engagement on the topic of governing GE algae.

The workshop objectives, as communicated explicitly to the participants, included the following:

1. Reflect upon past experiences and lessons learned regarding effective public engagement.
2. Identify critical audiences, questions, and data/information needs for engagement on EPA's Algae Guidance and other future governance on GE algae.
3. Identify preferred engagement methods and desired approaches for integrating public input into decision making.
4. Bring together stakeholders from industry, academia, civil society organizations, and federal agencies.

¹ Suggested citation: Delborne, J., Farooque, M., and Shapiro, J. (2017). "Genetically Engineered Algae Public Engagement Strategies: A Stakeholder Workshop Report." Expert and Citizen Assessment of Science and Technology (ECAST) Network. <http://ecastnetwork.org/research/genetically-engineered-algae-public-engagement-strategies>

2 Workshop Motivation and Purpose

The U.S. Environmental Protection Agency (EPA) Office of Pollution Prevention and Toxics regulates the use of intergeneric microorganisms, including GE algae, in commerce or commercial research under Section 5 of the Toxic Substances Control Act (TSCA). Motivated by 1) an increase in biotechnology submissions, 2) a 2015 White House call for updating the Coordinated Framework for the Regulation of Biotechnology,² and 3) the Frank R. Lautenberg Chemical Safety for the 21st Century Act (an amendment to TSCA, signed on June 22, 2016), the EPA is engaged in a process to update their “Points to Consider in the Preparation of TSCA Biotechnology Submissions for Microorganisms” (last revised in 1997).

As required by federal law, the EPA has followed a process that includes several avenues for public comment and input. On September 30, 2015, the EPA hosted a public meeting in Washington, D.C. entitled, “Workshop for Public Input on Considerations for Risk Assessment of Genetically Engineered Algae” (Federal Register 2015-21039). Approximately 100 persons attended, and 15 spoke in a series of 4 formal comment sessions. This was followed by a public comment period that generated 324 comments in the official docket.³ The EPA subsequently released a Draft Algae Guidance document on October 12, 2016, prior to a second public meeting in Tempe, AZ on October 25, 2016, entitled “EPA’s Draft Algae Guidance for the Preparation of TSCA Biotechnology Submissions. Forty-two persons attended (with 33 additional via LiveStream), and 7 public comments were received in the official docket.⁴

While announcements in the Federal Register, open comment periods, and public meetings ensure a degree of transparency and access to the policymaking process for citizens, ECAST recognizes that **formal, agency-organized communication may not be sufficient to integrate public values into highly technical decision making processes**. As a result, and partially motivated by research in the area of public engagement in the governance of emerging technologies, the EPA partnered with ECAST to explore innovative ways to expand the breadth and reach of their efforts to engage citizens in their rule-making process. In particular, by providing funding to support this ECAST workshop, the EPA has demonstrated interest in hearing stakeholder feedback on how to expand public engagement in the arena of governing GE algae.

² Holdren, J.P., Shelanski, H., Vetter, D., and Goldfuss, C. (2015, July 2) “Modernizing the Regulatory System for Biotechnology Products.” Memorandum for Heads of Food and Drug Administration, Environmental Protection Agency, and Department of Agriculture. Executive Office of the President of the United States.

³ <https://www.regulations.gov/document?D=EPA-HQ-OPPT-2015-0508-0001>

⁴ <https://www.regulations.gov/document?D=EPA-HQ-OPPT-2015-0508-0021>

3 Workshop Summary

3.1 Setting the Stage

Reflecting the intention to assemble a diverse group of stakeholder leaders in the domain of GE algae, workshop participants hailed from universities, federal regulatory agencies, national laboratories, trade associations, non-governmental organizations (NGOs), and industry (see Section 5 for additional detail). ECAST facilitators opened the workshop with introductions, a review of objectives and expected outputs, and a discussion of guiding assumptions. Julie Shapiro, ECAST facilitator and Senior Policy Director of the Keystone Policy Center, reminded participants of 1) the Chatham House Rule,⁵ 2) the lack of expectation for consensus - acknowledging the likelihood of areas of convergence and divergence, and 3) the importance of diverse expertise and perspectives to a rich and vibrant discussion. In addition, while the workshop was designed to inform future engagement initiatives, it was undertaken without a prior commitment of resources by ECAST, EPA, or any stakeholder to support and organize additional engagement activities.

3.2 Understanding Public Engagement: Key Strategies and Pitfalls

As preparation for discussion, Dr. Jason Delborne, Associate Professor of Science, Policy, and Society at North Carolina State University and ECAST lead facilitator, gave an overview of how to understand the importance of public engagement and its key strategic questions and pitfalls. The recent National Academies of Sciences, Engineering, and Medicine report on gene drives defined engagement as “seeking and facilitating the sharing and exchange of knowledge, perspectives, and preferences between or among groups who often have differences in expertise, power, and values.”⁶ Importantly, public engagement in the realm of the governance of emerging technologies addresses the tension between democratic and expert-led decision making. First, engagement offers the opportunity for mutual learning, integrating formal expertise, local knowledge, and public preferences. Second, engagement follows the principles of justice by furthering transparency and offering a form of informed consent. Third, engagement can build trust among experts, stakeholders, and public audiences.

⁵ Because the meeting was held under the Chatham House Rule, no portion of this report will associate ideas, remarks, or opinions with a specific participant. A draft of this report was shared for comments from all workshop attendees prior to public release, and attendees were given the option to exclude their names and organizations from the list of workshop participants (see Section 5). Nevertheless, inclusion of a name or organization does not signify endorsement of every detail in this workshop report - neither the workshop nor this report were organized to reflect unanimity nor formal consensus.

⁶ National Academies of Sciences, Engineering, and Medicine. 2016. *Gene Drives on the Horizon: Advancing Science, Navigating Uncertainty, and Aligning Research with Public Values*. Washington, DC: The National Academies Press. doi: 10.17226/23405.

Delborne reviewed several key considerations for the design of public engagement activities. First, information may flow from the sponsor to the public (public communication), from the public to the sponsor (public consultation), or in both directions (public participation).⁷ Public communication and consultation, exemplified by marketing campaigns and opinion polls, occur frequently, but public participation - despite offering greater opportunities for learning and finding creative solutions - seldom occurs because of higher costs and fears of becoming vulnerable through two-way dialogue. Second, any public engagement activity involves the “construction” of the public in the way that participants are included and excluded - explicitly or implicitly. Third, participants need to be empowered during engagement with sufficient autonomy to ask new questions, access experts’ knowledge, and consider alternative solutions. Fourth, engagement activities must be embedded in existing decision networks that are capable and willing to consider their outputs.

To provide a living example, Dr. Mahmud Farooque, Associate Director of Arizona State University’s Consortium for Science, Policy and Outcomes and ECAST Principal Coordinator, described ECAST’s recent participatory technology assessment project with NASA to organize citizen forums on its Asteroid Initiative. He outlined how the four key design considerations were operationalized in terms of information flow, participant recruitment, education and empowerment, and decision support.⁸

Workshop participants next discussed and shared their experiences with public engagement. Some ideas that were expressed included:

- The conveners of public engagement often gain new perspectives.
- Engagement creates the potential for new relationships to develop.
- The public is heterogeneous, and it is easier to get folks with more extreme views or vested interests to show up. This means that “middle-of-the-road” opinions are often not represented well.
- Engagement works best when diverse viewpoints are represented and a common goal to solve a problem remains the focus.
- Conversations (two-way) are better than one-way meetings, such as listening sessions or presentations with brief Q&A.
- Public opinion is under-informed; education is needed. Others commented about the importance of recognizing expertise within the public.
- Engagement can feel pointless if there is no sense that it will have an impact.
- Engagement requires meeting the public where they are and including people impacted by decision making.
- Conveners should adopt a “learning attitude,” which includes careful listening and humility.

⁷ Rowe, G., & Frewer, L. J. 2005. “A Typology of Public Engagement Mechanisms.” *Science, Technology and Human Values*, 30(2), p. 255.

⁸ Tomblin, D., Worthington, R., Gano, G., Farooque, M., Sittenfeld, D., & Lloyd, J. (2015). Informing NASA’s Asteroid Initiative: A Citizen’s Forum. Washington, DC: ECAST. Retrieved from https://www.nasa.gov/sites/default/files/atoms/files/ecast-informing-nasa-asteroid-initiative_tagged.pdf

- Scenarios work well as objects of discussion.
- Engagement should take many forms because different opportunities may appeal to different groups of people.

3.3 GE Algae Public Engagement: Critical Questions

The next phase of the workshop focused on critical questions for the design of engagement activities in the domain of GE algae. All of the following questions were discussed in small groups:

1. What potential GE algae technologies and applications will be of most interest to public audiences?
2. Who should be engaged (i.e., how should the public be constructed)?
3. What do citizens (non-experts) need to know to effectively engage them regarding GE algae?
4. What questions should we ask to make engagement useful?
5. When and how can the outputs of engagement be integrated into the decision-making process?

The following sections, each addressing one of the five questions, reflect discussions held at four workshop tables, each with at least one facilitator and formal note-taker. While not all comments are represented, the summaries attend to prevailing themes and some of the unique ideas that arose in discussion. The summary statements do not necessarily reflect a consensus of participants, as participants were not explicitly asked to agree or disagree with these statements.

3.3.1 What potential GE algae technologies and applications will be of most interest to public audiences?

- Discussions emphasized the salience of algae as food, food ingredients, or anything put into direct contact with the human body (e.g., cosmetics, medicine).
- A second focus involved algae as a sustainable fuel alternative to petroleum, especially with the expectation that conventional fuels are likely to become more expensive over time - either through scarcity or policy decisions. Relatedly, some participants mentioned the potential for public interest in algae to be farmed as a carbon sink to mitigate climate change.
- Surfboards made of algae might capture the public's imagination.
- Algae as a means of addressing the overfishing of oceans.
- Algae as a means to accomplish environmental remediation.
- Algae is of little interest to most members of the public at this moment, but GE algae may trigger significant attention, especially for communities near proposed sites for growing GE algae outside of highly controlled containers.
- The context of development (e.g., university lab vs. industry) is likely to affect public interest and concern about GE algae.

3.3.2 Who should be engaged (i.e., how should the public be constructed)?

- Those interested (who want to be engaged), consumers, the local community directly impacted by algae production and processing, workers who will handle the material.
- Stakeholders (including experts, producers, activists) may serve as public proxies, but there is also interest in hearing from lay people who might be more neutral and less vested in an outcome from the start. Existing institutions (e.g., churches, schools, community groups) may provide a link to such publics.
- NGOs represent a diversity of positions ranging from pro-GMO to completely opposed; this diversity, including NGOs with moderate stances are important to include.
- Using census data to create representative publics is an attractive, but expensive, option. Seeking a balance of perspectives may be more realistic.
- The scale of technology deployment should match scale of the public that is engaged. For example, systems of open-air algae ponds across a landscape could draw the attention of a broader public than the use of GE algae in a closed, industrial system contained within a facility and situated in a particular community.
- There was some concern about engaging the public - and creating worry or fear - if there were no evidence that GE algae would affect the ecosystem.

3.3.3 What do citizens (“lay persons”) need to know to effectively engage them regarding GE algae?

- What are algae? How diverse are wild algae and what uses do they have? Citizens need to move beyond seeing algae only as “guck on the pond,” or more frighteningly, toxic algal blooms.
- How are GE algae made? What supply chains will they enter?
- What are the problems that GE algae are meant to solve? And how do they compare to existing alternative solutions? What are the tradeoffs we face in considering a variety of solutions?
- How might GE algae affect human and environmental health?
- How do federal, state, and local agencies regulate GE algae now?
- What are areas of scientific uncertainty or ignorance (e.g., rates and potential implications of horizontal gene transfer)?
- Some participants expressed frustration that members of the public understand very little about algae, yet worry about risks that have no scientific basis. Others recalled the history of experts reassuring the public of the safety of products and technologies (e.g., tobacco, asbestos, petroleum) that later turned out to be quite harmful.
- We also need to ask what experts need to know to effectively engage public audiences: for example, about regulatory systems, cultural differences, and communication best practices.
- Providing information to citizens is not an easy or straightforward task. Because people listen to their friends and family, as well as to various voices of authority, the messenger may matter as much as the message.

3.3.4 What questions should we ask to make engagement useful?

- How do you feel about GE in general, and GE organisms/algae being released into the environment?
- How should the government be involved in oversight?
- What could biotechnology firms do to inspire consumer confidence?
- What would demonstrate transparency?
- How can accountability be achieved by both producers and regulators?
- What are your questions and concerns? How could your concerns best be addressed?
- What would be your highest priority for an application of this technology - what excites you? What would make GE Algae useful to you?

Participants raised the possibility that the public may drive engagement with their own questions. One group noted the importance of asking questions in ways that minimize bias. Finally, different applications of GE algae may require very different kinds of questions.

3.3.5 When and how can the outputs of engagement be integrated into the decision-making process?

- The most frequent comment made across all tables was the importance of conducting engagement as early as possible to maximize feedback into the development and governance processes. There was also a strong sense that engagement should be iterative.
- One table had a vibrant discussion about whether outputs from engagement fit into science-based risk assessments - whether social considerations are germane to a risk assessment of GE algae. Some argued that science-based risk assessments must transcend values debates, while others argued that value preferences underlie all risk assessment by determining what would be a positive or negative outcome.
- Some tables noted the importance of a decision maker (government agency or company) serving as the convener of an engagement activity – in contrast to a third party or advocate of a certain policy. For example, when a government agency sponsors an engagement activity, public audiences are likely to view it as more credible and important than an engagement activity organized by a civic group. Likewise, when a company organizes engagement, they are more likely to seek the information they actually need to make better decisions. The flipside is managing the perception that the decision maker has organized and designed the engagement to achieve a certain outcome.
- One comment raised the possibility that engagement might not always have an impact on decisions, which are constrained, but that such information can guide communication choices.
- Consider eliciting public values that may be in conflict and focus on how participants would advise making tradeoff decisions.

3.4 GE Algae Public Engagement: Designing for Specific Scenarios

Considering the responses to Critical Question #1 (above), ECAST facilitators chose four scenarios for further development during the workshop. Priority was given to scenarios according to both likelihood and diversity of application (e.g., sector, environment, product, etc.). Presented below are rough sketches of engagement designs for the four scenarios. Each group was asked to consider the following questions:

1. Who should be engaged (i.e., how should the public be constructed)?
2. What do citizens (non-experts) need to know to effectively engage them regarding GE algae?
3. What questions should we ask to make engagement useful?
4. When and how can the outputs of engagement be integrated into the decision-making process?
5. Who might support and advance this proposed effort?

No group had sufficient time to develop comprehensive answers to each question; descriptions below should be considered in the spirit of generating ideas and perspectives rather than providing definitive and complete responses.

3.4.1 Scenario: Indirect Food Consumption

Group #1 considered a scenario in which GE algae replaces conventional feeds used for farmed salmon.

Who should be engaged?

Consumers of fish, fish farmers, regulators, retailers (grocery stores), recreational fishers, native populations who have sacred connections to wild salmon.

What do citizens need to know to effectively engage?

- Risks and benefits compared to other products, existing alternatives.
- The advantage of using GE algae over conventional algae.
- Effects on fish health, nutritional value, and cost of fish.
- Basic understanding of biotechnology and algae biology.
- How salmon farming is typically done.
- What fish are going to be fed GE algae and where.

What questions should we ask to make engagement useful?

- Would you feed this fish to your family?
- What concerns do you have about this product?
- What research do you think needs to be done for you to be comfortable?
- Under what circumstances would you support the use of this feed (e.g. in the ocean, lake, what environment; what species of salmon)?

When and how can the outputs of engagement be integrated into the decision-making process?

- Need to pay attention to federal/state/county/marine regulatory environments.
- Focus on needed regulatory changes to ensure safety and nutrition.
- Help state officials prioritize what to consider during risk assessment, permitting, and monitoring.
- Clarify the potential for ripple effects and economic impacts.
- Provide information about public preferences and concerns to producers and suppliers during product development.
- Facilitate cooperation between regulatory agencies and industry to do public service announcements based on messages from engagement.

3.4.2 Scenario: Direct Food Consumption

Group #2 considered a scenario in which GE algae are grown in a closed fermentation system to produce DHA oil for use in human baby food to fortify its nutrition.

Who should be engaged?

Parents, guardians, care-givers, pregnant women, pediatric doctors, nutritionists, retailers of baby food, food advocacy NGOs, environmental NGOs, the FDA, critics.

What do citizens need to know to effectively engage?

- Benefits, risks, and unknowns.
- Why does this have to be produced with GE algae?
- Are there environmental impacts from this production process?
- Are these algae or their oil product already in use elsewhere?
- How are these algae and food product regulated?
- Will the food product be labeled?
- What are environmental and social impacts of sourcing this kind of oil from alternatives (e.g. from fish)?
- Are there differences between “naturally” derived DHA and what these algae would produce?

What questions should we ask to make engagement useful?

- What are your concerns?
- What benefits do you see or imagine?
- Do you want it labeled, and if so, what should the label say?
- Would you buy this product?
- Would you rather get this from GE algae or from fish?
- What is the purification level and quality standards and constancy that you would require for this product to be acceptable in a baby food?

When and how can the outputs of engagement be integrated into the decision-making process?

- Engage after proof of concept or proof of feasibility so as not to waste the time of concerned parties.
- Engage well before commercialization, perhaps before investing in R&D.

- Attempt to learn from engagement and address concerns genuinely, not simply deploy a marketing scheme.

Who might support and advance this proposed effort?

Regulatory bodies, companies, investors.

3.4.3 Scenario: Environmental remediation

Group #3 considered a scenario in which GE algae are used to remove heavy metals from mine waste in an active or closed mine.

Who should be engaged?

Local residents in the mining community, the mining company, insurance company, state and federal regulators (both of mines and of GEOs), environmental justice groups, Native American nations with lands nearby, local colleges, workforce development organizations, schools, community groups.

What do citizens need to know to effectively engage?

- Benefits and risks
- Suite of solutions available (e.g. GE algae, non-GE algae, other options), their chances of success, their expected impacts (environmental, social, economic), tradeoffs implied
- Details of the plan for remediation, especially if local people will be employed, and how long the remediation will take.

What questions should we ask to make engagement useful?

- Does the community perceive a problem that needs to be fixed?
- What level of pollution is acceptable?
- What types of risks are of concern (e.g. groundwater pollution, soil pollution)?

When and how can the outputs of engagement be integrated into the decision-making process?

- Even if the ultimate technical solution doesn't exist yet, engagement could start the conversation and help the process of creating a solution.
- Begin engagement in early phases of research when the project looks feasible, which could lead into some sort of prototyping process.
- Cannot just aim for buy-in; need to offer an authentic choice of approaches to remediation.

Who might support and advance this proposed effort?

Local community organizers, state and federal regulators, stakeholders, universities as neutral parties

3.4.4 Scenario: Algal biofuel

Group #4 considered a scenario in which GE algae are grown in open ponds to produce a biofuel that serves as a gasoline substitute.

Who should be engaged?

State government, the closest town, EPA, local agricultural community, landowners, oil and biotech industries

What do citizens need to know to effectively engage?

- How much water will be utilized and where will it come from? Are spent water and nutrients recycled?
- What are the health risks and benefits?
- What the prices are going to be, what economic impact it is going to have, and how many jobs will be generated?
- What are GE algae and how do we ensure they are “safe” (not harmful to humans or the environment)?
- Can it show up in my tap water?
- How will the GE algae be contained? If the algae get out of the facility, will they survive in the environment?

What questions should we ask to make engagement useful?

- What are your concerns?
- How should the facility be designed?
- Would you be willing to have this facility in your “backyard?”
- What are your priorities in terms of lower gas prices, mitigating climate change, energy efficiency, creating new jobs, etc.?

When and how can the outputs of engagement be integrated into the decision-making process?

- Engagement should be an ongoing process, a series of public events that start even prior to permitting.
- Conduct informal conversations with public leaders and stakeholders about the property that might house the facility.
- Use the outputs of engagement to identify the concerns of the community, which should be alleviated prior to breaking ground on a facility.

Who might support and advance this proposed effort?

Organizations that rely on liquid fuels (e.g., trucking companies, airlines, the U.S. Armed Forces, automobile associations and companies), partnering facilities (e.g., wastewater facilities, flue gas generators), petroleum companies that sponsor alternative sources of energy, leaders of economic and energy reform, government agencies (e.g., Department of Energy, Office of Energy Efficiency & Renewable Energy), and phycology scientists and universities with active algae research programs.

4 Recommendations

While this workshop was not organized to produce a set of consensus recommendations, the following guidelines are suggested by the conveners as particularly relevant for designing and implementing broader public engagement initiatives with respect to GE algae and their products.

1. While open public meetings or comment periods have the advantage of creating transparency and formal openness, they are unlikely to engage the diversity of stakeholders that will be critical to broad public acceptance - and perhaps endorsement - of innovations in GE algae.
2. Formats of public meetings are important and may induce different levels of engagement by stakeholders. Facilitated small group discussion, in addition to a panel presentation and statements of record, may help bridge gaps between information, expertise, and values. The panel could also be constructed to present a diversity of views from government, industry, NGO, and community groups, prior to questions and comments. Improved options for remote/virtual participation might lower the resource threshold for meaningful participation.
3. Because stakeholders differ in their beliefs about how and when to engage broader publics, those who organize and convene such engagements should be transparent about their design choices, their goals, and their strategies for incorporating the results of engagement into decision making.
4. GE algae represent a wide diversity of potential innovations in a variety of scientific and commercial arenas. While some issues may cross many such arenas (e.g., regulatory pathways), engagement will be most productive if built on scenarios of specific applications. Such scenarios not only reveal unique issues of concern, but also make it possible to consider technological alternatives, potential social and environmental benefits, implied tradeoffs, and key areas of scientific uncertainty.
5. Engagement plans by innovators should begin well before the technology has been finalized and a site has been chosen for implementation. While there may be little payoff - and the potential for stoking fear - in engaging public audiences at the purely conceptual stage, once there are some proofs of concept and a sense of feasibility, an iterative engagement plan should commence.
6. Although the EPA does not become formally involved until there is a potential viable product to be tested outside or commercialized, their review process could include a component that asks for applicants to describe outreach or engagement conducted by the applicant that can be used to create a shared repository of data and information. Such a process could serve one of several purposes: a) communicating best practices for engagement design and implementation (see recommendations 2-4); b) encouraging or incentivizing engagement activities; c) collecting data about efforts to engage stakeholder and public audiences; d) collecting data about public perceptions of emerging algal technologies at different stages of product development and testing.
7. While standalone stakeholder workshops, such as this one, are unlikely to serve as sufficient mechanisms to efficiently design public engagement initiatives, they can serve the important purpose of collecting diverse perspectives, identifying the most promising

scenarios (in terms of technical feasibility and public interest), and creating a foundation for future collaborative engagement across sectors.

8. The EPA could consider either directly sponsoring or organizing a collaborative effort to conduct engagement and outreach regarding emerging algal technologies and their governance. Increasing broad understanding of algal biology and ecology, genetic engineering, processes of risk assessment and regulation, and the identification of problems and alternative solutions could help lay the groundwork for future and more specific engagement. Broader understanding of such themes, perhaps in the context of scenarios suggested above, could preface engagement on future algal technologies that will eventually be reviewed by EPA.

5 List of Workshop Attendees

5.1 ECAST Facilitator Team

- Jason Delborne, Ph.D. (Associate Professor, Genetic Engineering and Society Center, Department of Forestry & Environmental Resources, North Carolina State University) jason_delborne@ncsu.edu
- Mahmud Farooque, Ph.D. (Associate Director, Consortium for Science, Policy, and Outcomes, Clinical Associate Professor, School for the Future of Innovation in Society, Arizona State University) mahmud.farooque@asu.edu
- Julie Shapiro (Senior Policy Director, Keystone Policy Center) jshapiro@keystone.org

5.2 ECAST Table Facilitators and Note-takers

- Michael Bernstein, Ph.D. (Postdoctoral Research Associate, Arizona State University)
- Jenny Dyk Brian, Ph.D. (Honors Faculty Fellow, Arizona State University)
- Anne Hammang (Graduate Student, Arizona State University)
- Nicole Reed (Graduate Student, Arizona State University)
- Nick Weller (Graduate Student, Arizona State University)
- Jameson Wetmore, Ph.D. (Associate Professor, Arizona State University)

5.3 Participants

- Amanda Barry (U.S. Department of Energy/Los Alamos National Laboratory)
- Ira Bennett (Arizona State University)
- Teresa Bock (Heliae Development, LLC)
- Stephan Cameron U.S. Environmental Protection Agency)
- Matthew Carr (Algae Biomass Organization)
- William Doley (U.S. Department of Agriculture)
- Rick Greens (TerraVia)
- David Hanselman (Synthetic Genomics)
- Jaydee Hansen (International Center for Technology Assessment)
- Michael Hansen (Consumers Union)
- Jafrul Hasan (U.S. Environmental Protection Agency)
- Bill Henley (Oklahoma State University)
- Jill Kauffman Johnson (TerraVia)
- Peter Lammers (Arizona State University, Algae Testbed Public Private Partnership)
- Lieve Laurens (National Renewable Energy Laboratory)
- Rachel Levinson (Arizona State University)
- Gwen McClung (U.S. Environmental Protection Agency)
- Carolina Penalva-Arana (U.S. Environmental Protection Agency)
- Dana Perls (Friends of the Earth)
- Mark Segal (U.S. Environmental Protection Agency)
- Rachel Smolker (BiofuelWatch)
- Clare Thorp (Biotechnology Industry Organization)
- Jianping Yu (National Renewable Energy Laboratory)

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