Why a Scialog on negative emissions science?

Evan S. Michelson, Andrew L. Feig, and Richard J. Wiener

Research Corporation for Science Advancement (RCSA), a private foundation that supports basic research in the physical sciences, launched Scialog (short for science and dialog) in 2010 (Wiener and Ronco, 2019). The goal of Scialog is to rapidly catalyze highly productive new collaborations between Fellows who never previously worked together to tackle interdisciplinary problems of societal importance. With input from many external scientists, RCSA identifies frontier areas of research that are poised for important advances, which are likely to be accelerated by cross-disciplinary research. Such areas then serve as themes for Scialog initiatives.

For each initiative, RCSA selects 50–60 promising early career scientists to become Scialog Fellows and convenes the Fellows in a series of annual 3-day meetings, typically over 3 years. The meetings, which are facilitated by leading scientists drawn from multiple domains, have an intensive workshop format designed to encourage ideation of innovative projects that can lead to scientific breakthroughs. Rather than reporting on previous work, Fellows are challenged to imagine new lines of research, especially those that cross disciplinary silos, that might transform the field. Meeting time is almost wholly devoted to breakout discussion groups intentionally engineered using data analytics to optimize interdisciplinary network building. Fellows are incentivized to form new collaborative teams that feature diverse areas of expertise and that are composed of scientists who have not previously worked together. Near the end of each Scialog meeting, teams write two-page proposals for seed funding of novel, cutting-edge projects, and then pitch their “on-the-spot” ideas in the last session of the conference. A few weeks after the meeting six to eight projects are selected for funding, with research starting shortly after.
thereafter. Proposals examining problems on these boundaries often do not review well in federal grant programs because of the siloed nature of peer-review and the fact that advanced scientific training is often highly discipline-specific. Thus, philanthropic organizations like RCSA and the Alfred P. Sloan Foundation can help by taking the risk to launch these high-risk projects while simultaneously supporting the work of early-career faculty as they develop the credibility to tackle some of the most important scientific problems of our time.

RCSA is committed to diversity, equity, and inclusion and each cohort of Scialog Fellows is designed around a complex matrix of factors. From a pool of highly promising nominees, RCSA chooses the Fellows for each series by taking care to create a balanced mixture of scientists with gender, ethnic, and racial diversity representing the multitude of disciplinary voices needed to address the topic. The selected scientists must also utilize a range of research methodologies and are drawn from different types of universities and institutions across the United States and Canada. The inclusion of such a wide swath of the available talent pool magnifies the cross-pollination of ideas between Fellows, who are usually unfamiliar with one another before Scialog despite having overlapping research interests and complementary knowledge and skill sets.

A critical aspect of Scialog is that each initiative is cosponsored by at least one other funding organization along with RCSA. Cosponsorship increases resources for funding Scialog collaborative projects, and more importantly, it demonstrates to Fellows the value that disparate funders attribute to each theme. Fellows and facilitators have the opportunity to network with program officers from cosponsoring organizations and from other interested philanthropies who attend Scialog meetings as guests. The Sloan Foundation is one such cosponsor of Scialog initiatives that have a focus on energy and environment research questions.

**ORIGINS OF THE NEGATIVE EMISSIONS SCIENCE (NES) INITIATIVE**

The initial idea for organizing the Negative Emissions Science (NES) Scialog emerged during a conversation that took place in November 2018, at the second of three meetings that were part of an earlier Scialog series focused on advancing interdisciplinary scientific research for energy storage solutions. Following the success of the Advanced Energy Storage Scialog (2017–2019), which was cosponsored by RCSA and the Sloan Foundation, and an earlier Scialog on Solar Energy Conversion (2010–2014), RCSA had an interest in developing a new Scialog series that maintained a focus on energy-related topics. At the same time, in late 2018, the Sloan Foundation’s Energy and Environment program was planning to formally expand the scope of its program beyond social science research to also support basic science related to emerging issues in the energy system.

As part of that programmatic expansion, in early 2019 the Sloan Foundation held an open Call for Letters for Inquiry to broadly identify collaborative science and engineering research projects led by early- and mid-career scholars to better understand net-zero interventions and negative emissions technologies in the United States (Michelson, 2020, 2021). The number of high-quality research project ideas related to negative emissions technologies received in response to that call for submissions—many from early-career, Assistant Professor faculty—made clear to us at RCSA and the Sloan Foundation that there was substantial interest among junior faculty to undertake interdisciplinary research on negative emissions science. In addition, proposed ideas cut across experimental and theoretical chemistry, biology, materials science, geology, atmospheric science, oceanography, and environmental engineering, indicating that there was a number of emerging research approaches across numerous fields that could productively be brought together in dialog.

The theme of negative emissions was chosen as the focal point for this Scialog given its emerging importance as a set of new interventions to address global climate change. The accumulation of greenhouse gases in the atmosphere and in the oceans is a pressing challenge that requires rapid decarbonization of the global economy. Although there is much debate over how to define and characterize these kinds of interventions, negative emissions technologies are generally categorized as ways of removing carbon dioxide and other greenhouse gases from the atmosphere and oceans for the purposes of sequestration or potential utilization. These kinds of nascent approaches will likely be needed to augment and complement other climate mitigation and adaptation strategies. Furthermore, the underlying science needed to make negative emissions technologies globally scalable still requires major scientific breakthroughs, from new chemistry that can improve the efficiency of direct air capture
systems to geology research that can help better sequester carbon dioxide via mineralization processes to biological processes that could be key to carbon dioxide removal interventions. Taken together, from the burgeoning interest in negative emissions science from early-career scholars to the pressing need for such new discoveries to address climate change, it became clear that negative emissions science was an ideal topic for a Scialog series.

The partnership to undertake the NES Scialog series was formalized in mid-2019, with planning taking place over the subsequent year to hold the first of three meetings in the series in November 2020. When the COVID-19 pandemic hit, our team quickly pivoted, moving to an online, virtual format that allowed for discussions and collaborations to take place. Although in-person gatherings remain ideal, the virtual format saw a high degree of participation and was an overall initial success, allowing the NES Scialog to get started and new ideas to flourish.

**THE FIRST MEETING**

The initial NES meeting was held November 5–6, 2020 in a virtual format. Nine facilitators and fifty-nine Fellows participated – the list of these participants is available on RCSA’s website at https://rescorp.org/scialog/nes-fellows-and-facilitators. Observers from other organizations also attended, including from the Allen Frontiers Group, the Climate Pathfinders Foundation, Carbon 180, the Grantham Foundation, and the Science Philanthropy Alliance. Julia King, Baroness Brown of Cambridge, chair of the Carbon Trust, and a member of the U.K.’s House of Lords, gave a kick-off presentation. The talk focused on the need for scalable negative emissions technology to augment other climate change mitigation strategies. King emphasized the opportunities for capitalizing on such technology over the next 30 years, and fundamental scientific advances that are needed to meet the challenge.

Discussion topics for each Scialog meeting are determined using a “bottom up” process. Fellows suggest topics several months in advance of the meeting. Of the 150 or so suggestions, many were overlapping, and were edited with input from the facilitators into a concise list of about twenty discussion topics. For the NES Scialog, discussion topics included direct air capture of carbon dioxide, mechanisms for electrochemical carbon dioxide reduction, how to improve electrochemical sorbent regeneration for carbon dioxide recovery, and methane capture. The Fellows then indicated their interest level for each topic in a pre-conference survey. Fellows also identify their professional connection to one another by indicating if they are familiar with the research of, or have had serious scientific discussions or previously collaborated with, each of the other Fellows. The matrix of responses allows the Fellows’ professional network to be charted. This information is then used, along with their interest levels in topics, disciplines, and research methodologies, to optimize the makeup of discussion groups.

For the virtual meeting, there were three breakout sessions, each 75 min in length, in which the Fellows were divided into six parallel discussion groups on different topics, staffed with one or two facilitators in each group. The goal of the discussions is to give the Fellows an opportunity to think cooperatively and ideate new research directions. Fellows also spend time in mini breakout discussions in which three researchers previously unfamiliar with each other are asked to brainstorm novel research projects that would make use of their complementary skills. Sometimes the ideas from these mini groups are translated into team proposals, while other times the conversations simply lead to scientists

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getting to know each other better, which can translate into other scientific collaborations in the future. The entire Scialog meeting structure is designed to enhance interactions that move researchers initially unfamiliar with one another to awareness, then to serious scientific discussions, and quickly to form teams to write proposals for novel collaborative projects. Teams that choose to write proposals together self-organize, they are not prescribed, and no one is required to join a team. Any two or three Fellows, who have not collaborated together prior to Scialog, can form a team, and Fellows are allowed to be on up to two teams so long as other team members are different.

To avoid “Zoom fatigue” proposals were written after the meeting, and teams had 1 week to submit their novel ideas. Thirty-two team proposals were submitted, with nearly 90% of Fellows choosing to be on at least one team. Five facilitators served as members of a proposal review committee. Proposals were evaluated on their novelty, potential for impactful scientific outcomes, and if the project were successful, whether the seed funding could help grow into a new line of research that could become self-sustaining through obtaining additional funding, for example from federal agencies such as the National Science Foundation or the Department of Energy. Teams were also evaluated on project feasibility and how well their skills and knowledge complemented one another to generate a dynamic team. Based on recommendations from the committee, RCSA and the Sloan Foundation choose to fund eight projects involving nineteen Scialog Fellows (Figure 1) – the list of these awards is available on RCSA’s website at https://rescorp.org/scialog/nes-team-awards.

Scialog is all about networking both horizontally and vertically: Fellow with Fellow, and Fellow with facilitators and program officers from the cosponsoring and guest organizations. This backstory features the voices of program officers of the NES Scialog series and how this program got started (Figure 2). As part of this process, guest organizations sometimes choose to support Scialog projects. The Thistledown Foundation, a Canadian philanthropy established in 2019 by Tobias Lütke and Fiona McKean, with a core mission to advance technological solutions for energy system decarbonization, decided to support four team members among the eight funded teams.

LOOKING FORWARD TO YEARS 2 AND 3
Planning is well underway for the second annual meeting in the NES Scialog series. Owing to ongoing concerns with COVID-19, RCSA and the Sloan Foundation decided to continue with the virtual format for Year 2. The meeting is scheduled for November
4–5, 2021. Jennifer Wilcox, who was a facilitator at the first meeting and is now the Principal Deputy Assistant Secretary in the Office of Fossil Energy and Carbon Management at the Department of Energy, will give the keynote presentation. Fifty-three of the fifty-nine Fellows from Year 1 will be returning for Year 2, with a half dozen new Fellows joining the cohort. All but one of the original facilitators are returning and several new facilitators will be joining the conversation. For Year 3 (in 2022) we hope to return to a face-to-face meeting, but regardless we will continue the NES Scialog series. The goal is to strengthen this emerging network of early career scientists who are dedicated to meeting perhaps the greatest challenge of our time, addressing and mitigating global climate warming.

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