Scientific and Technical Report from the National Council for Science and the Environment to the Department of Energy

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Applicant Institution	National Council for Science and the Environment
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Executive Summary

The National Council for Science and the Environment (NCSE) held its 19th Annual Conference from January 7-10, 2019. The *NCSE 2019 Annual Conference: Sustainable Infrastructure & Resilience* explored how systems thinking that includes tools, data, and synthesis effectively supports the increasingly urgent need to advance a more resilient, sustainable society. Nearly 600 participants from a range of scientific disciplines and sectors including natural and social science, humanities, engineering, government, business, and civil society attended the conference. Post-conference activities planned through this project were planned to extend the impact of the Annual Conference and were made possible through support from the Department of Energy. These efforts included: 1) developing and producing a research pilot on Energy Systems and Resilient Infrastructure, which advances research focused on the better alignment of education and workforce needs with respect to energy resilience; 2) facilitating dialogue and in-person convenings with the Energy Education Community of Practice across the broader NCSE research community; and 3) designing and hosting a webinar series focused on the role of science in infrastructure and resilience. This report summarizes the outcomes of the proposed activities and additional work made possible by support from the Department of Energy.

Proposed Projects: Post-Conference Activities and Outcomes

A post-conference Outcomes Report was produced as part of this grant period. This is attached as Appendix I. In addition, the following activities and outcomes were accomplished in response to the deliverables specified in the project proposal, with the support of funding from the Department of Energy.

I. Energy Education Community of Practice (EE CoP)

During the project period, NCSE continued to provide leadership and support for a Energy Education Community of Practice (EE CoP), that is co-chaired by faculty leads at Penn State University and Northeastern University. The aim of the EE CoP is to facilitate a discussion between NCSE Members in an effort to share curricula, research findings, and general scholarship across energy education efforts at two- and four-year institutions. Funding in 2019 from the Department of Energy supported NCSE staff time to coordinate activities (e.g. in person meetings and bimonthly calls) for the EE CoP, as well as maintain a presence for the EE CoP on NCSE's website.

- In 2019, the EE CoP undertook an initial planning process to identify research priorities to pursue collectively. Notably, faculty leads from Massachusetts Institute of Technology (MIT), Penn State University, and Texas A&M began initial planning and proposal for a development for an in-person workshop to be co-hosted by the UN Foundation that would focus on Energy Education for a Future Workforce. There is preliminary interest in co-hosting this meeting by the New York State Energy and Research Development Authority (NYSERDA), but due to the pandemic, plans for an in-person meeting have been indefinitely suspended. Core partners are continuing to explore opportunities to advance cross-university dialogue on energy education through virtual platforms.
- The EE CoP is also working to develop follow-up outreach and dissemination materials from a report that NCSE developed and published in the fall of 2018. This report focused

on a census of *Energy Programs in Higher Education in the United States: Assessing Trends Across Two Pathways.* The major finding of the report suggested that there were two distinct pathways for energy education in the U.S., one focused on more interdisciplinary programs and one focused more on foundation building block courses and core programs. One of the ongoing research priorities and areas of focus for the EE CoP has been to explore how the knowledge needs and workforce needs may differ between two and four-year institutions. More significantly, from a research standpoint, the question of whether there are better ways to sample and analyze the energy education and workforce landscape to ensure that we are educating a future workforce in a manner suited to the current and future needs of different fields.

II. Energy Systems and Resilient Infrastructure Research Briefs

In the months following the NCSE 2019 Annual Conference, NCSE worked with several scientists within the NCSE Member community to advance research focused on the better alignment of education and workforce needs with respect to energy resilience. Rather than produce a series of short briefs, NCSE is working to develop a longer report as part of a pilot study, in collaboration with scientists from George Mason University, Arizona State University, and the University of Arizona, that focuses on the current state of resilience education (including energy resilience) as it relates to workforce demands. This pilot study analyzed the current state of resilience education at over 100 universities in the United States and aligned the findings with nearly 80 relevant job listings that are seeking employees with resilience-oriented skill sets, across sectors. Some initial findings:

- There is clear demand in both higher education and in the workforce for increased training in resilience frameworks and approaches - it is indeed an emergent field of training needed to tackle challenging questions in everything from energy resilience, cybersecurity, urban planning, and environment.
- Initial findings suggest a "vocabulary lag" between what is being taught in universities and what is sought by prospective employers -- a gap that could be bridged by the outcomes of this research to help drive better alignment between supply and demand.
- A web crawler built to skim college course catalogs or job listing aggregates could read, evaluate, and document the relevant data at a much greater rate and enable a more comprehensive study of college course descriptions or job listings, in a manner that eliminates bias and unearths statistically significant trends.

NCSE anticipates the publication of this pilot study as white paper this fall.

III. Energy Resilience (Leadership activities)

In 2019, NCSE initiated a leadership circle of universities that are collectively focusing on the untapped role of university science research to inform local resilience. Among the activities were a major conference co-hosted by SUNY Albany and NCSE that included a workshop for university leaders focused on the role of universities in local resilience. The activities that evolved as a result of that conference were many and served as a greatly enhanced version of the original idea to host a single webinar series.

- From 2019-2020, this group has held bi-weekly calls to engage toward building a collaborative research agenda, focused on resilience (including energy) as a dedicated

discipline in higher education. This group is currently focused on launching a body of work that is focused on both the higher education enterprise and external communities.

- As part of the NCSE 2019 Annual Conference, NCSE and Arizona State University co-hosted an invite-only dinner event that focused on **Hacking for Carbon: Building an Innovation Pipeline for the New Carbon Economy.** This dinner brought together leaders from across sectors to participate in a facilitated discussion on how government, philanthropy, and private capital can fund and de-risk an innovation pipeline to accelerate renewable and clean energy with an aim to make the domestic, and in turn global energy system, more resilient, secure and source-diverse.
- Following the conference dinner, Executive Director Michelle Wyman led standing monthly conference calls with leaders from across sectors to further the discussions and work from the *Hacking for Carbon* event, with an aim to have sustained discussions and ideally accelerate work that leverages advanced technology, innovation, science, public sector and universities together for collective impact. In addition to NCSE, participants included: Shell,Pegasus Capital, Arizona State University, Long Island University, Desert Research Institute, Prime Coalition, the National Science Foundation, Carbon 180 and Kepos Capital, and the World Resources Institute to name a few.
- NCSE Executive Director Michelle Wyman was invited as a featured speaker at the 16th Annual AREDAY 100 Summit in Aug. 2019 in Aspen, Colorado. She provided keynote remarks focused on the role of energy system innovation in resilience at this distinguished event, which convenes and provides a platform for thought leaders and experts from multiple sectors to foster climate change solutions at the speed and scale necessary to phase out fossil fuels, and to usher in a rapid transition to a new, clean energy economy.
- NCSE is pursuing partnership with the Integrated Renewable Energy Systems Network (IRESN) to explore a role for universities in local energy resilience to provide science, data, analysis, and support to local planning and decision-making. A primary enabling factor will be a culture of collaboration between energy service providers, local governments and universities.
- NCSE is positioned at the intersection of two key networks, our core network of university members and a network of local governments that has recently become part of the NCSE network, called NCSE Applied Solutions. This is a valuable intersection for both connecting science to decision-making and enhancing the state of research in the field with emphasis on the energy water nexus. We envision co-hosting webinars and other joint activities with IRESN and other partners in the future.

IV. Convene NCSE Leaders at the NCSE 2019 Summer Member Meeting to discuss follow up to the NCSE 2019 Annual Conference

- NCSE held a dedicated session at the NCSE 2019 Summer Meeting, which was held at the University of Arkansas. This breakout group, co-chaired by one of the leaders of the EE CoP, focused on emergent research and education needs for two and four year institutions, related to energy.
- One of the key topics of discussion is the difference between the needs of two and four-year colleges with respect to educating a future workforce and the skills and competencies that are needed. An emergent theme was the potential value of an “energy

resilience certificate program," that could help boost earning potential for graduates entering into more vocational roles, with respect to energy.

Acknowledgements

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APPENDIX I: Outcomes Report from the 2019 NCSE Annual Conference

Introduction

Each year, the National Council for Science and the Environment (NCSE) convenes a diverse group of experts to learn, question, disseminate and work together towards the shared mission to improve the scientific basis of environmental decision-making. The Annual Conference is a global platform that brings together upwards of 1000 scientists, academics, policy-makers, researchers, government officials, and civil society members, including subject matter experts and business leaders, to work towards building a collective, sustainable future. The NCSE community reflects some of the most cutting-edge, relevant and current research and work on the cusp of science and environmental policy. This year, the 19th Annual Conference was held in Washington D.C. from January 7-10, 2019 under the overarching theme of Sustainable Infrastructure & Resilience.

The theme of the conference this built upon the Science, Business and Education of Sustainable Infrastructure narrative from the NCSE 2018 Conference with a continued commitment to work towards aligning the use of science in built, natural, social, and cyber infrastructure with the fundamental priority of resilience. Most commonly understood as the ability to withstand, adapt and bounce back, the notion of resilience goes hand in hand with our broad-based definition of sustainable infrastructure. The resilience of the natural environment lies in ecosystems, the physical on the sturdiness of built structures; and social resiliency lies at the heart of communities, collective action and social capital -- closely aided by massive social networks, communities and public services; big data and technological innovations as part and parcel of cyber infrastructure.

This report showcases the presentations, discussions, and stories that emerged from the 2019 Annual Conference under the overarching theme of Sustainable Infrastructure & Resilience. From the keynote speakers, to the breakout sessions, lifetime achievement award recipients, illustrious plenaries and the Chaffee Lecture – ideas presented from different perspectives round out a common powerful narrative.

TUESDAY, JANUARY 8, 2019

7:30 a.m. - 8:30 a.m.	Networking Breakfast with Exhibitors
8:00 a.m. - 5:00 p.m.	Registration Open
8:30 a.m. - 9:00 a.m.	Welcome and Opening Remarks
9:00 a.m. - 9:30 a.m.	Keynote 1: Blueprint for Tomorrow: Economic Transformation Through Science
9:30 a.m. - 10:15 a.m.	Plenary 1: Transforming How Companies Operate in a New Carbon Economy: Industry Leading Innovation
10:15 a.m. - 10:45 a.m.	Networking Coffee Break with Exhibitors
10:45 a.m. - 12:15 p.m.	Concurrent Sessions Group A

12:30 p.m. - 1:45 p.m.	2019 NCSE Lifetime Achievement Awards on Science, Service, and Leadership Lunch Served
2:00 p.m - 3:30 p.m.	Concurrent Sessions Group B
3:30 p.m. - 4:00 p.m.	Networking Coffee Break and Poster Presentations
4:00 p.m. - 5:30 p.m.	Concurrent Sessions Group C
5:45 p.m. - 7:45 p.m.	An Evening Discussion on Science, Ecology, and Hope Film Screening and Discussion. Light snacks provided

WEDNESDAY, JANUARY 9, 2019

7:30 a.m. - 8:30 a.m.	Networking Breakfast with Exhibitors
8:00 a.m. - 4:00 p.m.	Registration Open
8:30 a.m. - 9:15 a.m.	Keynote 2: Cultivating Productive Optimism in Environmental Science
9:15 a.m. - 10:00 a.m.	Plenary 2: Information and Decision Making: Response, Recovery, and Resilience
10:00 a.m. - 10:30 a.m.	Networking Coffee Break with Exhibitors
10:30 a.m. - 12:00 p.m.	Concurrent Sessions Group D
12:00 p.m. - 1:20 p.m.	New Perspective on Climate from NASA: From Exoplanets to Earth Planets Lunch Served
1:30 p.m. - 3:00 p.m.	Concurrent Sessions Group E
3:00 p.m. - 3:45 p.m.	Plenary 3: Applying the Convergence of Knowledge, Technologies, and Science to Resilience Thinking: The Case of RISE- PR and the Reconstruction of Puerto Rico's Electric System
3:45 p.m. - 5:00 p.m.	John H. Chafee Memorial Lecture on Science, Policy, and the Environment

THURSDAY, JANUARY 10, 2019

8:00 a.m. - 4:30 p.m.	NCSE Academic-Federal Dialogue and Science Policy Symposium (Registration Required)
8:00 a.m. - 5:00 p.m.	Related Organization Event: The Coastal Society's Coastal Career Workshop (Registration Required)
9:00 a.m. - 12:00 p.m.	Identifying Innovation in Teaching and Learning Resilience: Mapping Assets & Best Practices
1:00 p.m. - 4:00 p.m.	Progress on Building a Competency Based Curriculum for Sustainability

The Art of Storytelling through Science: How to tell the Climate Story

One of the many advantages of bringing people together under the same shared theme is their varied expertise, perspectives, lived experiences, and stories. Opening the conference, NCSE Executive Director Michelle Wyman stressed the importance of 'localizing' the impacts and risks the changing climate presents. Using data and research communicated through stories and in language that resonates in a concrete, place-based manner can empower leaders to inform their decision-making with locally relevant evidence.

This notion was further stressed by keynote speaker Jeff Nesbit, Executive Director at Climate Nexus, as he walked the attendees through some pivotal benchmarks of where we are in the 'climate story' today. Nesbit emphasized the importance of storytelling, reiterating the fact that "stories are how we learn." As people, we learn best when we are able to relate. Across the board, Nesbit pointed out that the majority of Americans believe that climate change is real - and it is our job to capitalize on that narrative now and advance it. Many countries the world over are facing climate vulnerabilities. Corporations, businesses, and sub-national actors are pushing to advance resilience and advance global climate agendas. The onus is on all actors to own the narrative, advance it, and tell the story.

The Climate Narrative

Language matters. Climate change is often portrayed as an insurmountable, technical, and overwhelming phenomenon that is difficult to grasp by those lacking scientific understanding and is often portrayed as over-technical or under-explained.

The 2019 NCSE Lifetime Award Recipient, Paul Hawken, prolific writer and the Founder of Project Drawdown, emphasized that it is imperative to communicate that "global warming," rather than "climate change," is the problem. Due respect must be given to earth as a living planet, and its climate has always changed over time and will continue to change as part and parcel of natural processes. The language surrounding "fighting" climate change promotes negativity, where what we are trying to do is collaborate, not drive differences.

"In every problem, there is a solution in disguise," Hawken explained. The problem today is global warming, and embedded in this is the solution that will drive the transformation of the world.

Reframing the narrative, and communicating in a way that reinforces positive imagery about nature and our planet that people are able to relate to, is key to shift the understanding of climate change today and ultimately to mobilize the level of action we need to effectively solve global warming.

A similar train of thought was mirrored by Julia Marton-Lefèvre, Former Director General of the International Union for the Conservation of Nature, also a 2019 NCSE Lifetime Achievement

Award recipient. Drawing from her experiences and illustrious career, Marton-Lefèvre touched upon the need for scientists to communicate in a way that people outside their fields can understand, and to become fluent in telling accessible stories that resonate with decision-makers.

Like Hawken, Marton-Lefèvre stressed the need to reverse the 'gloom and doom' scenario, and learn from and look to nature for solutions, where "nature is our best friend and strongest ally, it is not to be pitied."

A Call for Convergence, Collaboration, & Cooperation Across Sectors

Every year, NCSE invites a distinguished individual to deliver the John H. Chafee Memorial Lecture on Science, Policy, and the Environment. At NCSE 2019, Dr. Gary Geernaert, Director of Climate and Environmental Science at the U.S. Department of Energy delivered an inspiring call for convergence and collaboration – an overwhelming emerging theme at the conference this year.

Geernaert spoke about the importance of building a 'scientific enterprise', and how environmental decision-making should be based on science, not politics. In current times, scientific advancement and technology is moving at a rapid pace, that society at large is not able to keep up. In the same vein, social connectedness has never been stronger so we need to think more holistically about our relationship to nature and to society as we move forward. Key areas of change which will push us toward increased integration are:

- Sociological including an increased notion of public trust and accountability in science and data;
- Artificial Intelligence including advanced robotics which will revolutionize how we work in societies;
- Precision Biology including CRISPR; and
- Earth system prediction and impact including better projections of the future to build better infrastructure and increase resiliency.

In order to truly advance, the scientific community must engage with the local societies they are embedded in and approach policy makers and local governments with a unified voice. Faced with climate issues and catastrophes, communities are rapidly changing and it should be the role of scientists to help recognize these changes and effectively bridge the gap and influence policy for increased sustainability and resilience as we move forward.

As part of NCSE 2019, NCSE announced the launch of a local government program called NCSE Applied Solutions. The focus of the program is to connect local governments to the science community core to NCSE. The connection will be designed as a communications loop to engage ongoing "boundary spanning" between the scientists and local government leaders central to the NCSE community. The focus of NCSE Applied Solutions (http://www.appliedsolutions.org) is to increase the accessibility and use of science by local decision-makers and for decision-makers to provide feedback that furthers the scientific research and education work.

Innovation, Sustainability, and Resilience in Business

Climate related events in recent years have compelled all actors in society to reevaluate and think about the impact they are having on the environment around them. Not only through the perspective of mindfulness and taking innovative steps to reduce their carbon footprints, but also to build resilient and adaptable businesses for continued success.

A thought-provoking plenary at NCSE 2019 this year brought together panelists from business including Tesla, UPS, Midwestern BioAg, and the SPECTRUM Group. Panelists spoke extensively upon the need to innovate in sustainability measures to stay profitable, efficient, and adaptable; the need for government policies such as the carbon tax; investments in sustainable energy sources to accelerate change; and how to incentivize the public to get on board. Tesla Director of Policy and Public Engagement Rohan Patel, pointed out that from a business perspective, many people buy in more to the notion of safer, more cost-efficient technology rather than necessarily reducing their carbon footprints and that needs to recognized by businesses. Jim Bruce, from UPS, also shed light on the fact that to attract the best and brightest minds today, businesses need to consciously work toward building sustainable practices.

Overall, the idea that successful, profit-driven business practices are antithetical to environmental sustainability is becoming increasingly outdated.

These views and sentiments were echoed throughout the NCSE 2019 conference concurrent sessions which consisted of presentations from many private energy businesses, insurance providers, and energy consulting firms who have consciously shifted gears toward working for increased sustainability and resilience across their practices.

Local Communities, Local Solutions, Big Impacts

An emerging trend across the various presentations and plenaries was the utmost importance to localize issues, not just to increase awareness and communicate the climate story, but also to create innovative and lasting solutions for those adversely affected by the unfavorable effects of a changing climate.

During a plenary discussion consisting of representatives from ESRI, Sonoma County, and the University of Colorado, Boulder, panelists dug into the need to ‘listen’ to and work with communities. Supervisor Shirlee Zane, Sonoma County, recounted the massive loss and rebuilding efforts being undertaken after the wildfires on the west coast that wiped away roughly 5,400 homes in 2017. She stated that in the aftermath of such situations it is vital to collect data and initiate policy by closely listening to your constituents and people for their needs to promote sustainable, and effective solutions.

These solutions do not only center around efforts to rebuild safely, but also in the support required to overcome debilitating trauma and address mental health in communities. Ryan Lanclos, Director Public Safety at ESRI, also touched upon effective communication with

communities for bigger impacts through the use of technology and tools such as GIS and maps to encourage better planning, collaboration, and visualization to promote resilience.

In a similar vein, academics, public sector professionals, and representatives from non-profits also elucidated upon local resiliency efforts in their respective communities after adverse climate events. They touched upon the importance of branching out and working with the local community to deeply understand its natural landscape in order to bring about real change and meaningful impacts. Some of these localized case studies included a presentation on the aftermath and resiliency efforts undertaken by the local community after unprecedented flooding in Nashville, TN, aided by academics using science to reach communities as well as a presentation by policy-makers for wetland conservation essential to the ecology of the area in Middlebury, VT.

Higher Education and Boundary Spanning Organizations

Under the continuing theme of convergence and collaboration, the role of higher education institutions and boundary spanning institutions such as NCSE are imperative to highlight.

Academic institutions such as universities often support and engage their surrounding communities, where many are vital to the identities of the communities and towns they are housed in. From aiding in disaster response situations to continual research on local issues, they are undoubtedly key pillars of society.

A plenary that consisted of professors from the State University of New York College of Environmental Science and Forestry, University of Puerto Rico-Mayaguez, University of Buffalo, University of Minnesota, and University of Central Florida recounted efforts undertaken, as well as shortfalls in the aftermath of, Hurricane Maria in Puerto Rico. NCSE Senior Fellows Dr. Cecilio Ortiz Garcia and Dr. Marla Perez-Lugo from the University of Puerto Rico, Mayaguez, expanded upon the need for convergence between universities across the United States for efforts surrounding not just recovery, but coming together to promote cultural sensitivity trainings for university researchers in post-disaster situations.

Apart from emergency aid workers, university researchers play an active role in promoting post-disaster recovery. For instance, Kim Connolly, University of Buffalo, took student lawyers to Puerto Rico after the Hurricane as they were in short supply there. Many other university students and researchers stepped up similarly, but these efforts may not always translate positively for local communities if the ethic of intervention is not communicated beforehand effectively. Hence, we can better use our resources and brain power if there is convergence and collaboration beforehand – an area that a boundary spanning organization can assist with.

The power of connectivity and knowledge is essential in preparing for, and overcoming, a multitude of issues that societies will undoubtedly continue to face in coming years due to climate related events – hence, the more we focus on pre-covery versus solely recovery, the more resilient we will be.

Looking Ahead:
NCSE 2020 Annual Conference: Science in Environmental Decision-Making

NCSE 2019 culminated with a forward look toward 2020, when NCSE will mark its 30th anniversary year. The 2020 Annual Conference, will mirror the theme of our inaugural conference, **Science in Environmental Decision-Making**. Building upon the stage set at the 2019 conference, NCSE 2020 will help chart a course toward a future in which the science policy interface is robust and foundational to environmental decision-making. More about the conference at www.ncseglobal.org/conference.