

# Report from the 2<sup>nd</sup> National Energy Education Summit

---



---

A report from the National Council for Science and the Environment and the  
Council of Energy Research and Education Leaders

June 7, 2016

David E. Blockstein and Robert I. Long, Editors  
James J. Henn, Summit Assistant



National Council for Science and the Environment  
*Improving the scientific basis for environmental decision-making*

---

1101 17th Street NW • Suite 250 • Washington, DC 20036-4722 • TEL 202/530-5810 • FAX 202/628-4311 • [www.NCSEonline.org](http://www.NCSEonline.org)

## **The National Council for Science and the Environment**

The National Council for Science and the Environment (NCSE) is dedicated to improving the scientific basis of environmental decision-making. We envision a society where environmental decisions are based on an accurate understanding of the underlying science, its meaning and limitations, and the potential consequences of action or inaction.

NCSE is a not-for-profit 501(c)(3) organization that does not take positions on science or the environment. Rather, we provide sound research, tools and convenings that seek to amplify the value and role science, data and analysis provide to environmental decision makers.

## **The Council of Energy Research and Education Leaders**

The Council of Energy Research and Education Leaders (CEREL) is a multi-disciplinary membership organization made up of heads of academic energy research and education centers, institutes, and programs. It provides the means for leaders in energy research, education, and communication to collaboratively use knowledge about energy to improve education, decision-making, and, more generally, the well-being of society.

The main areas of activity for CEREL are:

Research – advocating for support of university-based energy research as well as generally advancing, informing, and elevating the national debate about energy;

Education – developing an interdisciplinary field of energy education and sharing approaches to preparing the future workforce;

Collaborating – achieving success with engagement, education, outreach and communication.

## **Index of the Report from the Summit**

### Introduction

- Page 1 Welcome Letter from the President of CEREL to the participants of the  
2016 National Energy Education Summit
- Page 2 Summit Speakers and Events

### Summit Breakout Session Reports

- Page 4 K-12 Energy Education – Classroom Practices
- Page 6 K-12 Energy Education – Professional Development and Research
- Page 8 Introductory Energy Education – Energy 101 and General Education
- Page 12 Pedagogy and Assessment of Student Learning
- Page 14 Defining Sustainability in an Energy Context
- Page 17 Connections between Energy Education and Energy Practices on Campus and in  
Local Communities
- Page 20 Diversity Advancing Diversity in the Sustainable Energy Field
- Page 22 Career Preparation, Workforce Development, Employer Needs and Student  
Opportunities
- Page 24 Undergraduate Degree Programs, Minors and Concentrations
- Page 26 Courses and Programs at Two Year (Community) Colleges
- Page 29 Graduate and Professional Energy Education
- Page 31 Public Energy Education
- Page 33 Bioenergy Education

### Additional Information

- Page 35 Responses about Energy Education from the Post-Summit Survey
- Page 38 Summary: Summit Follow-up Workshop at the 2016 AESS Conference
- Page 48 OurEnergyPolicy.org Online Summit Discussion: Expanding Energy Education
- Page 50 *Council of Energy Research and Education Leaders*
- Page 53 Sponsors of the 2016 National Energy Education Summit
- Page 54 *National Council for Science and the Environment*

Presentations from the Summit can be viewed at [www.EnergyEducationSummit.org](http://www.EnergyEducationSummit.org)



2<sup>nd</sup> National Energy and Education Summit  
American University  
Washington, DC  
June 7, 2016

**Welcome Letter to the 2016 Summit Participants from the President of CEREL**

The energy field is vital to all aspects of society and presents ever-increasing challenges as well as new opportunities. These challenges call for future generations to be energy literate, beckoning change in technology, policy, and behavior. New forms of energy education must be incorporated into K-12 and higher-education curricula to ensure the energy security and efficiency of our nation. The *National Energy Education Summit* serves this goal by bringing together educators, leaders in industry, government officials, and civil society to catalyze new initiatives and develop meaningful partnerships.

A sustainable energy future must be imagined before it can be attained. Such a future will be the product of vision, people, and perspectives. A shared vision for energy literacy, one that addresses the changing needs of our nation and the globe, sets the stakeholders involved in energy education on a common goal. The people involved in nurturing energy literacy, whether at the personal level, the classroom level, or at the policy level, propel this movement towards new curricular models incorporating classroom learning with experiential opportunities. The importance of energy education spans across disciplines, and a variety of perspectives informing this effort will ensure the success of energy literacy permeating business, politics, and civil society, ultimately leading to new societal practices and sustainable norms.

The Summit creates a space where a shared vision for a sustainable energy future can be imagined and re-imagined. It brings together the people who most directly influence the energy literacy of future generations. And it offers an opportunity to share the perspectives that will converge to develop best practices for programs and initiatives. Each person in attendance at this year's summit is part of the ever-changing energy ecosystem. I invite you to build on the momentum from this Summit as you shape your role in impacting energy education.

A handwritten signature in blue ink that reads "Nagi G. Naganathan". The signature is fluid and cursive, with a long horizontal stroke at the end.

**Nagi G. Naganathan, Ph.D., ASME Fellow**  
CEREL President (2015-16);  
Dean of Engineering, The University of Toledo

## 2<sup>nd</sup> National Energy Education Summit Speakers and Events

### Welcomes and Introductions

**Nagi Naganathan**, President, Council of Energy Research and Education Leaders

**David Blockstein**, Executive Secretary, Council of Energy Research and Education Leaders

**Michelle Wyman**, Executive Director, National Council for Science and the Environment

### Keynote Addresses



**Joe Soldano** is Director of Business Development with Worthington Energy Innovations. WEI is on a mission to develop new technologies that dramatically reduce energy costs and carbon footprints, proving that the move to sustainable energy practices with innovative strategies can be a key feature of corporate culture.

Mr. Soldano was WEI's primary liaison with the Wege Foundation, a nonprofit foundation that is funding the Economicology Sustainable Strategy for Colleges and Universities pilot program. This program enables colleges and universities to define and implement the practical actions necessary to transform their energy use and reduce their carbon footprint. The pilot involves six universities – Arizona State University (ASU) and others to showcase sustainable energy efficiency using WEI's energy systems and technology on university and college campuses through curriculum-based, student-led demonstration projects.



**Dan Kammen** is the Class of 1935 Distinguished Professor of Energy at the University of California, Berkeley, with parallel appointments in the Energy and Resources Group, the Goldman School of Public Policy, and the Department of Nuclear Engineering.

Dr. Kammen is the founding director of the Renewable and Appropriate Energy Laboratory (RAEL), Co-Director of the Berkeley Institute of the Environment, and Director of the Transportation Sustainability Research Center. He has served the State of California and U.S. federal government in expert and advisory capacities.

He was appointed the first Environment and Climate Partnership for the Americas (ECPA) Fellow by Secretary of State Hillary R. Clinton in April 2010. During 2010-2011 Kammen served as the World Bank Group's Chief Technical Specialist for Renewable Energy and Energy Efficiency. In 2016, the Department of State appointed him as the U.S. Science Envoy. He has authored or co-authored 12 books, written more than 300 peer-reviewed journal publications, testified more than 40 times to U.S. state and federal congressional briefings, and has provided various governments with more than 50 technical reports.

Plenary Discussion: What is Energy Education for Sustainability?

Moderated by **Jennie Stephens**, Associate Professor, Blittersdorf Professor of Sustainability Science & Policy, University of Vermont

**Susan Meabh Kelly**, Teacher and Instructional Coach, Connecticut State Dept. of Education

**Debra Rowe**, Faculty, Sustainable Energies & Social Sciences, Oakland Community College, President, U.S. Partnership for Education for Sustainable Development

**Don Scott**, Director of Sustainability, National Biodiesel Board

**Monty Alger**, Director, Institute for Natural Gas Research, The Pennsylvania State University

Federal Agency Panel: What is the role of your agency in supporting energy education?

Moderated by **David Blockstein**, Ph.D., Executive Secretary, Council of Energy Research and Education Leaders, and Senior Scientist, National Council for Science and the Environment

**Natasha Campbell**, Jobs Strategy Council, U.S. Department of Energy (DOE)

**Frank Niepold**, Climate Education Coordinator, Climate Program Office, National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce, Climate Education Interagency Working Group, U.S. Global Change Research Program

**Jillian Worthen**, Bioenergy, Climate and the Environment, National Institute of Food and Agriculture, U.S. Department of Agriculture (USDA)

**Karen Scott**, Senior Environmental Education Specialist, Environmental Education Grants Program, Office of Public Engagement and Environment, U.S. Environmental Protection Agency (EPA)

Breakout Sessions

Thirteen breakout sessions were held the afternoon of the 2016 National Energy Education Summit. The goal of each session was to move toward a common vision of energy education in their topic area and to identify and share effective practices. They identified areas of consensus and divergence on the vision of their area and identified critical questions and needs to build, improve and expand Energy Education to serve the needs of diverse student learners. If funding is obtained for a multi-year project, the breakout participants and others will constitute a working group who will develop a living guidance document that will identify the vision for their domain and characterize “effective practices”.

## National Energy Education Summit Breakout Sessions

### SESSION 1: K-12 Energy Education – Classroom Practices

Chaired by **Mary Spruill**, Executive Director, Project NEED (National Energy Education Development) and **Sally Mitchell**, Einstein Fellow, Office of Science, US Dept of Energy

*Becoming an Energy Superhero*, **Patricia Harcourt**, MADE CLEAR Maryland Delaware Climate Change Education, Assessment and Research, University of Maryland Center for Environmental Science

*Energy 2020: Using Online Games to Educate on Climate Change and Energy*, **Tania Ouariachi Peralta**, M.A., Universidad de Granada, España, Fulbright Scholar at Center for Climate Change Communication

*Teaching Energy with a Global Approach: Interdisciplinary Learning in a Middle School Classroom*, **Liza Esser**, Teacher, Capitol Hill Day School, Washington, DC

*Strategies for Integrating Renewable Energy Technologies into Life Science Instruction*, **Dana B. Haine**, K-12 Energy Science Education Manager, University of North Carolina-Chapel Hill Institute for the Environment

*Why We Need to Change the Way We Teach the Conservation of Energy Law*, **Patricia Higby**, Energy Education and Outreach Coordinator, University of Northern Iowa

*Being Green: Making What You Need with Plants*, **Jay W. Staker**, Iowa 4-H Stakeholders and Partnerships Manager, Iowa State University

*Creating University Partnerships in Providing Effective Teacher Professional Development in Energy Education*, **Matthew Johnson**, Ph.D., Assistant Director, Penn State Center for Science and the Schools

This session was altered in delivery based on feedback from the 2015 summit. The 2016 summit lacked K-12 teacher presence (largely due to date of event and cost) but the format allowed for more sharing of information and best practices and less discussion time for such a small group (14).

The presentations selected for this session were selected because of the immediate ability to use them in the K-12 classroom and their connection to research, energy, in school and out of school programming and the connection to state standards. The participants in this session were all presenters in the session with the exception of one attendee from the Florida Solar Energy Center and organizers Mary Spruill and Sally Mitchell of National Energy Education Development Project and of the Department of Energy respectively.

After presentations, each presenter shared a hands-on activity that could be used in the classroom immediately. This option would be key to the summit should the date and cost ever make it possible and attractive for K-12 teachers to attend.

The final 30 minutes of the session were used for discussion about the challenges and opportunities to further energy education in the K-12 classroom. Among those discussed:

- Teacher preparation and the way we certify K-12 educators. More integration between subjects. Not just becoming a science teacher and not grasping the math or vice versa. This integration would dramatically change how K-12 STEM and energy is taught;
- Training is needed in content, but also how to teach at many levels, especially early elementary where many teachers are generalists;
- Teacher time and teacher prep – show integration into the curriculum, not an add on;
- Teach with examples, experiential learning;
- Don't just teach an "item" i.e. water cycle, teach it in context and make it local and real;
- Help teachers make connections – in a system;
- It is important to make the content local and connected for the student (and teacher);
- Math and science should not be in silos, but cross walked;
- Matter and Energy are usually taught separately in the standards – this leads to misconceptions and missed opportunities;
- Mentors are necessary to change the current practices and styles;
- Don't miss the broader impact – partnering projects with ongoing higher education research, context and outcomes;
- Evolve the content delivery – active research, field trips, gamification;
- Systemic change in teacher prep is needed;
- Professional development for educators is HARD, and changing how that is done is hard. Changing how ideas are incorporated into the schema;
- Always do outreach, keep pushing it out, capture teachers interest and bring them in;
- Expect a lot out of K-12 teachers; outreach – tell the story; whole community teaching the kids about energy; and
- Value teachers a LOT more.

These items have been raised elsewhere in the national discussion about STEM, energy and education in general but action is needed.



## **SESSION 2: K-12 Energy Education – Professional Development and Research**

Chaired by **Susan Meabh Kelly**, New England Director of the National Earth Science Teachers Association and **Margaret A. Holzer**, Ph.D., National Earth Science Teachers Association

*Rethinking K-12 Renewable Energy Education*, **Timo Lukkarinen**, CEO, Horizon Educational

*Duke Energy Academy at Purdue: Inspiring Future Leaders in Energy Sciences and Engineering*, **Pankaj Sharma**, Ph.D., M.B.A., Associate Professor and Managing Director, Energy Center, Discovery Park, Purdue University

*Energy Literacy Effect on Attitudes of Teachers and Students in K-12 Classrooms-Cognitive Fix or Inadequate Norms?*, **Nirav S. Patel**, Doctoral Candidate, Cornell University

*High Impact of STEM through K-12 Energy Education*, **Amelia Gulling**, GreenPower K-12 Education and Outreach Administrator, Desert Research Institute

*Focus on Energy: Preparing Elementary Teachers to Meet the NGSS Challenge*, **Sara Lacy**, Ph.D., Senior Scientist, TERC

*Energy Hogs: the Super Villains Students Love to Defeat*, **Jennifer Alldredge**, Program Manager, Alliance to Save Energy

*Infusing Energy Topics into the K-12 Curriculum*, **Margaret A. Holzer**, Ph.D., National Earth Science Teachers Association and **Susan M. Kelly**, New England Director of the National Earth Science Teachers Association

The session included presentations on a variety of current energy-related projects designed to engage K-12 students in energy education. Although the foci of the presentations and the funding sources for the projects varied, they all presented opportunities and challenges in developing K-12 energy and sustainability education resources. Below are a number of take-home messages.

### **Coordination of Efforts:**

- Many states have utility-funded energy and sustainability education initiatives in place. Efforts to identify and coordinate these efforts through a national network would support efficient use of limited funds and time;
- Efforts to provide a common platform for K-12 energy and sustainability education resources (such as CLEAN) should be leveraged, and coordinated with other initiatives (such as forthcoming peer-reviewed NGSS [Next Generation Science Standards] - coherent activities published on the Achieve site);
- Continued engagement of all stakeholders is critical. This includes soliciting education research community, corporations, utilities, and science teacher organizations (such as

National Earth Science Teachers Association [NESTA], National Science Teachers Association [NSTA], and American Association of Physics Teachers [AAPT]).

### **Sustainability of Programs:**

- Funders increasingly expect expansion of reach of project outcomes, however schools are limited in their ability to purchase supplies to replicate these projects given the budgetary constraints found in most districts. This reality should be recognized and addressed in future solicitations;
- Creative methods to ensure the sustainability of quality programs should be employed, such as training teacher-leaders to turnkey the resources, or identifying low cost project materials to replace current project materials.

### **Identification of Research-Informed Practices:**

- A venue to share research on efficient and effective energy and sustainability programs should be developed and maintained;
- Coordination with associations already involved in K-12 science education will ensure the K-12 science teacher audience is included.

### **Challenges to Supporting Robust Education Research:**

- If classrooms are to serve as controls in research design, the school must benefit through some other means, such as a stipend for classroom resources. Grant proposals and funding should support classroom educators; for otherwise it is difficult to establish robust research design;
- Solicitations for funding should require an articulated plan as to how the energy education research will be translated to improve national K-12 energy and sustainability education practice.

### **SESSION 3: Introductory Energy Education – Energy 101 and General Education**

Chaired by **Dan Kammen**, Ph.D., Director of Renewable and Appropriate Energy Laboratory, Class of '35 Distinguished Chair in Energy at the University of California, Berkeley

*Department of Energy's Role in Energy Literacy*, **Alexis T. Wolfe**, ORISE Fellow, Bioenergy Technologies Office, US Department of Energy

*Energy and Sustainability: An Introductory Level Undergraduate Course at the Intersection of Science and Society*, **Bhawani Venkataraman**, Ph.D., Associate Professor of Chemistry, Eugene Lang College, The New School

*An Energy Course and Free Online Textbook for University Students*, **Jason M.K.C. Donev**, Ph.D., Professor, University of Calgary

*Game Design for Energy Literacy*, **Peter McDonough**, Adjunct Professor, University of Montana

*Health, Sustainability, and the Oil Patch*, **Tee L. Guidotti**, M.D., M.P.H., DABT, Fellow of the Energy Institute (London)

Teaching energy is harder than other topics– there are so many topics, so how do you stay abreast and communicate the material? Energy literacy is *hard*; many elements, many fields, constantly and rapidly changing. How to represent and be inclusive of the disciplines? There is a tradeoff between presenting basic physical principles of energy versus being interdisciplinary.

Not a 'boutique topic,' Department of Energy's Energy 101 website now provides resources and standards.

- Can't cover it all!
- Being effective with your time is key. Students: 20% retention from a lecture. When shifted to energy literacy: multilayered, complex, and boring.
- Need to overcome pre-conceived notions and misconceptions of energy issues.

Energy is inherently interdisciplinary.

- Energy issues cannot be understood by taking only a natural science approach.
- Need to go beyond the physics definition.;
- Students struggle with stock vs. flow, Resource versus Reserve, Carbon free versus Carbon capture;
- It is hard for some students to "Do the math;"
- Topics in 'energy literacy' need to be based on fundamental concepts drawn from but integrated across disciplines.

The preconceptions about energy are many - running from views that only fossil fuels can affordably power modern economies, to market and institutional barriers to change the are often widely held, but have no basis is what we could do.

View energy through the lens of impacts and consequences. Open and explore questions.

Debate real world issues (examples include fracking, role of nuclear, illustrating growth of coal):

- Energy – climate linkage important to discuss and connect. Climate change – the ultimate externality. How can costs be internalized?
- The energy-sustainability nexus can help students to understand the scientific principles. What does it take to transition from one fuel mix to another?
- Many of the world’s public health advances resulted from energy challenges;
- *Energiewende* (German for energy transition) is the transition by Germany to a low carbon, environmentally sound, reliable, and affordable energy supply;
- What is the “oil endgame?”
- Oil is efficient, portable, fungible, etc.;
- Unconventional energy resources – large;
- Is shale a transitional fuel? We are seeing the rise of renewables at a time of low fossil-fuel prices;
- Carbon vs. hydrocarbon accounting – additional metrics to consider;
- What will happen in terms of the energy supply?
- How to break loose from oil and gas?
- How to switch gears in transportation?
- Pump gasoline ... pump biofuels ...?
- Can oil and gas be repurposed? Coal does not have that convertibility.
- Are we moving on from gas as a ‘transition’ to ‘long term solutions,’ for instance, algae diesel?
- Where do social sciences and technological challenges meet?

It is not abundantly clear that the science of climate change is aligned with society’s need to change, but the historical records of major economic transformations indicate that true change can take decades (e.g. smoking, managing the ozone hole), but time is something we do not have.

Decisions on energy are nuanced, so how to make decisions on incomplete information?

- Energy Return on Investment (EROI) - shows the ‘sticky’ nature of fossil fuels, but at the same time EROI is only one metric of energy benefits and costs.
- How is population addressed?
  - Impact = Population x Affluence x Technology (Paul Ehrlich).
  - The consequences of eugenics.
  - Gender, education ... and its role and impact.

Students should leave the class with a stronger grasp of the challenges of the energy crisis.

Link energy literacy principles to energy science and management.

Offer energy in liberal arts education.

Policy engagement: how to bring more policy analysts and policy makers to the conversation.

In business schools, there is excitement over disruptive energy technologies.

Push energy education down all the way to elementary schools

Make ‘dry’ topics engaging (e.g. utility structure – “shrouded by a force field of boringness”).

- Rapid learning;
- Feedback and iteration;
- Self-challenging;
- Cooperation and competition (diversity builds trust).

Pedagogy: Game based learning. Games provide a point of access: Montessori

- Ownership of the issue (not just studying);
- Who will have the most fun/biggest challenge?
- What are the opportunities to make interesting choices?
- Where can uncertainty and randomness be introduced to keep everyone interested and to reflect real life?

Balance and play test. Balance realism and abstraction. (Michael Cohen, UC Berkeley)

Use problem sets.

Data visualization tools – these are vital – and hard to maintain in the energy field as things are changing dramatically.

Graphic design and energy information.

GIS – Spatially representing the connections of energy resources and Native American/First Peoples lands.

#### Resources for Educators:

- Literacy Principles supported by fundamental concepts: [www.energy.gov/energyliteracy](http://www.energy.gov/energyliteracy)
- “Energy and Society” course at UC Berkeley
- Univ. of Calgary – free online Energy textbook in Encyclopedia-style [www.energyeducation.ca](http://www.energyeducation.ca)
- <http://www.psehealthyenergy.org/ABOUT/Mission>
- Energy and Technology Policy Energy 101 – MOOC (Michael Webber, University of Texas, Austin) <https://www.mooc-list.com/course/ut101x-energy-101-edx>
- Energy, the Environment, and Our Future – MOOC – (Richard Alley, Pennsylvania State University) <https://www.class-central.com/mooc/679/coursera-energy-the-environment-and-our-future>
- The Higher Education Solutions Network (HESN) is a partnership between USAID and seven top universities, designed to channel the ingenuity of university students, researchers, and faculty towards global development: <https://www.usaid.gov/hesn>

- Physics of Sustainable Energy – back of the envelope methods
- <https://www.aps.org/units/fps/newsletters/201310/energy.cfm>
- Gapminder.org - Outdated data!
- International Energy Agency (IEA) & Energy Information Agency (EIA)
- Dallas – Calgary Oil World Nexus
- Michael Cohen’s Energy Game “Griddle”: <http://citris-uc.org/social-apps-lab/project/griddle/>
- The Great Energy Challenge:  
<http://environment.nationalgeographic.com/environment/energy/great-energy-challenge/about/> (National Geographic / Shell)
- Energy Education: Easy, Difficult, or Both? *David E. Blockstein, National Council on Science and the Environment (NCSE), Catherine H. Middlecamp, Univ. of Wisconsin-Madison and John H. Perkins, The Evergreen State College*  
[http://www.jsedimensions.org/wordpress/content/energy-education-easy-difficult-or-both\\_2015\\_01/](http://www.jsedimensions.org/wordpress/content/energy-education-easy-difficult-or-both_2015_01/)
- Hall, C.A.S., D. Lindenberger, R. Kümmel, T. Kroeger, and W. Eichhorn. The Need to Reintegrate the Natural Sciences with Economics  
<http://www.esf.edu/efb/hall/documents/The%20Need%20to%20Reintegrate.pdf>
- Guidotti TL. Energy. Chapter 10, in: Health and Sustainability: An Introduction. Oxford University Press, 2015, pp. 327 – 366
- Climate Adaptation and Mitigation E-Learning [www.CAMELclimatechange.org](http://www.CAMELclimatechange.org)

## **SESSION 4: Pedagogy and Assessment of Student Learning**

Chaired by **David Gosselin**, Ph.D., Director of Environmental Studies, University of Nebraska-Lincoln and **Jan DeWaters**, Ph.D., Assistant Professor, Walter H. Coulter School of Engineering, Clarkson University

*Beyond Geopolitics: A Pedagogy for International Energy Policy*, **Sharlissa Moore**, Ph.D., Michigan State University

*Renewable Energy: An Undergraduate Course*, **Alan McGowan**, Ph.D., Lecturer, The New School

*Energy and Climate: Imperative Concepts for Tomorrow's Engineers*, **Susan Powers**, Ph.D., Director, Institute for a Sustainable Environment, Clarkson University

*Energy Analysis, Policy, and Security: A Multidisciplinary Energy Elective Course at the US Naval Academy*, **Patrick Caton**, Ph.D., P.E., Associate Professor, US Naval Academy

*Introductory Energy Education Framework with Topic-Based Modular Course Design*, **Zhenglun Li**, Ph.D., Bioenergy Instructor, Advanced Hardwoods Biofuels Bioenergy Education Project, Oregon State University

*A Cloud Enabled Virtual Reality Based Pedagogical Ecosystem for Solar Energy Education*, **Pramod Abichandani**, Ph.D., Assistant Clinical Professor, Drexel University

**“State of the Art” – Best (or Common?) Practices:** Instructional practice should be adapted to the particular instructor/student situation, and incorporate adaptive management, but in general the following teaching practices were identified:

- Experiential/student centered learning -
  - Student involvement;
  - Peer-to-peer education.
- Make it relevant, keep content current, use case studies -
  - Community based instruction;
  - Application-driven curriculum;
  - Data-driven approaches;
  - Use methods that impact affect and behavior.
- Opportunities to develop critical and systems thinking skills.
- Interdisciplinary learning/learners -
  - Include both technical and social/economic/political aspects related to energy;
  - Cross-disciplinary teaching (interdisciplinary teams) that includes both DEPTH and BREADTH.
- Rigorous pre/post assessment that is aligned with desired outcomes.

**Common Vision:** “To have a variety of approaches to systems awareness, emphasizing the centrality of energy, the importance of values in decision making and the implications thereof.”

- Teach energy in the context of concepts – a comprehensive/pluralistic/unified approach instead of a set of disparate topics;
- Maintain a SYSTEMS approach;
- Include technical aspects as well as non-technical - energy security, social justice, philosophies, economics, energy markets, etc.;
- Develop assessment tools that align with desired outcomes;
- Stimulate lifelong learning.

### **Critical Questions/Needs**

- How do we adequately prepare faculty to engage in this process? (See “Key Issues”)
- How do we track progress toward multi-disciplinary teaching and learning?
- Instructional practice must be carried out effectively – e.g.:
  - Effective peer-to-peer learning;
  - Data-driven approaches need adequate and accessible portals to relevant, current data sets.
- Social justice and policy must be included:
  - Instruction must include broad spectrum of philosophies, politics, etc., and remain neutral in presentation to engage students to self-identify their position on the spectrum;
  - Learning situation must remain open to broad range of ideals;
  - Talk about energy justice from an analytical (and unbiased) standpoint.

### **Key Issues (for Policy Makers and Industry Partners at any level)**

- All policymakers / industry partners should take ‘Energy 101’ → educate employees.
- Create a coordinated energy education consortium across federal agencies:
  - Establish clear goals/outcomes to help clarify assessment strategy (coordinated consortium to do this?);
  - Funded support for curriculum development;
  - Available funding opportunities (e.g. DOE) need to incorporate human and social aspects in energy education R&D;
  - Establish an interdisciplinary energy education leadership program to facilitate faculty training – perhaps include a prestigious fellowship opportunity to attend? Could be in the form of a summer institute;
  - Web page developed on ENERGY (analogous to what exists for sustainability science).
- Secure buy-in from key university administrators:
  - Include interdisciplinary energy education WITHIN disciplinary education (as part of general education requirements? And/or as part of core curricula?)



## **SESSION 5: Defining Sustainability in an Energy Context**

Chaired by **John Perkins**, Ph.D., Member of the Faculty Emeritus, The Evergreen State College and **Tom Richard**, Ph.D., Director of Penn State Institutes for Energy and the Environment, Pennsylvania State University

*Life Cycle Sustainability Assessment for Balancing Impacts of Energy*, **Barry Benedict**, Ph.D., Professor of Mechanical Engineering, University of Texas at El Paso

*Assessing Tradeoffs: Issues at the Nexus of Energy, Water and the Environment*, **Kelly Sanders**, Ph.D., Assistant Professor, Sonny Astani Department of Civil and Environmental Engineering, University of Southern California

*Understanding the Energy-Food Nexus*, **Ali Shahrukh Pracha**, Graduate Institute of Development Studies, Lahore School of Economics, Pakistan

*Promoting and Assessing Students' Understanding of Sustainable Energy Policymaking: A Unique Framework*, **Jennifer Sklarew**, Ph.D., Senior Fellow for Energy Policy, Center for Energy Science and Policy, George Mason University

*How Does Energy Education Fit in with Sustainability?*, **Don Scott**, Director of Sustainability, National Biodiesel Board

To become a meaningful, operational, and actionable term, sustainability must address specifics. Sustainability of what? For whom? Over what space and time periods? Paid for by whom? Decided by whom? How do resources, knowledge, and political-economic power affect decisions? Huge equity issues, both between countries and within countries, strongly affect outcomes. Gender may play a fundamental role in assessments of sustainability. Ethical dimensions strongly affect the sustainability of energy systems.

Sustainability has close ties to “energy nexus” issues: energy, for example, ties tightly to supplies and uses of water and to quality and quantity of food production, transport, processing, and preservation. Analyses of energy systems must address the many dimensions of this nexus to produce information that can be interpreted and used by citizens and policy makers.

Agreement about the sustainability of an “energy system” depends crucially on adoption of clear and meaningful system boundaries and on agreement about both spatial and temporal scales. “Solutions” for one region may be different from or cause problems in other regions. Different regions may also operate on different timescales. Europe and North America developed early (and with “dirty” energy). Asia, South America and Africa are now embracing much higher uses of energy, much of it “dirty,” and at different rates. Sustainable energy transitions must recognize different starting points and time scales. Important metrics will also vary as a result.

### *Dimensions of and Metrics for Sustainable Energy*

Energy discussions often focus on supplies and/or demands for energy itself. However, a focus on energy services can hold more significance, by enabling achievement of meaningful goals,

such as education, nutrition, health, clean water, and economic development. Analyses must compare different means of achieving those services, including primary energy sources, energy conversion technologies, and energy efficiency measures. Is it possible to recognize the range between minimum sufficiency and excess energy use? Energy “gluttony” creates problematic spillovers.

Useful metrics include:

- Resources (primary energy sources, ancillary materials, e.g. soil and rare elements);
- Energy Return on Investment (EROI);
- Life Cycle Analysis (LCA) of system to provide energy services, focused on various variables of interest;
- Proportion of energy services provided by renewable energy sources;
- Change over time in efficiency in providing specific energy services;
- Population size and growth rate;
- Water (blue, gray, green);
- Cost and affordability, but note that Price is not always a good indicator of the energy going into a process. Dollars are distorted by many variables e.g., markets, public policies, time, changing tastes, and living standards;
- Infrastructure, microgrids, transportation networks;
- Greenhouse gas emissions;
- Environmental Impact Assessment (Environmental Impact Statement [EIS] from National Environmental Policy Act [NEPA]);
- Impacts of energy use on human health, ecosystem services, and biodiversity;
- Decommissioning and other end-of-life costs and requirements;
- Demand elasticity, consumer behavior;
- Energy security, access, availability;
- Energy required to provide specified level of development measured by Human Development Index (included education, life expectancy, gross domestic product [GDP]);
- Child labor and other forms of human exploitation;
- Degree of flexibility and adaptability for the future, minimizing path dependence;
- System resilience to acute and chronic stresses.

#### *Implementation Strategies:*

Sustainable energy is an adaptive management opportunity. Multiple metrics inform decision-making for incremental changes that anticipate further adaptations and modifications. The pace of change (including technology development) is accelerating, and analytical tools must match and accommodate the dynamics of this rapid change.

Sustainability targets and indicators need policies to guide development, with adequate technological absorption capacity, along multiple pathways to reach diverse goals. Basic energy literacy about technology, finance, and policy must be widespread among communities to enable informed citizen participation and democratic governance. Engineers and other technical people must also understand issues of sustainability.

Social and environmental dimensions of sustainability cannot be achieved entirely in market systems, and need policy interventions and effective governance to reach important goals. Citizens, energy experts, and policymakers must recognize intrinsic uncertainties about energy options and sustainability metrics, but avoid paralysis in decision-making. Multi-criteria policy tools and processes, like NEPA and Environmental Impact Statements, can contribute to development of sustainable energy systems at multiple scales.

Energy transitions, particularly a decrease in use of fossil fuels, will dislocate people and government revenues, so new forms of industrial and workforce development mechanisms are needed. Failure to absorb and manage dislocations may limit change, although education can assist in avoiding stalemates. Innovation will remain important for development of technology, financial instruments, policy frameworks, knowledge sharing, and cultural adaptations.

## **SESSION 6: Connections between Energy Education and Energy, Practices on Campus and in Local Communities**

Chaired by **Scott Sklar**, President, Stella Group and Adjunct Faculty at George Washington University and **Jeff Ramsdell**, Ph.D., Professor and Director at Appalachian Energy Center, Appalachian State University

*Energy Literacy Campaign*, **Michele Putko**, Ph.D., Climate Change Institute, University of Massachusetts Lowell

*Failing Well to Build Resilience in Energy Education*, **Ian Carbone**, Ph.D., Assistant Professor of Environmental Science, Allegheny College

*Project-based Learning as a Catalyst for Energy Education at Duke University*, **Steve A. Hicks**, Ed.D., Associate Director for Energy Education: Duke University Energy Initiative, Duke University

*Campus as Energy Efficiency Laboratory in an Interdisciplinary Undergraduate Energy Curriculum*, **Joel N. Swisher**, Ph.D., P.E., Director, Institute for Energy Studies, Western Washington University

*Enhancing Approaches on Interdisciplinary Learning on Sustainable Energy*, **Scott Sklar**, President, Stella Group and Adjunct Faculty at George Washington University

### **Integration of campus infrastructure into courses:**

- Off campus housing for upperclassmen as potential projects with many benefits;
- Student dorm energy use reductions:
  - Individual thermostats;
  - How does students' awareness of energy use and cost compare between on campus and off campus housing.
- All of these have the potential to attract and save money.

### **Integration of community into courses:**

- Real world projects with community: health, energy, water, modeling and real world data sets;
- Using real world models can be a barrier for some students;
- Developing different models for different student levels is important.

### **Interdisciplinary programs:**

- Multiple student groups and students from all disciplines can get involved with campus energy issues;
  - Using interdisciplinary as an advantage for recruiting students;
- How do we actually achieve this?
- A big hurdle is giving credit to students and educators in these programs.

**Developing productive relationships with facilities and sustainability coordinators to develop and execute successful projects is critical:**

- Sustainability coordinator reporting to academic business affairs is an advantage in terms of making inroads to physical plant operations;
- Facilities staff sometime do not want to interact with faculty, but strategies such as facilities employees taking courses can begin to break down these barriers;
- Having sustainability coordinators develop good relationships with physical plant is critical;
- On campus energy competitions for students are also an avenue to start the conversation.

**Collaboration between institutions:**

- Energy programs at Appalachian State have seen impressive buy in from the whole NC system. Schools are open to working together on these issues.

**Governance hierarchy at specific institutions can determine communication dynamics between facilities and faculty:**

- Can we distinguish among sustainability, interdisciplinary, diversity, and globalization?
  - Perhaps all of these are prerequisites for one another.
- How do we take specific strengths of a college and ties those in with energy issues?
  - Western Washington University and the Peace Corps;
  - Duke ENGAGE has had some success in tying energy development in with Duke energy education;
  - Key might be experiential learning or project-based learning to merge goals:
    - Health, energy, water, etc.
- Centers and institutes at Duke integrate interdisciplinary work across campus;
- Western Washington University's Energy Institute can give degrees unlike Duke's institute which supports interdisciplinary work;
- Accreditation and certifications can limit interdisciplinary opportunities;
- Sometimes there are opportunities for providing elective courses for other degree programs.

**We come back to the question of rewarding and valuing these types of opportunities that do not fit into traditional disciplines/departments:**

- Not only just for course credit but also as experience for finding work;
- Along these lines, how do faculty get credit?
- Letters for promotion from institutes and interdisciplinary programs;
- It has to look better to teach interdisciplinary courses if we actually want the system to shift towards an institute model;
- How do we rework course designations and major requirements to make more room in upper division requirements for interdisciplinary work?
- Cross-listing can be a useful tool;
- Campuses want interdisciplinary courses, but universities are supporting creating and teaching courses when only allow you teach in one time;
- Giving co-taught courses instructors' flexibility in how they distribute teaching credit for the course;

- Schools do not reward independent studies either;
- Figuring out these things can also be frustrating for students.

**Changing values in society are changing the roles of higher education institutions (Job prep vs. critical thinking skills):**

- Transitional degree programs might be an opportunity to reach a wider audience;
- Military service members are unprepared when it comes job experience by the time come back. Military is interested in retraining service members and ex-coal employees for energy jobs;
- Many times for energy degrees you don't necessarily need a 4-year degree;
- Experiential education is more of an adult learning model. Service members might be good candidates for programs that emphasize this type of learning.

**Non-traditional teaching methods can be effective at getting students interested without needing to re-haul the organization of departments and institutions:**

- Project based learning;
- Experiential learning;
- Hands-on, field trips, current events, and other best practices to bring energy to life;
- A cultural change also needs to happen so that educators and administrators feel like this more involved teaching is worth the effort;
- Learner-centered teaching is generally not well rewarded;
- Finding a connection between this type of teaching and research can help tenure-track faculty make time to do learner-centered teaching;
- In many cases institutions need to better define their goals so that the reward structure encourages the type of teaching they want to encourage;
- A lot of employers want “hybrid” graduates who have knowledge, toolsets, and communication skills. How does higher ed catch up?
- Non-traditional teaching has given students experience to help them in this realm;
- There is a real shortage for “trade” engineers;
- How do we overcome the aversion to STEM fields in some US students?
- Multiple energy tracks would be worth considering;

**Final Remarks:**

- What is the best way to develop industry connections for creating access to real problems for students?
- Gateways can introduce students to energy literacy and also create job opportunities and professional connections;
- General education courses can provide that first exposure.

## **SESSION 7: Diversity Advancing Diversity in the Sustainable Energy Field**

Chaired by **Chuck Stone**, Ph.D., Professor of Physics, Colorado School of Mines

*Engaging Diverse Student Populations in Renewable Energy: Undergraduate Research and Building STEM Capacity*, **Chuck Stone**, Ph.D., Professor of Physics, Colorado School of Mines

*EnergyWhiz: Learning Through Real World Energy Challenges*, **Susan Schleith**, Director of K-12 Education Programs, Florida Solar Energy Center/ University of Central Florida

*Ten Years of Projects in Alternative Energy, Renewable Energy, and Energy Efficiency at SIPI 2007 – 2016*, **Nader Vadiie**, Ph.D., Faculty and Engineering & Engineering Technology Programs Coordinator, Southwestern Indian Polytechnic Institute (SIPI)

*Fieldwork in Energy Democracy: Designing Community Solar For Diverse Communities*, **Kathryn Milun**, Ph.D., Associate Professor, Sociology/Anthropology Department, University of Minnesota, Duluth

*Energy Democracy and Increasing Energy Workforce Diversity in the Renewable Energy Transition*, **Jennie C. Stephens**, Ph.D., Associate Professor, Blittersdorf Professor of Sustainability Science and Policy, University of Vermont

*Outcomes of Integrating a Project-based Learning STEM Research Project into a Summer Bridge*, **Adam Talamantes**, **Jay Well**, **Renee O’Neill** and **Katharine Field**, Oregon State University

This session revolved around the themes of goals, strategies for engagement and barriers to engagement, empowerment, and challenges.

### **Goals:**

- Recruit more people to the conversation about energy and the future of energy
- Increase innovation with diverse voices;
- Level the playing field to allow for more voices;
- Disrupt the traditional normative of learning about, interacting with, and using energy;
- Address the sociocultural and political transition from non-renewables to renewables in an equitable way;
- Address the tension between advocates for energy efficiency and alternative energies.

### **Strategies for Engagement:**

- Use projects that are relevant to participants, their families, their community, and cultures;
- Use project-based learning with energy-themed projects;
- Show participants how energy education can be useful to them;
- Pay attention to diversity;
- There is a fine line between entertaining kids, and doing inquiry and science;
- Disrupt normative ways of teaching and learning about energy;

- Use science and math to understand technology;
- Position statistics and numbers as political and in a social context;
- Addressing barriers for engagement:
  - Provide stipends and travel support;
  - Target specific populations.

**Empowerment:**

- Growth mindset;
- Create ownership;
- Meet students where they are;
- Utilize peer and faculty mentors.

**Challenges:**

- If diversity not attended to, could perpetuate inequality;
- Expand reach to families and students not attending programs;
- Assess who isn't participating and why;
- Why do some choose to participate and others do not?



**SESSION 8: Career Preparation, Workforce Development, Employer Needs and Student Opportunities**

Chaired by **Monty Alger**, Ph.D., Director of the Institute for Natural Gas Research, Penn State University and **Matthew Garcia**, Ph.D., Jobs Security Council, U.S. Department of Energy

*Why Business Cares*, **Ann Goodman**, Ph.D., City University of New York

*Calpine Corporation’s Career Preparation Programs*, **Yvonne McIntyre**, Vice President, Federal Legislative Affairs, Calpine Corporation

*A Workforce Pipeline for the Wind Energy Industry: An example from Virginia*, **Remy Pangle**, Associate Director, Center for Wind Energy, James Madison University

*Energy Education and Engagement Experiences – Connecting Students to Professionals and Preparing them for their Careers*, **Stacy Peterson**, M.Ed., Energy Education Program Coordinator, Duke University Energy Initiative

*Energy Education and Professional Practice*, **Stacy Fineran**, Ph.D., The Ohio State University

*Developing the Workforce Talent of the Future through STEM K-12 Teacher Professional Development*, **Ann Seifert**, K-12 STEM Manager, Idaho National Laboratory

*URI Energy Fellows Program: Energy Extension Workforce Development as a Catalyst for Energy Academics in Rhode Island*, **Kate Venturini**, Program Director, University of Rhode Island

*Figure 1 Summary of Discussion Section 8*

	<i><b>K-12</b></i>	<i><b>University</b></i>	<i><b>Professional Life</b></i>
<b>Working</b>	Wind for Schools STEM education	Professional development (Duke, URI)  More students for industry projects	Fellowships, apprenticeships, internships, client-based projects
<b>Not Working</b>	Education standards impacting implementation of STEM	Need for more students for industry projects	Connections with agencies  Don’t understand education outcomes, include in planning education programs  “Silver Tsunami” – retirement and lack of knowledge transfer across generations in the workplace  Companies should be more open – “Only want engineers” (job filters)

			unnecessarily limits recruiting opens
<b>Gaps + Needs</b>	Industry mentors and role models for students	Better communication of best practices (tools, data sets, teaching techniques)  Involve more majors (disengagement of students)	
<b>System Level Comments</b>	<ul style="list-style-type: none"> <li>• Need communication from K-12 to Workplace ... technology has enabled integrated education model, but gaps exist across K-12, university and workplace “verticals”</li> <li>• Need to engage more majors in system-level projects to create contemporary education experiences</li> </ul>		

The group concluded that there are a number of very good practices underway in each of the 3 vertical categories. However, the conclusion was that areas for improvement exist at the interfaces K12/University and University/Professional life. Each vertical has a series of best practices; the design across verticals is not coordinated and is where gaps / opportunities exist.

**Five summary points were captured:**

1. Great practices exist in all verticals. The team captured several practices from the presentations; they believe that a longer list could be developed from external practices.
2. There are gaps between the verticals K-12/university and university/professional life. This is where the major opportunities exist for new development.
3. The gaps identified between verticals are related to the basic design of education practices and are not specific to energy. However, energy is not a discipline. It is a highly integrated system problem, so gaps are much more visible in the energy domain.
4. Important to have system thinking – for energy development and also for designing an effective education practices spanning K-12 through to professional life.
5. The gaps are an area for future focus and development. There is opportunity for good progress. However, there is a functional role for K-12 and university in basic education. Knowledge development that should not be lost.

## **SESSION 9: Undergraduate Degree Programs, Minors and Concentrations**

Chaired by **Scott Williams**, Research and Education Coordinator, Wisconsin Energy Institute, University of Wisconsin, Madison

*A Systems Approach to Energy Education*, **Cutler J. Cleveland**, Ph.D., Professor, Boston University

*Engaging Adult Students: Penn State's Online Energy and Sustainability Policy Program*, **Brandi J. Robinson**, Lecturer, Penn State University

*Oregon State University's Undergraduate Minor in Bioenergy: Producing Graduates with the Skills to Advance the Bioeconomy*, **Katharine G. Field**, Ph.D., Director, Advanced Hardwoods, Biofuels Bioenergy Education Project, Oregon State University

*Traveling Workshops from National Association of Geoscience Teachers and Project InTeGRATE*, **David E. Blockstein**, Ph.D., Executive Secretary, Council of Energy Research and Education Leaders, and Senior Scientist, National Council for Science and the Environment

*University of Toledo Minor in Renewable Energy*, **Andy Jorgensen**, Ph.D., Associate Professor of Chemistry and Environmental Sciences, University of Toledo and **Sanjay Khare**, Ph.D., College of Engineering, University of Toledo

### **Observations and Principles:**

- There is increasing demand and supply of interdisciplinary energy education academic programs for undergraduates across the country;
- Rather than developing these programs in isolation, the energy education community, with support from NCSE/CEREL, can share resources and case studies with those who are either creating a new academic program or evaluating an existing program;
- Choices governing curriculum content, learning objectives, and whether to create a major vs. minor will largely depend on the structure, culture and practices of each institution. Choices include quantitative and scientific rigor, breadth vs. depth, skills vs. concepts, etc;
- Minors and certificate programs have been the preferred route for most new programs. Reasons include wider reach, fewer administrative hurdles, and the belief that energy literacy should permeate the more established disciplines (business, science, engineering, social sciences, humanities, etc.);
- Due to resource constraints, some academic programs may rely largely on existing courses for their curriculum, which will have varying levels of energy-related content;

- Learning objectives will vary from program to program. The current process for evaluating learning objectives at institutions is not consistent over the lifespan of each program;
- Because this is an emerging field, it is often difficult to know what careers will emerge and how to convey that to students in these academic programs;
- External advisory committees provide valuable guidance for these programs in understanding what skills and concepts are useful for future workers;
- Hands-on learning experiences (capstone, internship, practicums, and research) are an important facet of many programs in order to connect concepts to practice. They also offer an opportunity to assess students' achievement of learning objectives through written reports and/or presentations.

### **Recommendations:**

- NCSE/CEREL, with contributions from member institutions, should create a guidance document to help institutions that are creating new energy programs or assessing existing programs. The guidance document would compile information such as:
  - Case studies with examples of curriculum, learning objectives, and the processes for creating and assessing programs;
  - A list of publications of relevant educational research studies;
  - A list of industry professionals willing to serve on external advisory boards
- NCSE's Center for Environmental Education Research (CEER) should update its census of non-traditional and broad energy education programs every four years (last conducted in 2012), and should include content analysis of various programs. The online version should have links to program websites.
- The Department of Energy should create a document that would be useful to academic career centers on how to advise students regarding emerging energy careers.
- Each academic program should create a systematic way to track and survey alumni so that the long-term impacts of the program can be evaluated.

## **SESSION 10: Courses and Programs at Two Year (Community) Colleges**

Chaired by **Debra Rowe**, Ph.D., Faculty, Sustainable Energies & Social Sciences, Oakland Community College, President, U.S. Partnership for Education for Sustainable Development

*Community Colleges and Energy Education: Connecting Energy Industry's Current and Evolving Needs to the Secondary and Post-Secondary Pipeline*, **Linda H. Baxley**, Director, Advanced Technology Environmental and Energy Center, Eastern Iowa Community Colleges

*Energy Education at Community Colleges: Issues, Solutions, and Resources for You!*, **Debra Rowe**, Ph.D., Faculty, Sustainable Energies & Social Sciences, Oakland Community College, President, U.S. Partnership for Education for Sustainable Development

*Preparing the Energy Professionals of Tomorrow: the Center for Renewable Energy Advanced Technological Education (CREATE)*, **Ken Walz**, Ph.D., Center for Renewable Energy Advanced Technological Education, Madison Area Technical College

*Integrating Across Disciplines to Meet Needs in Indian Country: Renewable Energy Curriculum Development at a National Tribal College*, **William Schaedla**, Ph.D., Environmental Science Program Coordinator and Faculty Member, Southwestern Indian Polytechnic Institute (SIPI)

*Design and Assessment of an Associate Degree-level Plant Operations Technical Education Program*, **Jason Selwitz**, Instructor and Advisor, Plant Operations, Walla Walla Community College

### Recommendations:

1. To improve completion numbers that will enhance student and institutional success and to meet the employer needs for employees, educators need to share and promote flexible and customizable degree and certificate designs as specific initiatives. Such flexibility makes it easier to spread energy education across multiple fields (e.g. engineering, behavioral economics, heating and cooling, business, construction) and multiple programs (high school, 2 yr., 4 yr., post-degree).
2. Most energy jobs don't require a 4 year degree. Linda Baxley at Advanced Technology Environmental and Energy Center (ATEEC) provided a video -"Success in the New Economy" - <https://www.youtube.com/watch?v=zs6nQpVI164> with a link to the transcript with extensive footnotes - <http://www.citruscollege.edu/academics/cte/Documents/Success-in-the-New-Economy.pdf>.
3. Federal agency grant funding should provide more support for community colleges to develop and sustain energy courses, certificates and programs, and energy materials integrated into other academic courses because that is where workforce demands can be met.

4. Survey community colleges and NGOs (build on what ATEEC and IRECUSA [Interstate Renewable Energy Council] already have) about what sustainable energy related courses/certificates/program exist, what they offer, and, most importantly, what they need to grow and be more effective. This last item would be a unique and important contribution. Perhaps work with American Association of Community Colleges on this as a joint funded project to with CEREL and SEED.
  
5. Big Problem: Many faculty outside of energy teach about climate change and other environmental problems but they do not teach about energy solutions because they don't feel comfortable teaching about energy. It is outside of their area of expertise so they leave students without solutions, frustrated, disempowered and worried.  
 Solution: Provide professional development to faculty outside of the energy field in the basics of energy solutions to climate change, particularly the opportunity and need to scale up the use of renewable energies and energy efficiency (re/ee). Include in the professional development materials:
  - The potentials for meeting US and global energy needs with re/ee (see National Renewable Energy Lab study and International Renewable Energy Agency info and the Disciplinary Associations' Network for Sustainability (DANS) Call to Action for Energy Literacy materials);
  - The present day cost effectiveness and job creation data of solar, wind, energy efficiency and other renewable energies;
  - Career pathways information;
  - Impacts of policy at state and federal levels;
  - Civic engagement opportunities and skills so students can participate in democracy and apply their knowledge;
  - Basic technology descriptions. Too much energy education only includes technology descriptions and is therefore woefully incomplete.

Given the small percentage of students who take a course specifically on energy, energy literacy can only be accomplished by having it taught within a wide variety of disciplines. Include in this professional development real world projects for class assignments. The professional development could also be used for student life and residential life coordinators to enhance student life programming. Some of this could be in person but, to reach scale, most should be by webinar and vignettes, materials, and assignments that can be imported into the classroom and the campus. Materials should include videos that describe energy solutions for climate change presented by credible energy experts (e.g. National Renewable Energy Lab) so educators are comfortable including this information in the classroom. The outcome should be more knowledgeable and empowered students who understand and can participate in creating energy solutions.

5. Related to the above, NSF, EPA, DOE and other funding sources need to structure ongoing support for professional development in energy education across multiple disciplines and across K-12, community college and 4 year institutions.
6. Help faculty with energy education programs understand how to market their program (National Wildlife Federation did a webinar on this a few years ago but need is great now to keep and grow the number of energy programs ).
7. The same way hotels have Trivago and flights have Kayak, energy educators may need an overarching search engine that will help identify information across multiple sites. There are overlapping sources of energy education that can be confusing to educators and an overarching search engine could scan multiple sites (e.g. SEED, CEREL, ATEEC, createenergy.org, CLEAN, CAMEL, SERC). At the very least, these sites should all cross-list each other. Only some do now.
8. The energy education community needs a listserv for high school, 2 year colleges and 4 year colleges and universities. Having all these levels on one listserv would enhance: coordination of education pathways, sharing of curricula and career pathways information, mentoring, and real world project partnerships.
9. A lot of energy programs need to weather downturns in enrollment but still survive to serve the community and provide solutions, an educated workforce and education for the public. Poor and disadvantaged people don't have access to the internet at home but many have smart phones. The field of energy education needs a smartphone app that would have video of people with jobs in clean energy and energy efficiency fields to expose students and the public to these growing areas and educate them about career pathways. Such an app could also keep them informed about how energy is impacting them and what they can do about it.
10. Conduct an employer survey in clean energy fields (i.e. renewable energy and energy efficiency) to identify skills and knowledge desired for new employees (build on what ATEEC and the Solar Foundation is doing and work with industry associations and the SEED center at AACC).
11. Community colleges suffer from a status problem. Many think 2 year colleges have less status even though job training from community colleges often result in higher paying jobs than a wide number of majors in bachelor's degrees. Funding is needed to educate the public about the economic savings and the career pathway values of a community college certificates and degrees.

## **SESSION 11: Graduate and Professional Energy Education**

Chaired by **Seth Blumsack**, Ph.D., Associate Professor, Energy and Mineral Engineering, and Co-Director, Energy, Environmental and Resources Economics and Policy Institute, Penn State University

*Stakeholders, Ethics, Earthquakes & Energy Production – Graduate Energy Education*, **Meredith A. Wegener**, J.D., LL.M. Director Graduate Energy Education & Assistant Professor, Oklahoma City University, Meinders School of Business

*Energy Management Certificate at IUPUI*, **Ali Razban**, Assistant Director of IAC / Faculty of Mechanical Engineering, Indiana University - Purdue University, Indianapolis (IUPUI)

*Remote and Virtual Labs at GridSTAR Smart Grid Experience Center*, **Parhum Delgoshaei**, Ph.D., Penn State University, Research Associate, and **David R. Riley**, Ph.D., Associate Professor, Penn State University

*Evolution Footprint of Energy Systems Modeling: Implications for Energy Education*, **Nima Shahriari**, Fulbright Scholar, Energy Systems Modeling, Old Dominion University

*Building Cross-campus Coalitions to Support Graduate Programs in Energy Economics and Policy*, **Jerald Fletcher**, Ph.D., Professor and Director, US-China Energy Center, Natural Resource Analysis Center, West Virginia University

Below are several key points for consideration in the design and implementation of graduate and professional programs in energy:

- There could be much to be gained from cross-university collaboration in energy-focused graduate programs. While challenging, this would avoid the need for every institution to invest its strength in many different areas. This may be helpful in tight financial times. It also reduces the dependence of programs on specific faculty. Agencies like DOE could play a role in promoting cross-institutional collaboration through its various workforce initiatives.
- There is much interest in developing more graduate and professional energy programs (particularly professional Masters degrees) but gathering information on successful implementation and structure is difficult. Can CEREL help to support community development? Could a “syllabus” bank be set up? Other ways to facilitate curriculum/materials sharing include the MIT open courseware and the NTER learning system that Penn State uses.
- There is great value in bringing in perspectives from different disciplines but building those bridges is hard. In part this is because of natural disciplinary barriers (like language or skill sets) but is also because in many cases faculty and their department heads and deans don't have a strong stake in the success of such programs.



- Maintaining a sustainable program (one that is able to ride through the natural commodity cycles of the energy business) is a challenge. Breadth can mitigate some of the ups and downs, but a lack of focus and specialization makes it harder to sell the program to industry in particular, and to keep industry engaged during downturns.
- Setting up new programs, particularly to meet *anticipated changes in workforce needs* (versus responding to current needs) presents a chicken and egg conundrum. Universities are hesitant to bear the first cost of setting up new programs, particularly residential programs. Ongoing seed support from federal agencies (DOE, NSF) would be helpful but should be regular programs rather than intermittent ones.
- Graduate programs in energy can have a special relationship with their state or regional constituencies in locations going through painful economic transitions (e.g. the collapse of the coal economy in West Virginia and Wyoming). Faculty and students in these programs can provide leadership, training and information to state policy-makers. There was some discussion regarding the degree to which “energy” and “economic development” should be commingled in a graduate degree program.
- Besides typical measures of economic self-sufficiency, what does a successful graduate program with an energy focus look like:
  - Enthusiasm among students – do they fall in love with the energy world?
  - Stakeholders get something valued that they have not seen before;
  - Develops innovative thinkers who can generate creative solutions and can help stakeholders anticipate how the energy world is changing;
  - Industry is successfully brought to the table with regular interactions to ensure that students have needed skills (this may be most appropriate for professional programs, but not irrelevant for research-focused programs).

## **SESSION 12: Public Energy Education**

Chaired by **Andra Wilcox**, M.S., Research Scientist at the Houston Advanced Research Center and **Robert Wingfield**, Ph.D., Director of the Fisk Community Environmental Toxics Awareness and Sustainability Program, Fisk University

*Citizen Science: An Effective Tool for Conducting Bioenergy University Outreach*, **Jill Euken**, Deputy Director, Iowa State University Bioeconomy Institute

*Overcoming Offshore Wind NIMBYISM: Steps for Educating the Public to Contribute to Informed Siting Decisions*, **Drew F. Bush**, Doctoral Candidate, McGill University

*Informal Youth Energy Education in Summer Enrichment and After-School Programs*, **Robert C. Wingfield Jr.**, Ph.D., Associate Professor, Fisk University

*Virtual Oil & Gas Site: Stakeholder Engagement*, **Andra Wilcox**, M.S., Research Scientist, Energy Production, Houston Advanced Research Center

*Public Energy Education: A Theoretical Model and Review of Approaches*, **Beth Karlin**, Ph.D., Research Director, The Norman Lear Center, University of Southern California

**Vision:** Informed and targeted engagement that is tailored to specific stakeholders and encourages individual and collective action.

### **Challenges:**

- Existing pre-conceptions, cultural biases or traditions;
- Complexity of the issue and the science;
- Economic costs and issues and unintended consequences.

### **Recommendations:**

- Broaden focus beyond education to informal lifespan efforts outside of schools;
- Better updating and coordination of federal and state agency resource libraries along with lists from National Geographic Society, PBS, Florida Solar Energy Center, North Carolina Solar Center, and others;
- Updating and coordinating outreach efforts from the above organizations, national laboratories and state/federal agency outreach programs.

<b>Audience</b>	<b>Desired Action</b>	<b>Message</b>	<b>Mechanism of Delivery</b>
Adults needing energy literacy	Informal education	<ul style="list-style-type: none"> <li>• Emphasize behavior change;</li> <li>• Evaluating trade-offs.</li> </ul>	<ul style="list-style-type: none"> <li>• Simulations and virtual programs;</li> <li>• Work as citizens scientists.</li> </ul>
Adults making energy related decisions	Outreach (cities, churches, community groups, nonprofits, businesses, etc.)	<ul style="list-style-type: none"> <li>• Emphasize behavior change;</li> <li>• Evaluating trade-offs.</li> </ul>	<ul style="list-style-type: none"> <li>• Targeting early adopters using theories of social diffusion;</li> <li>• Simulations and virtual programs;</li> <li>• Work as citizen scientists;</li> <li>• State regulations and infrastructure budgets to promote behavioral changes.</li> </ul>
Youth	Outside school or during extracurricular activities	<ul style="list-style-type: none"> <li>• Integrating social and natural sciences;</li> <li>• Connect energy and STEM learning.</li> </ul>	<ul style="list-style-type: none"> <li>• Hands-on, inquiry-based learning using games, tools, and real data;</li> <li>• STEM learning or energy education;</li> <li>• Using informal venues such as museums and science centers.</li> </ul>

## **SESSION 13: Bioenergy Education**

Chaired by **Danica Hendrickson**, M.Ed., Northwest Advanced Renewables Alliance, Western Washington University

*Advanced Sustainable Biofuels Basics and Resources for Teachers and Students*, **Joanne Ivancic**, Executive Director, Advanced Biofuels USA

*Online Bioenergy Curriculum and Internships Programs in the Cenusa Bioenergy Project*, **Patrick T. Murphy**, Ph.D., Education Co-Project Director, Bioeconomy Institute, Iowa State University

*Enhancing Bioenergy Education Pipeline Through Development of K-12 Bioenergy Curricula*, **Jay Well**, Ph.D., Oregon State University

*Engaging and Educating Bioenergy Stakeholders through Field Tours, Outreach Events, and Extension Materials*, **Kevin W. Zobrist**, Ph.D., Associate Professor, Extension Forestry, Washington State University

*Online Bioenergy Education for Everyone: Bioenergy on YouTube*, **Katharine Field**, Ph.D., Director, Advanced Hardwoods Biofuels Bioenergy Education Project, Oregon State University

*Education at the Speed of Research – An Overview of the NARA Approach to BioEnergy Literacy*, **Danica Hendrickson**, M.Ed., Northwest Advanced Renewables Alliance, Western Washington University

Speakers in this session shared a diversity of approaches to bioenergy education at the K-12, undergraduate, graduate levels as well as public education and outreach. Five of the speakers have been working on education teams associated with USDA-National Institute of Food and Agriculture (NIFA), Agriculture and Food Research Initiative's (AFRI) biofuel projects.

Participants discussed our, 1) overall goals for and vision of bioenergy education, and 2) specific opportunities and challenges we see for advancing this field:

- 1) A clearly defined, coherent, and realistic vision and goal for bioenergy education with metrics for different levels of education are needed.
- 2) Opportunities and challenges related to advancing bioenergy education include:
  - a) Creating a Bioenergy Education Coalition;
    1. Leverage the existing resources produced by the USDA NIFA Coordinated Agricultural Projects (CAP) education teams to provide the foundation for this coalition.
  - b) Create a repository for bioenergy resources and connect lessons to professional development resources for teachers or other end users;

- c) Convene bioenergy educators;
  - 1. Hold a meeting with bioenergy educators working in the bioenergy ed field;
  - 2. Encouraging collaboration and sharing among the CAP education teams and other bioenergy educators would make efficient and effective use of time and funding with respect to advancing biofuel education. Perhaps a regular webinar or annual meeting could help foster this collaboration.
- d) Hold a bioenergy education conference with bioenergy nonprofits and industry experts around an already existing teachers' conference;
- e) Energy is a fast growing major and minor, how do we leverage that growth to raise awareness and understanding of bioenergy? How can we make bioenergy a more important topic within energy education?
- f) The grant culture can sometimes impact the long term success of bioenergy education: How do we sustain these programs especially the human capacity that is built after these grants? How can we ensure that we are thinking long-term when writing grants? Encouraging a culture that recognizes there is inherent value in the educational portion of a grant and that education is integral to the success of a bioenergy project could be helpful. Partnering with industry partners who seem to value education components is also helpful.

**References: Bioenergy: Biomass to Biofuels, edited by Anju Dahiya and published by Elsevier Inc./Academic Press (ISBN 978-0-12-407909-0; TP339.D34 2015) She and her panel of experts explore not only biomass for transportation fuels, also for heat/power generation. <http://advancedbiofuelsusa.info/elsevier-science-publishes-bioenergy-biomass-to-biofuels-by-anju-dahiya-editor/> and <http://store.elsevier.com/product.jsp?isbn=9780124079090&pagename=search>**

**Teacher resources page (<http://advancedbiofuelsusa.info/education/for-teachers/>)  
PowerPoint slide resources (<http://advancedbiofuelsusa.info/biofuels-basics/primer/>)**

## Responses about Energy Education from the Post-Summit Survey of Participants

*What are the biggest needs in energy education and workforce preparation?*

1. Vision and Theory: A common vision of the most effective approaches to energy education/literacy and a more cohesive, collective effort to foster energy literacy. Energy education lacks a theoretical framework or construct.
2. Interdisciplinary Systems Learning: Interdisciplinary learning that incorporates both the sociopolitical and technical aspects. Encouraging greater cross-sector fluency and understanding - make generalists before specialists. Energy education needs to include instruction on vetting at the systems level. There are many proposed solutions that are glitzy but not effective in reducing impact.
3. K-12 Education: Preparing an educated and informed K-12 student population that can make sound decisions about college studies. In K-12, do not make it "energy education" since there is no room for "extra studies". Energy Education curriculum that covers NGSS content and practices, so teachers don't need extra time to teach something additional to their already crowded schedules. Start in the younger grades with energy education; NGSS is a hook for this.
4. Professional Development: Professional development for teachers and faculty; money for hands-on energy education. VERY few faculty have degrees that were specifically focused on energy or renewable energy. PD is needed especially at undergraduate and community college institutions. Many people who are doing the energy education don't know nearly as much as they think they do, that needs to be addressed. Integrating energy concepts into traditional STEM classes is very hard for faculty who do not have much energy knowledge.
5. Public Education: Outreach and education programs for adults and the public. Expand public education to adults.
6. Workforce preparation: Apprenticeships and training opportunities. Job market analysis. What is cutting edge research, where will the field go, what employers are looking for? Awareness of the range of opportunities and the changing skills and knowledge needed to be competitive in the marketplace. Integration among government agencies and the educators in the field.
7. Funding: More funding. Programmatic funding, resources and training for instructors. Faculty hires to teach energy broadly.

*What educational and training approaches have shown success in attracting and retaining students and a workforce in clean energy fields?*

1. Courses: Classes geared to what students see as relevant. Inquiry and research-based courses and informal learning.
2. Hands-on learning: Hands-on learning; activity-based learning; experiential-learning (internships, etc), service learning, project-based learning, community-based learning, tours and visits to renewable energy sites. Instructional practices that nurture a growth mindset However, these are each challenging to implement, often times expensive to administer, and can be difficult to assess. Faculty need training in these areas to be able to teach using these methods. Use demonstrations and videos when hands-on approaches are unavailable.
3. Challenge Assumptions: Continuously challenge students to re-examine their assumptions, not just at the beginning or end, but throughout a course or program. Students respond well to being challenged and addressed individually. Use conversation-based approaches.
4. Context: Build context; without climate change literacy there is no energy literacy, Millennials want to make a difference but need to understand why they do something.
5. Jobs and money: And a way and place to advertise them and direct students to those websites.

*What methods should be used to attract and connect underserved communities and populations to energy education and workforce development opportunities?*

1. Diversity: Diversity among faculty; but also we need cultural change in the sector which currently undervalues diversity of perspectives.
2. Community-engagement: Including leaders and community-members from under-served populations in conversations about energy education and workforce development. This might require those of us in energy education to be more open minded about what qualifies as energy education.
3. Enrichment: Summer science enrichment experiences, internships to give students a career opening.
4. Financial Support for students: Scholarships or fellowship programs.
5. Financial Support for programs: Public and private funding for good K-12 programs. Funding and support for teachers and administrators trying to piece together these programs that don't fall easily into established sectors. Stable programs that are free to tailor methods to their students and communities naturally attract participants.

6. Two-year colleges: Students from traditionally under-represented groups overwhelming begin their educations at two-year colleges. If CEREL wants to tap into these groups, then those are the schools to engage with.
7. Professional Development: In-depth K-12 teacher training programs coupled with follow-up and student learning assessments.
8. Hands-on learning: Hands on activities and tours and visits to energy production sites. Demonstration projects. K-12 field trips to energy related businesses; start early familiarization with technology; experiential learning with energy problems (e.g. efficiency).
9. Contact with nature: Hands on and contact with nature. Also connecting sustainable actions, like gardening and conservation, to the values of their parents or grandparents. Generate concern, and foster a values based desire to contribute to bettering the world. This works on a portion of students. Others are hopelessly enshrouded in the materialistic cocoon.
10. Continuity: 1 + 1 + 2 + 2 program of study, Hands -on and community-based.
11. Professional society: Push for or create an official professional society that we could all be members of. Make the Summit a real multi-day conference. Push for making Energy Education as its own distinct field.
12. Outreach: Continue supporting successful formal and informal outreach programs at the K-12, college, and community levels.



## **The Energy Education Summit follow-up workshop at the Association for Environmental Studies and Sciences (AESS) Conference, June 8<sup>th</sup>, 2016**

### *Summary*

On Wednesday, June 8th, about 35 individuals discussed the previous day's 2nd National Energy Education Summit and further tried to flesh out the challenges and problems facing energy education in the United States. The workshop was led by David Blockstein and John Perkins. It consisted of a variety of individuals; about half of whom had attended the Summit and others who attended the AESS Conference.

Participants noted that energy education is an interdisciplinary field without a clear vision for moving forward shared by all energy educators. Instead, gaps exist in which there is little to no collaboration among major groups (public education, universities, and professional workforce). But a multi-perspective may be appropriate for this diverse topic. Energy educators need to understand each other more and collaborate to look at energy education as a whole.

There are many available paths for students seeking careers in energy, but there are not many pathways dedicated to energy education when it comes to undergraduate and graduate programs. Questions raised are “should energy education be practical/vocational or focus on critical thinking skills?” and “should students start to think of sustainability having more meaning in a positive sense?” (Is sustainability considered to be too much of a ‘buzzword’)?

Lastly, many speakers began to acknowledge the vast amount of technical expertise and education in the energy field, but a lack of social and economic viewpoints. It was suggested that students should be able to retain the basic technical knowledge so that they are not discredited for getting something such as the units wrong, but should also be taught in the liberal arts area of social and economic impacts of energy.

---

### *Introductory Remarks*

**David Blockstein:** Today we will mainly be covering two things, 1) For everybody to have an opportunity to talk about their interest in energy education and what they are doing in relation to energy education; and 2) Those of us who were at the summit yesterday, a mutual briefing on what happened during our Summit Breakout Sessions.

Our main goal is to build interdisciplinary communities of energy, environment, science and engineering and connect them to decision-making. “Energy Education: Easy, Difficult, or Both?”, by David E. Blockstein, Catherine H. Middlecamp, and John H. Perkins addresses the challenges facing students, faculty, and administrators in regards to energy education and literacy (Journal of Sustainability Education 2015). .

**John Perkins:** We (energy educators) are where the field of environmental studies was around the ‘80s, there is some budding material but nothing official yet – practical demands are driving the formation of academic fields and interdisciplinary fields.

## *Summit Takeaways*

**DH:** As a professor of biology, if its energy education I want to pursue where do I apply for a grant? Especially if it's not bioenergy, it seems like you have to finagle your way into whatever focus the federal organization is interested in.

**CS:** Dan Kammen said the written proposals do not fail on the technical aspects, but they need to bring more social and environmental responsibility in order to get approved.

**JP2:** I have no concerns on the technical aspect, but we need to find a way to transform people's thinking and political engagement.

**RS:** Another layer is that non-technical students need a fundamental understanding of energy, but are more interested in social science and humanities. They would benefit from this fundamental understanding, allows them to engage in the discussion in a more intelligent way (how do you measure energy? What's the difference between gas and coal?) need to be able to make this decisions ----- instead of being refuted for getting the units wrong.

**John Perkins:** As a suggestion for the future - invite private foundations to see there are real people interested in energy education and for "us" to see the sources. It has been hard to find people who want the energy education resources. Kind of like a speed dating session between funders and the people who practice energy education.

## *Reports from the Summit Breakout Sessions*

### Bioenergy Education

**Danica Hendrickson (DH):** We had seven people attend our presentations before one had to move. It was a challenge because we realized we needed a clear vision of bioenergy education.

Out of 6 of us, we were coming from USDA NIFA funded projects where the goal was develop regional bio-production systems (NARA) biofuel research projects – a significant amount of the budget goes to outreach and education (about a third) the USDA has contributed a significant amount to bioenergy education which is energy education, one of the main outcomes we realized is that we still need a clearly defined, realistic, goal with a metric that is measurable at different levels.

Joanne Ivancic was from Advanced Biofuels USA, a nonprofit, with another on the extension team that does more public outreach. The K-12 group had a little more divergence when it came to goals, in advancing bioenergy education, one of the things we talked about was how some good work was done in energy literacy (by Jan DeWaters) as it is not just content knowledge but attitude and behavior. One of these organizations did a Delphi study where they connected with experts to identify professional skills in careers related to bioenergy.

How do we place ourselves within the energy education field? (inside, outside, and how?) Most of us are in these bioenergy projects that are coming to an end, so what do we do with all of these great resources with limited grant funding nearing the end of its timeline? We should create a repository to collect all of the resources and continue to support each other and not keep creating

things that are already created. We wanted to impart the federal agencies and grantors and let them know that we are not just an afterthought.

**John Perkins:** Was there discussion how bioenergy educators deal with various forms of resistance in your session?

**DH:** Yeah! We did talk about it, part of it came back to what is our vision, an extension team member said their project came to conclusion they are not an advocacy group but an education group (USDA funded the research on growth of hybrid poplars but wants the public to be educated too).

**John Perkins:** Positioning yourselves as educators and not advocates does a lot in the realm of education.

**DH:** Our goal was about creating lessons for “is this a good idea or not?” Enough content knowledge to know the science and know the sustainability but have the skills to take multiple perspectives into account in a discussion. Frequently the discussion is still about ethanol although the science is much more advanced in that, so how do we move beyond that discussion?

#### Career Preparation, Workforce Development, Employer Needs, and Student Opportunities

**AG:** Our session was called Career Prep, just to underscore what John Peterson said – the overarching principle in what we learned is that we don’t play well in the sandbox – we need to understand each other more and collaborate. It is holding us back that we do not collaborate.

We looked at different verticals – the K-12, University, and Professional. We came up with five points in our session.

1. There are great practices at all levels, but there are gaps between them that nobody ends up talking to each other and realizing what they have in common.
2. Things stay in the way of people collaborating (i.e. professors don’t talk to professionals; there are few university and workforce collaborations).
3. The gaps we saw are related to the basic design of education practices and aren’t specific to energy. They exist in a parallel fashion in many different disciplines, but the gaps are more visible in energy because it is not a discipline.
4. It is important to have systems for energy thinking development, K-12 practices through professional life for development (systems point of view).
5. These gaps are an area for future focus and development, an opportunity for progress.

**David Blockstein:** I was in the majors & minors session, we found people didn’t really have good pathways to follow for energy careers.

**AG:** Businesses may come to universities to find workers and then train them because there is no one with a background they need. Perhaps if we talk more to each other there could be ways for universities to prepare certain kinds of notable upcoming careers.

**David Blockstein:** There is a sense that people are trying to create new energy programs, but do they get the logical question “what are the students going to do when they graduate?” Do they have an energy certificate? And what does it enable them to do?

**AG:** Not really, actually the reverse, there are a couple people from Duke saying there are a lot of interactions between them and the companies that come to campus, almost a problem. We discussed “What do you need in the solar workforce? How do we make sure we’re training our workers on these new fuels?” One of the geographical challenges is the unevenness of resources (like Virginia or Wyoming)-- what does it mean for the communities? If you’re training social scientists, give them statistics work because it is very important.

**John Perkins:** Did the liberal arts perspective raise its head? We are educators not trainers, we teach people to think critically but we do not train for a specific industry.

**AG:** Yes, we asked “should we be thinking about more practical workforce development?” To learn the skills, to what degree do we become a vocational school rather than university?

### Defining Sustainability in an Energy Context

**John Perkins:** I was in session 5, a tricky one that has puzzled me very often because sustainability is such a wonderful buzzword, should it have more meaning in a positive sense? We did come to the conclusion that sustainability can be measured with relevant metrics with accomplishments along a scale, it can be better implemented. We tried to raise basic questions like “what does it mean to be sustained?” and also “in what area?” and then “what period of time?” and also “for whom? Who gets the benefit? Who pays the cost? Does everyone share equally?” There were five papers discussed.

We tried to divide our points in what we think we had in common and what we thought about metrics and implementation strategies. Then we moved on to goals and visions, the problem was to focus on something specific (say sustainable – what exactly do you mean? Set boundaries) what tech, special, time, cultural boundaries have you identified?

We learned that divisions within a group are important in realizing sustainability, as well as gender issues in what is defined as sustainable.

Two metrics we found useful are:

1. LCA can produce a conclusion for something that is either good or bad
2. Energy Return on Investment (ROI) – gets too low then it may be difficult to have a sustainable system, a lot of the figures say the human development index describes low amount of energy use (efficiency?)

Population levels and supply of individuals on an average aggregate level, the distribution between societies say 60 GJ vs. 30 GJ and how does that change their socio-economic status.

Hard to find a one size fits all (NEPA assessment process does it give you a way to open up a conversation that moves from experts into the public and their perception of it).

Regarding implementation, there needs to be more than technical progress to get everything in, there needs to be much more in the socio-economic side that deals with aesthetics and social

structures. Why should we create an ugly world when, with a little thinking, we can make a beautiful world?

**David Blockstein:** In bioenergy, there are still some fundamental scientific barriers.

**DH:** Yes, we are still looking at things like cellulosic structure, technical development, efficiency, and alternatives.

**David Blockstein:** In general, yes we need to ramp up the societal aspects of energy education, but not all of the technological issues are settled.

**John Perkins:** Right, but it is not the main barrier and the enthusiasm that drives the technology behind it all is starting to decline, the cost however is very high for cellulosic structures.

**DH:** Right, the economics are struggling in our R&D projects. I was recently at an energy symposium that made me connect with environmental justice. It was the political and economic choices behind energy investment (angel investments, etc.) hoping that those with lots of financial capital can change the direction of energy education. How are we making sure that our next phase of this energy education path is inclusive, especially for those that don't have that financial capital?

**John Perkins:** There was one point in my session, where we asked if we are successful with moving to all these new energies, what happens when these old industries start to decline and are reduced to nothing? People lose jobs and livelihoods, especially when you say your sustainability initiatives dispossess a large group of people. How do you accommodate these people that are dislocated?

**JJ:** You presented the case “what are we trying to sustain?” When we started the energy minor I wanted to mention “systems awareness for the common good” but the sustainability one was the only identifiable topic that they really liked. Social implications, ecological implications, behavioral implications, quality of life implications, economic implications are all considered in the common good.

**KM:** The term “public good” is a great term, but in the 20<sup>th</sup> century it was encoded in our laws by creating utility monopolies and eminent domain powers. If you look at state statutes, this is what the public good is. It is being manipulated completely in fossil fuel industries. I think the public good as a term needs to be taken back by sustainability – it is solid and we need to translate what the public good was for the 20<sup>th</sup> century and what it is now, there are no laws for common good, just public good (public trust and invocation of the state to use its things). We can't let the public good be turned over to subsidies.

**CS:** I like “common good”, I have the students distinguish between renewable, non-renewable, green energy, and sustainable energy sources. The students can use whatever source they want to get the right answer, and the timescale is important for all of these terms. I made the comment that if David and I got together and designed some tissues, everything would be rectangular and then if Kathryn joined she would want polka dots, etc. The final product appeals to the largest amount of people, we need to determine “how are we inclusive?” If you do all these activities they can affect a lot of people over the world.

## Diversity Advancing Diversity in the Sustainable Energy Field

**KM:** We had a really interesting presentation by Nader Vadiie from the Southwestern Indian Polytechnic Institute. He talked about how he taught Native American students all with around an 8<sup>th</sup> grade math education and then he brings them up into a four year program into engineering. It was so interesting to hear about Jennie Stephens' discussion about gender in engineering and energy. There's a different temporality in the experiential context between women and Native American identities. Nader tried to do space-based projects so they could better understand abstract concepts. Students would go back and show off their projects and get feedback from their communities. Successful and sustainable within one community might mean something different for another community. Grandmother standards need to be reached.

**CS:** Family types of trust and belief that had to be gathered to get to a decision.

**KM:** Women are taking zigzag paths in decisions and achieving things different and how the slow democracy affects that, the science that is done more slowly and in that sense, the but, you can do different things with it maybe that diversity needs to be brought to energy.

**CS:** We had 6 talks in our session and each said "we have a group of people we're working with, and if you don't have something to engage them you are missing everything". There is a certain amount of respect they had to have in regards to their age, the activities have to be meaningful for them, and most importantly, authentic to give value to the student. And then we talked about how it's one thing to get up on the stage and graduate and another to get into the workforce effectively. We want people to open their mindsets and challenge predispositions.

**KM:** Nader said the four year colleges come to his community college where he has been working hard and they take his students and want him to get on their grants. He doesn't let them take their students but he gets on their grants for a graduate student as a mentor. The university will fund the graduate student to bring them into Nader's group. They are effectively leveraging diversity for people who need it on their grants.

**CS:** That's something we do with our youth program, peer mentors that work with students. Guest speakers are able to captivate the audience in a different way than the teacher is able to. The catchphrase is you never learn something until you have to teach it, a process of reflection that helps you develop ownership. Having to explain hard concepts in easy ways develops a certain level of understanding the students don't absorb through normal means. Goes back to common good, people with unique talents and different studies, (like fixing HVAC vs. making photovoltaic materials).

This parallels Joe Soldano's talk about how there is such a huge need for people like welders because there is a huge amount of technical understanding and learning but not the actual people who go out and do the things. There are lots of elements to diversity, not just setting them apart from others to help them learn.

**John Perkins:** Gender diversity came up very specifically, a few classes on diversity and international diversity, but none on ethnic and cultural. Diversity is terribly important for sustainability, yet we barely scratched the surface.

## Pedagogy and Assessment of Student Learning

**SM:** I was in the pedagogy session, with six presentations about their classes from The New School to the U.S. Naval Academy (USNA). We talked about instilling common themes within the session best practices; i.e. hands on learning, discussion sessions, getting students out to actually see projects and work with the communities. Doing local projects with decision makers is a good way to get sustainability in their communities. It is much more effective when it comes from a peer and not an instructor. Another good theme we touched is Jan DeWaters' research on whether students are really learning what we want them to learn.

We want to encouraging critical thinking, what does it mean? Interdisciplinary learning, 4-5 ghost instructors at USNA discussed the Keystone Pipeline and all these people gave their own perspectives on the project. This helped students to think critically and understand complexity.

We spoke on systems learning and demonstrating the relevance of what students are learning, what critical themes recur within the presentations? One can't be an expert on everything and it is hard to put it all together into one course. We then wrapped up talking about key action items for policy makers coming out of this.

We discussed funding mechanisms of some sort for an agency that will fund an interdisciplinary education leadership program, maybe a 2 week boot camp where professors learn about energy education. What if we had that for policy makers as well?

Web science and web sites for energy as an easily useable resource, how do students want to see the energy mix change within their communities?

**JJ:** Our vision is to have a variety of approaches. Our university decided that we need different people from different domains, taking students out and hiring them sample the river, working it into education experiences. For other people they experience the immersion of having engineers working with aboriginals. Students are receptive and learn that not all things are technological.

Another issue was systems awareness – it is important for everyone over everything (the importance of values in decision making, the decisions we make should reflect our values). Our sociologist from the Naval Academy said you cannot be preachy and must present it how it is – let the student make the conclusion.

So what are we going to do with these areas that will be dislodged by innovation in renewable energy?

## Undergraduate Degree Programs, Minors and Concentrations

**David Blockstein:** We began with Cutler Cleveland of Boston University – he talked about the importance of getting students to start thinking in a system view and in scales. He used the example of the shift from the farmer to the substation of energy for labor, using energy in different processes to build the tractor. The most difficult thing to explain is the concept of feedback; a system could change from one action and understand how it will impact the whole system.

**CS:** Talking about how folks will be out of business, people are going to have to make adjustments. I've seen it in my stint in education, students come to my school and their parents expect someone to pay for their education (you owe us!) -- Nobody owes anybody anything, if we move towards these better systems, tech, do we have to provide for these people that are dislodged? Is the burden on us? Everything comes into play here.

**JJ:** We won't get backing in regards to energy and transportation unless you give people a view out the door to some place where they can move to, something they can land on, have to have concern for these people and show them the way out. Everyone could be in electric vehicles if everyone, including the policy makers got serious.

**JF:** We talk about solar and wind in an effective way, we looked at different ways energy crossed each other. A way to get at systems thinking is by developing these visualizations.

**KM:** Did anybody in the pedagogy group talk about the Power Dialog or energy democracy?

**David Blockstein:** The Power Dialog was Eban Goodstein's use of President's clean power plan (CPP) as a teachable moment for students on April 4<sup>th</sup>. We had 30 states and their students participate with a gathering in an auditorium in the state capitol with regulators discussing transitioning to clean energy. The Supreme Court decision on the CPP undercut the momentum. Students take learning in the classroom and apply it to the issues of today. Pennsylvania had a competition for students to become presenters.

**KM:** In Minnesota, the Power Dialogue was their favorite thing- so hands-on, and everyone was really proud about it. We have a utility that is 70% coal and when they could get questions asked to the leaders about it, they discovered the grid agreement that happens up until 2020 and "we can't talk on your panel" and now students have a campaign to start grid agreements, they have a website where everything is up. I didn't think it was just me, the organizers made it national and inclusive for all the communities.

**SM:** We participated in the Worldwide Views on Climate Change project. What can we do in the future like this – a public engagement exercise (citizen engagement activity done in 80 countries? Our dialogue had four guys from the energy industry – students found it too technical. Student engagement should be more central. The Worldwide Views on Climate Change explains the basics behind the science and policy, and then citizens break out into small sessions to discuss, and then make a small recommendation to policy makers afterwards.

**KM:** In the Power Dialog, our students went away from that too for the same reason, we put a citizen association, Sierra Club, etc. on the panel in order to get the students more involved in the process. Had a narrative to follow questions and bring the panelists into their desired point of conversation.

**David Blockstein:** Reinforces Rumi's ideas, if you don't have the technical or factual information it is hard to participate in the discussion of energy. That makes energy education hard because the people who want to move it don't have the quantitative skills.

**John Perkins:** I say if you can balance your bank book you can deal with energy. People tell me "well I can't balance my bank book." Team Teaching - a natural scientist and a social scientist



that co-teach. However the natural scientist thinks in terms of (the most important things first, and then go to the social science). Do natural scientists have a monopoly over the knowledge?

**SM:** It seems that setting it up in the beginning to get people understanding what is important and what we'll cover later from the get-go. All of the faculty members are pretty humble in division of expertise; a lot of it is about personality and how well people are able to appreciate the people and social part behind everything. Need to find the right people.

**JJ:** Personality is important; you have to want to do it in order to be good at it. It is a learning thing that people develop and faculty members will learn to think interdisciplinary. There is a difference in modality –scientists are technically rich and dense where social scientists have a more fluid and interactive discussion.

**KM:** Were there any team studio creation projects?

**JJ:** There were many different flavors, some travel ones where we focused on immersion and staying in hotels and getting to know the culture by going into local businesses and homes to learn about energy. We look at how they use energy and what is the demand, do they really need more, are they happy, etc. Sometimes they do projects with the community like energy surveys. Or use team based learning courses – a completely different way to teaching all projects and activities.

**David Blockstein:** You've been quiet Merle, what do you think about this?

**MP:** I find it funny because I come from Freiburg, Germany -- a town very much known for their 'eco-city' approach to landscape. It seems as if America is behind compared to Germany, what you are discussing now are things we dealt with 10, 20, 25 years ago.

**CS:** I agree, it would be great to see how it is done better and what we can learn from going over to Germany and getting the backbone to say, we need to change and we need to change now.

**David Blockstein:** NCSE Senior Fellow Andy Jorgensen of the University of Toledo spent a sabbatical in Hamburg, Germany where he taught about climate and energy to American students. Also, there is Sustainability in Higher Education – a European sustainability education journal, edited by Walter Leal.

**KM:** The University of Minnesota works with the German government and collaborates within students and faculty level. They educate us and say you are where we were way back when. Diverse people really bring productivity within these organizations.

**CS:** We should blend in some of the ideas around the table to find a way to offer some type of summer course school to go over to Germany to learn about the right ways to do this for a reasonable cost in order to bring it to the students.

**DH:** In energy education do we have to learn about how we address mindset and worldview? We should have students examine their world perspective.

**JJ:** We have to break this isolation and generate this sense of the common good for our students and for the professionals.

**David Blockstein** – There are resources such as America’s Future: Environmental Research and Education for the 21<sup>st</sup> Century by NSF’s Advisory Committee on Environmental Research and Education (AC-ERE 2015) [www.nsf.gov/geo/ere/ereweb/ac-ere/ac-ere\\_thriving\\_century.pdf](http://www.nsf.gov/geo/ere/ereweb/ac-ere/ac-ere_thriving_century.pdf); American Chemical Society’s “Chemistry in Context” program; the Summit website [www.energyeducationsummit.org](http://www.energyeducationsummit.org) ; CEREL webinars; the “Behavior, Energy and Climate Change” (BECC) conference in October; PBS series “Earth: The Operators’ Manual” <http://www.earththeoperatorsmanual.com/> ; Penn State has a world campus for online education has an online energy course; the annual Earth Educator’s Rendezvous;

**David Blockstein:** Something to think about in the future, should we have an Energy Section in the Association for Environmental Studies and Sciences (AEISS)?

## ***OurEnergyPolicy.org* Concurrent Online Summit Discussion: Expanding Energy Education**

NCSE and CEREL partnered with *OurEnergyPolicy.org* to hold an online discussion examining the need to expand energy education to prepare for the renewable energy transition <http://www.ourenergypolicy.org/>. The mission of *OurEnergyPolicy.org* is to facilitate substantive, responsible dialogue on energy policy issues, and provide this dialogue as a resource for the American people, policymakers, and the media.

The discussion, led by CEREL Executive Committee member and plenary discussion moderator Jennie Stephens occurred concurrently with the 2016 National Energy Education Summit. Here is a snapshot of the perspectives offered by OEP's diverse community of experts.

*“Strengthening the technical side of energy education while expanding beyond engineering, to include sociology, policy, economics, psychology and the environment, is critical to preparing students and society for the renewable energy transition.” - Jennie Stephens*

### Education

“Students should be taught that implementing clean-energy infrastructure for energy supply, transportation, energy conservation in residential/industrial sectors, and other methods of reducing greenhouse gas emissions are the way to solve the global warming problem. It needs to be emphasized that every individual, business, and organization globally has a role to play for society to have a livable environment in the future.” – **Henry M. Goldberg**, Consultant, Independent

“[W]hile formal education can help the situation over the long term, the time frame required for dramatic reductions in fossil fuel emissions is quite short, since CO<sub>2</sub> lasts in the atmosphere for hundreds to thousands of years and current levels may trigger (and may have already triggered) tipping points that will make it difficult for our children to manage the problem.” – **Dan Miller**, Managing Director, The Roda Group

“It may be useful for students and others to understand the science, engineering, and economic principles that underlie the complex controversies over alternative energy scenarios. But in reality, most people do not have the time to track and drill deeply into the many questions and issues involved, regardless of their educational background.” – **Lewis J. Perelman**, Principal, Perelman Group

### Workforce

“The federal Dept. of Labor should partner with the federal Dept. of Education and state workforce development agencies and departments of education to develop plans for universities, community colleges, and trade schools to properly train students in these areas.” – **Henry M. Goldberg**, Consultant, Independent

## Social Implications

“The transition to a global clean-energy economy is a long-term transition. Our education system and government will have critical functions to perform in preparing young people properly for the future society they will live in and be responsible for sustaining.” – **Henry M. Goldberg**, Consultant, Independent

“The other non-technical challenge is that our government is greatly influenced by corporate contributions to political campaigns and the influence of dirty energy interests has slowed the implementation of renewable incentives while maintaining incentives (both direct and indirect) for fossil fuels.” – **Dan Miller**, Managing Director, The Roda Group

“The dominant political reality, not just in the US but globally, is embodied in Roger Pielke Jr.’s ‘Iron Law’ of climate policy: The public will not accept any GHG emissions scheme that undermines the standard of living or threatens economic development.” – **Lewis J. Perelman**, Principal, Perelman Group

## Innovation

“Growth happens when we use less energy because our buildings get retrofitted and become more efficient and because we are developing new industries in both wind and onsite energy generation. Even just making our appliances run more efficiently save lots of energy. Spending less on energy we can move those monies to other uses.” – **Jane Twitmyer**, Principal, CACW|Watts

“The solution to that conundrum lies not in sociology or cultural manipulation but in the accelerated development of new technologies that can make clean energy cheap enough for the poor to afford, without subsidies.” – **Lewis J. Perelman**, Principal, Perelman Group

“While I’m all for the development of new energy technologies...we can’t wait for those technologies because we are simply out of time. We have all the technology we need to immediately begin phasing out fossil fuels.” – **Dan Miller**, Managing Director, The Roda Group

*To read the full discussion, please visit: [OurEnergyPolicy.org](http://OurEnergyPolicy.org).*

**Member Institutions of the Council of Energy Research and Education Leaders**  
*(at the time of the National Energy Education Summit):*

Adelphi University  
Alabama A&M University  
Ball State University  
Boston University  
Chatham University  
Colorado State University  
Desert Research Institute  
Iowa State University  
The Ohio State University  
Pennsylvania State University  
Southern Illinois University  
SUNY College of Environmental Science and Forestry  
Texas Tech University  
University at Buffalo  
University of Georgia  
University of Kentucky  
University of Maryland  
University of North Texas  
University of South Florida  
University of Toledo  
University of Vermont  
University of Wisconsin - Madison  
University of Wisconsin - Oshkosh  
West Virginia University  
Western Washington University

The **Council of Energy Research and Education Leaders (CEREL)** is a multidisciplinary organization of university-based energy centers and programs working together to advance the role of higher education in the energy field. The **National Council for Science and the Environment (NCSE)** serves as the secretariat.

### **Goals**

- Strengthen the links among energy sciences and engineering in academia, government, and industry
- Advance university-based energy education research
- Promote the role of energy research and education in society

### **Activities**

- Research—advocating funding for university-based energy research; advancing and elevating the national dialogue about energy
- Education—developing sharing approaches and best-practices to prepare the future workforce
- Collaborating—bringing together research and education leaders from all energy fields

### **Member Benefits**

- National Energy Education Summit—Share best practices for degree programs, concentrations, curriculum, pedagogy and practice. One complimentary registration plus five registrations at a 20% discount.
- Academic-Federal-Foundation Dialogue on Energy Research and Education, and Congressional Visit Day. One complimentary registration to an exclusive annual workshop with federal agency funders and foundation program officers. Followed by visits to key congressional offices.
- Reports on Energy Education Programs—research and analyses on energy academic programs
- Weekly Newsletter for Energy Educators and Researchers—weekly email updates on funding opportunities, federal actions, significant reports, meetings, jobs, etc.
- Campus-wide subscription to NCSE’s Daily Environmental News Digest providing articles from a variety of news sources on energy, environment, policy, etc.

CEREL Executive Officers:

President: **Nagi Naganathan**, Ph.D.

Professor and Dean, College of Engineering, *University of Toledo*

Past President : **Tim Carr**, Ph.D.

Marshall S. Miller Energy Professor, *West Virginia University*

President Emeritus: **Susan Jenkins**, Ph.D.

Managing Director, Energy Biosciences Institute,  
*University of California, Berkeley*

Founding President: **Mohamed Abdou**, Ph.D.

Director, Center for Energy Science and Technology Advanced Research, *University of California, Los Angeles*

CEREL Executive Committee (At-Large Members):

**Ardeth Barnhart**, Ph.D.

Program Director, Renewable Energy Network (UAREN)

*The University of Arizona*

**Tom L. Richard**, Ph.D.

Professor of Agricultural and Biological Engineering

*The Pennsylvania State University*

**Jennie Stephens**, Ph.D.

Blittersdorf Professor of Sustainability Science & Policy

*University of Vermont*

*(now with Northeastern University)*

**Eric Wachsman**, Ph.D.

Director, Energy Research Center, *University of Maryland*

CEREL Secretary Treasurer:

**Scott Williams**

Research & Education Coordinator, Energy Institute

*University of Wisconsin, Madison*

CEREL Executive Secretary:

**David Blockstein**, Ph.D

Executive Secretary, Council of Energy Research and Education Leaders

*National Council for Science and the Environment*

**CEREL Annual Membership Dues**

\$800—NCSE University Affiliate Members

\$2,500—Non Affiliate

**To Join, Please Contact:** David Blockstein,  
CEREL Executive Secretary  
David@NCSEonline.org or (202) 207-0004

Many THANKS to our 2016 Sponsors!



**WORTHINGTON**  
ENERGY INNOVATIONS  
A Worthington Industries Company







**Join higher education institutions from across the country as a member of the National Council for Science and the Environment and advance interdisciplinary environmental education and research on your campus.**

Membership benefits and services include:

- Representation on NCSE's Council of Environmental Deans and Directors (CEDD) or Community College Alliance for Sustainability Education (CCASE) Affiliate Council, the leadership organizations advancing the quality and effectiveness of interdisciplinary environmental and sustainability education and scholarship on the nation's campuses; Participate in biannual complimentary meetings;
- Exclusive access to information on federal funding for environmental research and education, including participation in the annual Academic-Federal Dialogue on Environmental and Energy Research and Education;
- Opportunities to participate in multi-institutional collaborations to secure federal funding;
- Complimentary registrations (up to five) to NCSE's National Conference: *Integrating Environment and Health*, January 24-26, 2017, valued at \$495 per attendee;
- Exclusive environmental education reports series providing data, analysis, and case studies for understanding the fields of interdisciplinary environmental and sustainability education programs, institutes and centers in the U.S.;
- Campus-wide subscription to NCSE's *News Service*, an online resource on environment, energy and science-related news and information;
- Affiliate schools can become a member of the Council of Energy Research and Education Leaders (CEREL) for an additional affiliate membership rate.

To join or for more information, call NCSE Director of University Relations Shelley Kossak at 202-207-0009, e-mail [affiliates@ncseonline.org](mailto:affiliates@ncseonline.org) or visit [www.NCSEOnline.org/Affiliates](http://www.NCSEOnline.org/Affiliates).