

# Integrating Energy Technology and Policy an interdisciplinary course for STEM and Policy graduate students

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University of Pennsylvania

# NSF Research Traineeship (NRT) on Soft Materials, Autonomous Experimentation and Energy Policy

## *Goals of the National Science Foundation Research Traineeship*

- To train graduate students in the skills, knowledge, and competencies needed to pursue a range of STEM careers.*
- To train STEM graduate students in high priority interdisciplinary or convergent research areas.*
- Details: <https://new.nsf.gov/funding/opportunities/national-science-foundation-research-traineeship>*

This NRT is focused on

**Soft Materials – Autonomous Experimentation – Science Policy**

(aka the “Soft AE Program”)



Soft AE Program website  
NSF Award #2152205  
(2022-2027)

# Climate change creates societal grand challenges (interdisciplinary solutions needed)

## Course focus

The energy sector's relationship to and impact on greenhouse gas emissions, specifically at the interface between technology & policy

## Goals

- Examine how science & technology interact with policy
- Use case studies from the energy transition to identify best practices for solving complex, systemic problems
- Prototype interdisciplinary collaboration using real-world, timely, complex, societal scenarios

# Tech & policy challenges related to the energy transition in 3 course sections

## Logistics

Graduate Level, cross-listed in Penn Engineering & Weitzman School of Design

## Sections and Activities

Part 1: Basics - policy, tech, climate change; Focus - tech and policy intersections

Part 2: Case Studies from the energy transition

Part 3: Grand Challenge Team Projects

Typical class structure for Parts 1 and 2.

- Pre-lecture reading and written assignments
- Lectures by instructors building upon the reading
- Small group in-class activities & presentations

# Course materials span a range of sources

SPEAK OUT

## Bridging the Divide Between Technologists and Policy-Makers

BY JON M. PEHA  
Carnegie Mellon University

Modern governments face an increasing number of issues that require extensive knowledge of science or technology for effective decision-making. These include issues of health care, environment, energy, agriculture, national defense, communications, and transportation, to name a few. There is no shortage of expertise to address these issues; the majority of scientists and engineers who have ever lived are alive today. Yet all too often, the policy-making process does not benefit from this technical expertise. There is a great divide between technologists—research-oriented, forward-looking engineers and scientists—and policy-makers, elected legislators and their staffs at the local, state, and Federal levels.

As a result, we have a system in which policy-makers are too often deprived of knowledge that they need to do their job well, and in which technologists with this knowledge have limited influence. Each side may blame the other for its inaccessibility. At the core of this failure to communicate are two groups with different operational systems and different cultures.

### Two worlds, two cultures

Superficially, technologists and policy-makers appear similar. Both groups work extremely hard. Both must acquire extensive expertise for success. And both are convinced that they do the important work, while the other group debates the minor details.

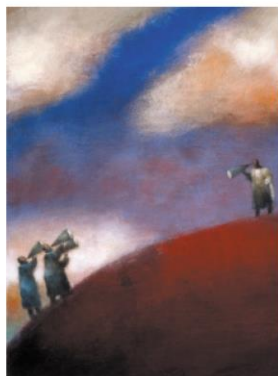
But fundamental differences between technologists and policy-makers should be expected, because the systems in which each group operates have evolved for entirely different purposes. The goal of the technical research community is to produce and disseminate the best ideas to advance technology and scientific understanding. If most good ideas come from a handful of renowned experts, that is not a problem.

In contrast, the goal of the policy-making community is to create a process that is immune to domination by any single group. It is therefore better, policywise, to reach a suboptimal decision, or to take an excessively long time in reaching a decision, than to allow any single group to control the system for long periods of time.

These fundamental differences in objectives have led technologists and policy-makers in opposite directions.

### Process versus product

Technologists measure success exclusively by what they produce, whereas policy-makers must be concerned about the process. The first attempts to create some semblance of Inter-



## Special Report on Solar PV Global Supply Chains



### ADVANCING ENERGY EFFICIENCY IN DEVELOPING COUNTRIES

#### Lessons Learned from Low-Income Residential Experiences in Industrialized Countries

Alexandra Aznar, Jeffrey Logan, Douglas Gagne, and Emily Chen  
National Renewable Energy Laboratory

April 2019

A product of the USAID-NREL partnership  
Contract No. IAG-17-2050

U.S. DEPARTMENT OF THE TREASURY

ABOUT TREASURY POLICY ISSUES DATA SERVICES NEWS

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**POLICY ISSUES**

- COVID19 Economic Relief
- Inflation Reduction Act**
- Informational Resources
- Impact and Stories
- IRA-Related Tax Guidance

## Inflation Reduction Act

On August 16, 2022, President Biden signed the Inflation Reduction Act (IRA) into law, marking one of the largest investments in the American economy, energy security, and climate that Congress has made in the nation's history.

Find out how the IRA can help you!  
Treasury and the IRS are

Sustainable Energy Technologies and Assessments

Volume 47, October 2021, 101410

ELSEVIER

Original article

## Future of photovoltaic technologies: A comprehensive review

Santosh Ghosh <sup>a</sup> ✉, Ranjana Yadav <sup>b</sup> ✉

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<https://doi.org/10.1016/j.seta.2021.101410>

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### Abstract

Presently, the world is going through a euphoric rush to install photovoltaic

LONGMAN CLASSICS in POLITICAL SCIENCE

## Agendas, Alternatives, and Public Policies

UPDATED SECOND EDITION

JOHN W. KINGDON

Includes a new epilogue: HEALTH CARE REFORM in the Clinton and Obama Administrations

Foreword by James A. Thurber

ipcc  
INTERGOVERNMENTAL PANEL ON climate change

## CLIMATE CHANGE 2023 Synthesis Report

Summary for Policymakers

A Report of the Intergovernmental Panel on Climate Change

who UNEP

POLICY PARADOX

THE ART OF POLITICAL DECISION MAKING

Includes a new epilogue: HEALTH CARE REFORM in the Clinton and Obama Administrations

3<sup>RD</sup> EDITION

DEBORAH STONE

#1 NEW YORK TIMES BEST SELLER

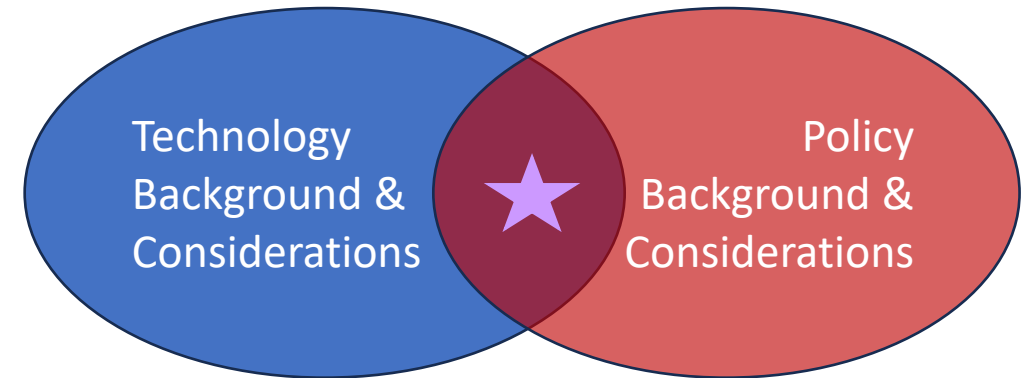
BILL GATES

## HOW TO AVOID A CLIMATE DISASTER

THE SOLUTIONS WE HAVE AND THE BREAKTHROUGHS WE NEED

# Part 2 Case Studies change each year and focus on intersections of tech & policy

- Building, Appliance & Efficiency Standards
- Solar
- Hydrogen
- Carbon Dioxide Removal
- Solar Geoengineering
- Aviation & Maritime



Examples from a range of mature to emerging tools & approaches

# Part 3 Students choose grand challenges team projects

**Can Hydrogen Solve the Public Transportation Problem?**  
Societal Grand Challenges 2024



**Modular Nuclear**  
a clean energy solution hiding in plain sight?

EAS 5010 Final Presentation | Spring 2023  
Eva Zhou, Kait Wang, Sharvari Kemkar, James Dohm

**Microgrids**

Implementation of renewable energy through microgrids to address energy-based equity concerns for historically underserved communities in the US.

By Aline Uwase, Greg Campbell, Gwen Cochran, and Justin Hughes for ENMG5100



**Industrial Decarbonization**  
"A Hydrogen-based study"

Katherine Gomes  
Sarah Dar  
Sharan Deepak Menon  
Yueying Yang

**PLUGGING IN**  
The Rise of Electric MHDV and the Future of Mobility

With a focus on Pennsylvania



Group 2: Gabriel, Manling, Shefall, and Shrey  
MHDV= Medium and Heavy Duty Vehicles

**Ethical Cobalt**  
**A Grand Challenge**

<b>Ashwath Anbuchelvan</b>	Introduction to Grand Challenge
<b>Shelvey Swett</b>	Recycling & China
<b>Arwen Kozak</b>	Geopolitics & Foreign Aid
<b>Anna Neuman</b>	Policy-Driven Ethical Investments

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**EV BATTERY RECYCLING:**  
Current landscape and technical considerations for policy design

Ben Indeglia, Ritik Shah, Delfina Maria Vildosola  
Final project for EAS 5110/ENMG 5100  
Societal Grand Challenges at the Interface of Technology and Policy  
April 2024

**GEOHERMAL ENERGY**

**What Role do Abandoned Oil and Gas Wells Have in the Future of the Geothermal Industry?**

Societal Grand Challenges: Intersection of Technology and Policy  
By: Victoria Fethke, Max Pisciotto, Aria Zhang, Michael Zechokke

April 26, 2023

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# Outcomes support increased student comfort & background with policy and tech

## Pre-post survey

N=29, rank options range from 0 – 5 (highest comfort); combined 2023 & 2024

For **science policy**, 22 students increased rank, while 6 indicated no change

For **tech** (science & engineering), 5 students increased rank, while 21 indicated no change

1 student (policy) and 3 students (tech) decreased ranks – *indication of new awareness of complexity of grand challenges?*

# Students felt there were opportunities to learn from others with different expertise

## Final Survey

N=15, rank options range from 1 – 5 (highest agreement); 2023 (2024 forthcoming)

10 students gave opportunities for **peer-to-peer** learning 4 or 5

14 students gave opportunities for **learning from instructors** with different expertise 4 or 5

# Students felt skills gained were useful for their next academic or professional steps

## Final Survey

N=15, rank options range from 1 – 5 (broadly useful); 2023 (2024 forthcoming)

12 students gave **usefulness of skills** 4 or 5

2 students ranked usefulness at 3

1 student ranked usefulness at 2

# Selection of responses to “Did this class affect your career plans?”

*No, I still want to do academia BUT I do feel confident in interfacing more with policy and using my expertise in science to influence policies in ways I never thought about prior to this class.*

*Yes. This course really sparked my interest in energy policy and made me want to include it more in my research moving forward.*

*I realized there were other paths where I can help with communication between scientists and policy makers: ex NGOs, congress, start ups. I don't /have/ to go into industry!*

*No, but it will help me in my pursuit of them! I came into the class knowing I wanted to go into energy law, and I feel better equipped to tackle difficult questions of technology and policy.*

*I would say yes. It's given me connections and insights to national government which I could never understand otherwise. It helped me way better understand infrastructure and its importance.*

# This course is dynamic and unique

## Collaboration across disciplines, academic cultural norms

- **Energy & effort:** “discipline-typical” materials, assignments, expectations → more intention for integration, syllabus to summaries
- **Guidelines & guardrails:** conflict of interest, team plans, explicit expectations for projects, iterative feedback (peer & instructor)
- **Reinforcing benefits of backgrounds/perspectives:** intersection of policy & technology, in-class activities
- **Cultivating collaboration & pro-social culture:** incentivizing grading structure

## Reflection & Feedback

**Institutional support** for interdisciplinary courses

**Programming/infrastructure support** (NRT Soft AE, KCEP)

Larger community with complementary activities

# Thank you!

NRT program - National Science Foundation (Award 2152205)

Co-instructors: Shuchi Talati (2023), Oscar Serpell (2023, 2024)

KCEP Staff: Bill Cohen, Angela Pachon

EAS 5110

Section 401, CRN 18279

Societal Grand Challenges at the Interface of Technology and Policy

Last Updated 6/8/2023, 4:22:12 AM

Schedule Type: Seminar

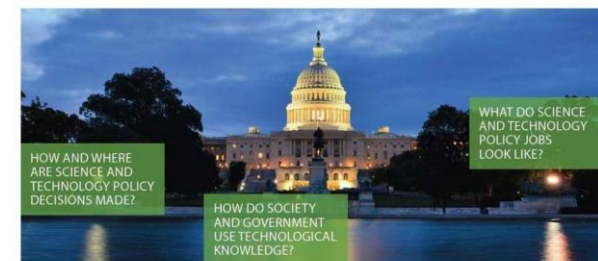
Instruction Method: In Class

Campus: Philadelphia

Credit: 1

Scheduled With ENMG 5100, section 401

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Science Outside the Lab: Energy

For Graduate Students \* May 20-24, 2024

This week-long program will bring a small group of graduate students to Washington, D.C. to explore the relationships among science, innovation, and policy.

The program will investigate the context of science and technology decision-making with a focus on the US Federal Government. Participants will meet and interact with congressional staffers, funding agency officers, regulators, journalists, museum curators, and others to learn how and why technologies related to the energy transition are funded, regulated, shaped, critiqued, and publicized. The ultimate goal is to empower participants to extend the impact of their research.

We are looking for candidates interested in how decisions are made about science and innovation funding, regulation, and policy. This program for Penn graduate students is facilitated by the Penn [SoR AE Program](#) and the [Kleinman Center for Energy Policy](#). The workshop itself will be implemented by Arizona State University's Center for Engagement & Training in Science & Society ([CENTSS](#)).

*If selected, participants will have all the program fees, housing, most meals, local transportation, and transportation to and from Washington, D.C. from Philadelphia covered.*

Application review will start on February 5, 2024, with offers being made on a rolling basis, which will continue until the positions are filled (expected by the end of February).

**APPLY [here](#).** Questions can be directed to the Penn Soft AE Program [softae@seas.upenn.edu](mailto:softae@seas.upenn.edu).

INSIGHT

## Grace Under Pressure: How AI Can Help Us Design the Next Generation of Smart Separations Membranes

SAM LAYDING | FEBRUARY 12, 2024  
EMERGING TECH

SHARE ON [f](#) [in](#) [e](#)

AI can provide a new approach for using polymers for carbon emissions reductions, propelling us closer to victory in the fight against climate change.

*This blog is the written winner of our 2023 Blog Competition.*

Separating gas mixtures has been a cornerstone of process engineering for as long as the field has been around. [Purifying oxygen from nitrogen for medical and industrial applications](#), [upgrading renewable natural gas before it enters our homes](#), and as of