

Nuclear and Innovating the Clean Energy Landscape

Prof. Rachel Slaybaugh
September 21, 2016
ANS NorCal Dinner, Berkeley

A little bit about me

- My path has been all nuclear all the way
 - BS in NE from Penn State, where I was also a research reactor operator
 - MS/PhD from UW-Madison
 - 2 years at Bettis Atomic Power Laboratory
 - Highly involved in the American Nuclear Society
- Now I'm a nuclear engineering professor at Berkeley
- Our department focuses on advanced nuclear reactor design, nuclear security, and applied physics



Environment, Health, Prosperity

How do we help the world develop **sustainably**?



<http://www.insidesources.com/wp-content/uploads/2015/11/bigstock-Energy-4298515-300x300.jpg>

We Need Cleaner Energy

- Nuclear's lifecycle emits very little CO₂ or air pollution

g CO ₂ eq /KWh	Solar (PV / CSP)	Wind	Nuclear	Coal	Natural Gas
Min	5 / 7	2	1	675	290
Max	271 / 89	220	220	1689	930

- Nuclear energy is an important component, it
 - Exists and is large scale
 - Is reliable / always on
 - Uses little land
 - Can be an economic boon

What's Not Working?

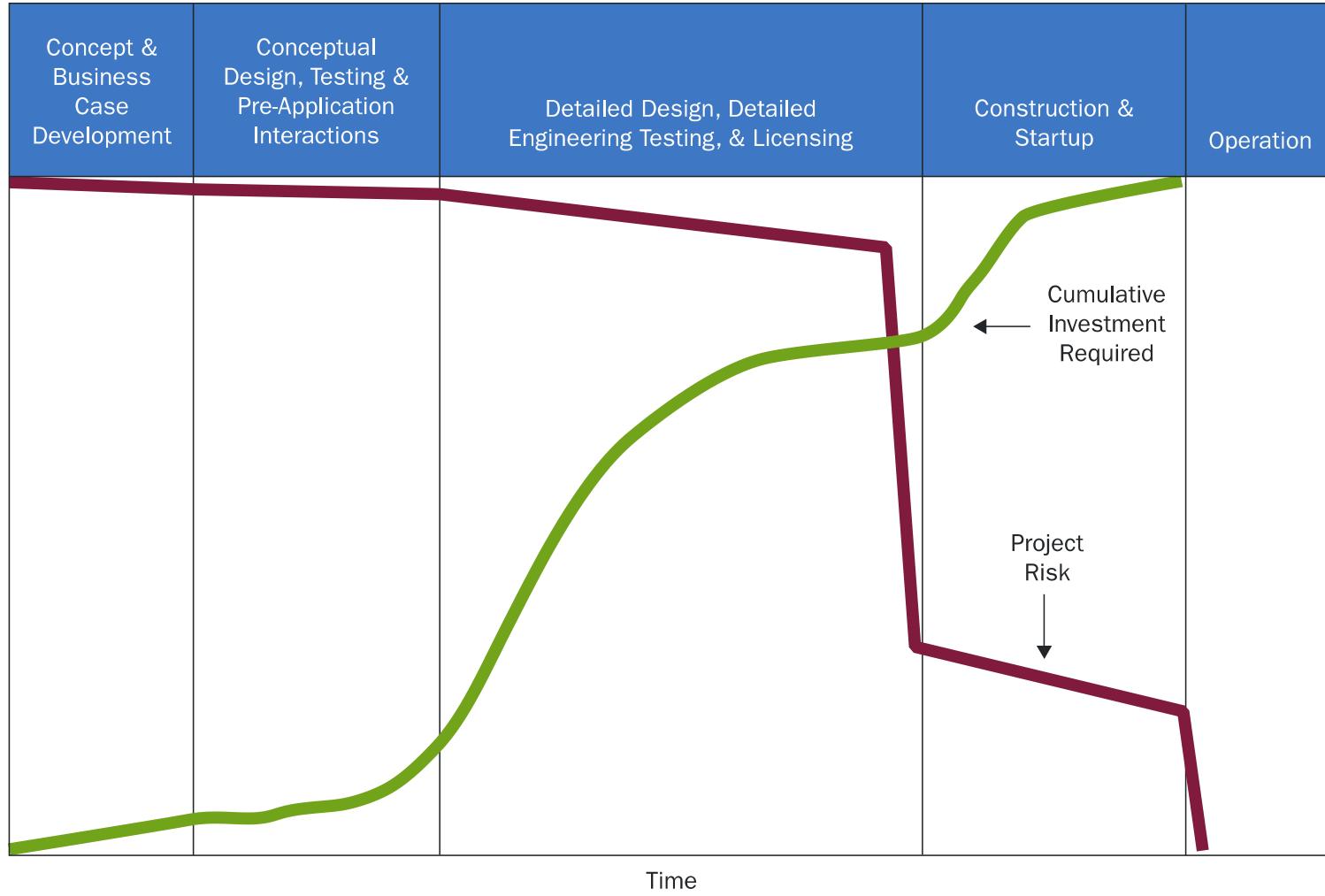
...But it's not perfect

- Rate of change
- Poor public communication
- Small range of products
- Innovative mindset?
- Economic viability
- Capital intensity
- Used fuel and waste / long-term fuel supply
- Safety and security

We must *shift how we think* about nuclear energy and nuclear innovation

Why Isn't it Working?

Financial Risk



What If?

- National and international scientific resources are leveraged
- An inspired, innovative workforce is available
- Regulation is fast and responsible
- Policy supports global cooperation and market health
- Communication is clear
- Technology needs are met
- Big improvements become viable

Companies are rewarded for new motivations

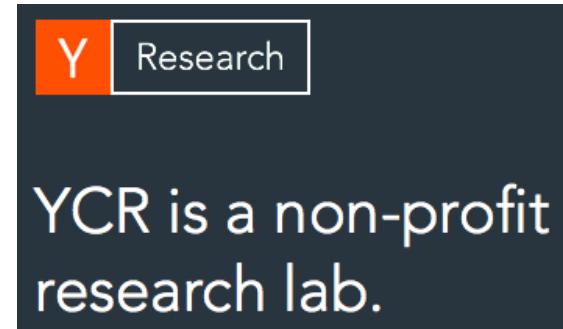
But How Do We Get There?



Examples of Broader Motivation



<http://www.gatesfoundation.org/What-We-Do/Global-Health/Malaria>



<http://www.mission-innovation.net/>



Introducing the Advanced Nuclear Industry



~50 companies

~\$1.3B of private capital

Build A Pipeline

TRAIN the current and
next generations through
Bootcamps

A U.S. example

SUPPORT companies
through
Innovation Centers

LEVERAGE public
resources through
GAIN

UPDATE Policy and Regulation to support innovation
TRANSFORM Communication

Nuclear Innovation Alliance

- The NIA's mission is to lead advanced nuclear energy innovation by addressing:
 - Regulatory Pathways
 - Testing and Development
 - International Cooperation
 - Financial Support
- Assemble companies, investors, experts, stakeholders, students
- Find ways to bring new ideas to market more efficiently



GAIN: Public-Private Leverage



New DOE-NE Initiative
within the Clean Energy
Initiative



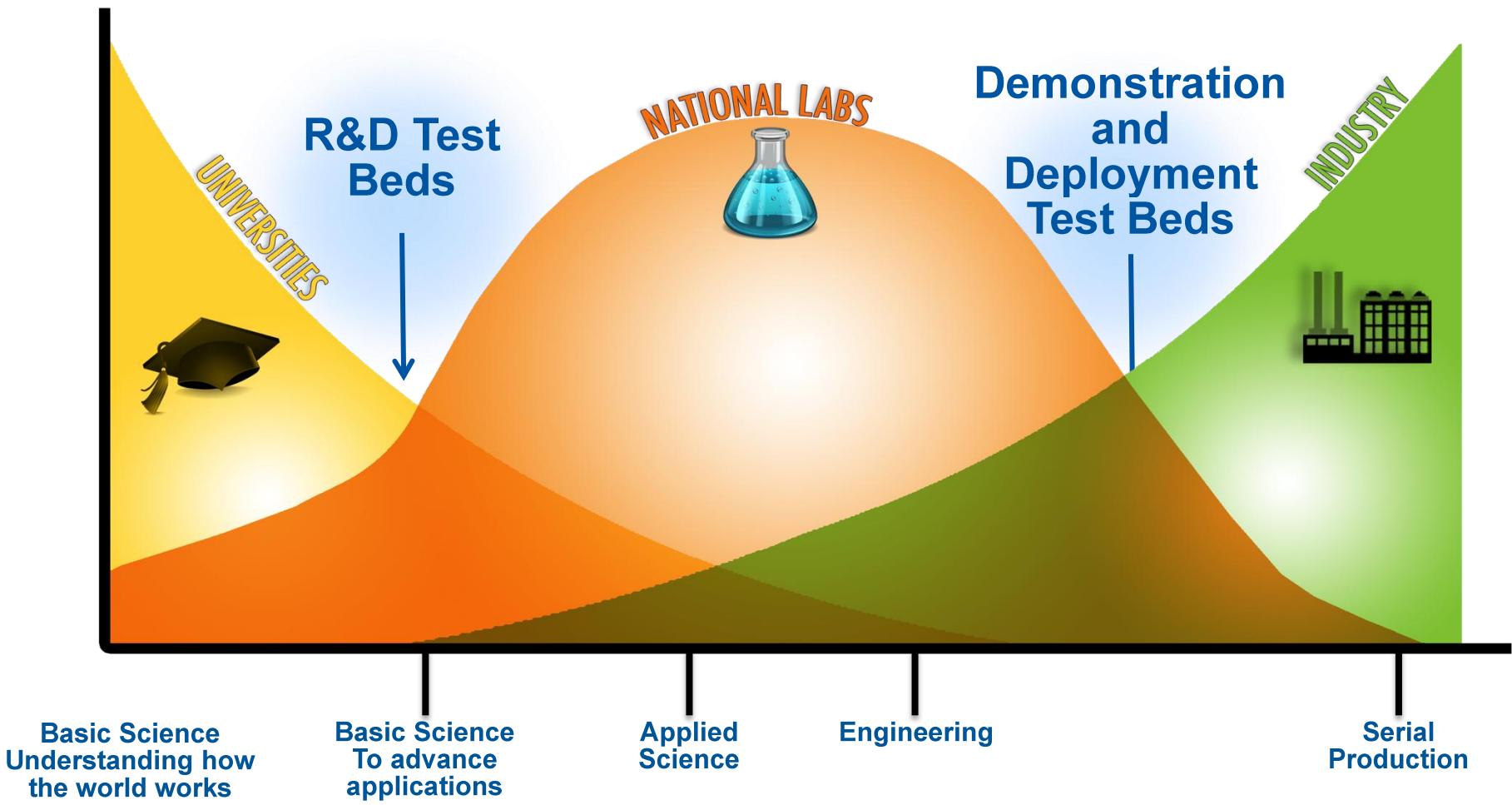
Integrated institute managing a distributed test-bed and demonstration platform, dedication to innovation in Nuclear Energy

Public-private partnership including Industry, Entrepreneurs, National Laboratories, and Academia

Headquartered at the Idaho National Laboratory

- Tens of \$B in DOE and partner assets (experimental and computational)
- More than \$1M in yearly investments for R&D and infrastructure
- \$12.5B in loan guarantees
- \$10M in SB vouchers
- Expertise and intellectual infrastructure

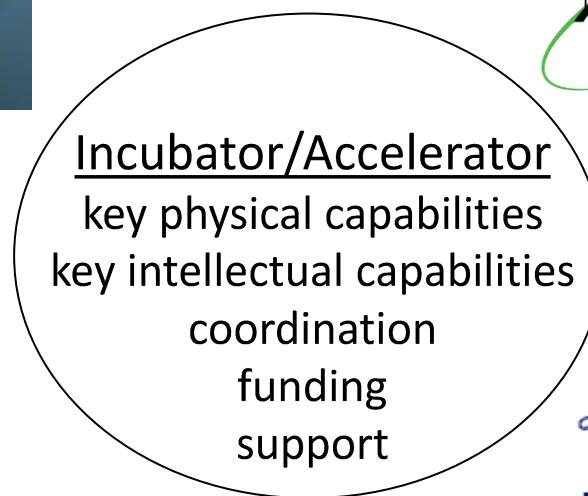
Bridge the “Valleys of Death”



Innovation Centers



Regulators



- Learn from other programs: YC, Lemnos Labs, Breakout Labs, etc.
- Leverage Cyclotron Road program
- Investigate future paths forward

Nuclear Innovation Bootcamp



[http://www.nuclearinnovationalliance.org/
bootcamp](http://www.nuclearinnovationalliance.org/bootcamp)

- Teach students *how* to innovate:
 - Entrepreneurship
 - Nuclear aspects
 - Non-traditional material
- Pilot program August 1-12, 2016 held at UC Berkeley
- Team design projects
- Large company involvement
- Experts teach and mentor
- Judged completion



Unprecedented Success

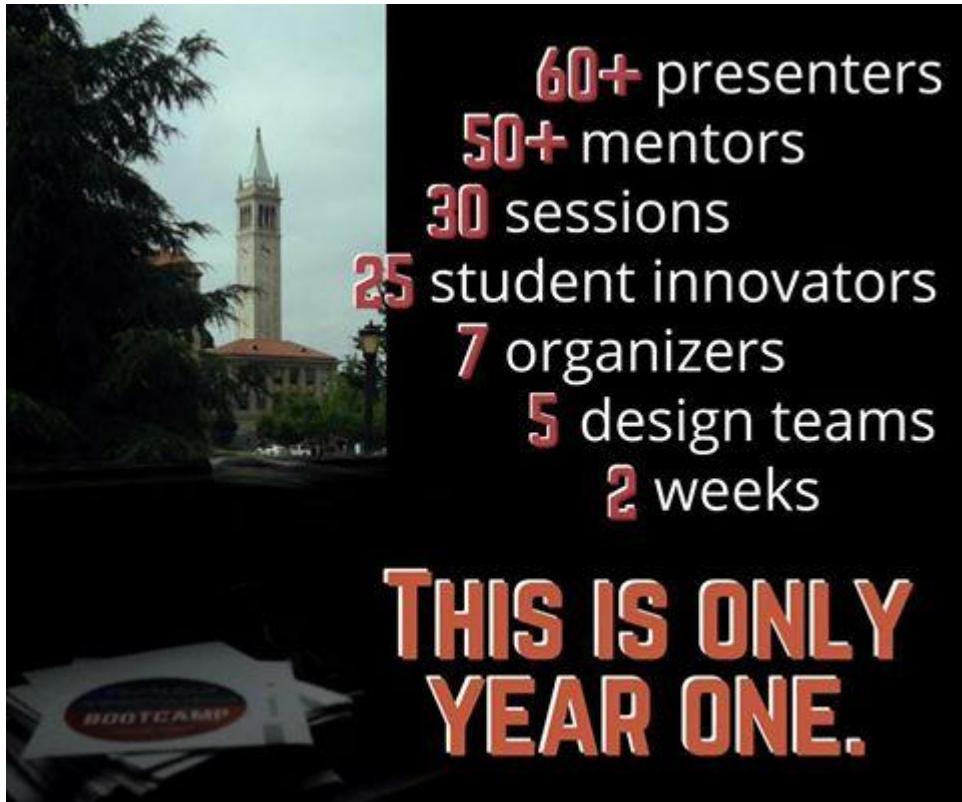
Learning through sessions, projects, and play



Abdalla Abou Jaoude • Adam Scheider • Adriana Ureche • Advanced Reactor Concepts, LLC • Advanced Reactor Solutions • Alan Bolind • Alex Cheung • Alex Polonsky • Alphabet Energy • Alyse Scurlock • American Nuclear Society • Andrea Saltos • Andres Alvarez • Andrew Greenop • Andrew Worrall • Andy Klein • April Novak • Argonne National Laboratory • Aries Loumis • Arun Khuttan • August Fern • August Fern Consulting LLC • Bala Ramamurthy • Bart Roe • Behnam Taebi • Ben Reinke • Beth Zoller • Bipartisan Policy Center • Boris Hombourger • Breakthrough Institute • Brenden Heidrich • Brett Rampal • Canadian Nuclear Laboratories • Canon Bryan • Caroline Hughes • Center for Financial Services Innovation • Chris Comfort • Chris Poresky • Christina Castellanos • Cindy Rodriguez • Cyclotron Road • Daine L. Danielson • Dan Yurman • Darby Kimball • Dave Pointer • David Charpie • David Matthews • Delft University • Dennis Hussey • Dishcraft Robotics • Doug Crawford • Dr Atambir RAO • Duke Energy • Ed Blanford • Edward Kee • Ehud Greenspan • Electric Power Research Institute • Elizabeth McAndrew-Benavides • Emily Nichols • Eric Fettner • Exelon • Fran Bolger • Frank Rahn • Gaetan Bonhomme • Garon Morgan • GE Hitachi Nuclear Energy • GE Power & Water • General Fusion • Georgia Institute of Technology • Gigi Wang • Gil Brown • Gilbert Brown • Haas School of Business • Harvard Business School • Ian Hamilton • Idaho National Laboratory • Igor Bolotnov • Ilan Gur • Institute of Nuclear Power Operations • Irfan Ali • Ivan Maldonado • Jacob DeWitte • Jacopo Buongiorno • James Kendrick • James Lim • Jared Friedman • Jeremy Conrad • Jessica Chow • Jessica Lovering • Jing Hu • Joe Lassiter • Joey Kabel • John Jackson • John Kotek • Karl van Bibber • Kathryn Yates • Kathy Shield • Kurion Veolia • Kyle Brumback • Lara Pierpont • Lars Jorgensen • Lawrence Berkeley National Laboratory • Lemnos Labs • Leslie Dewan • Lightbridge Corporation • Linda Pouliot • Lindsay Dempsey • Lindsay Miller • Lin-wen Hu • Lucas Davis • Lydia Sohn • Marissa Zweig • Marius Stan • Mark Mawdsley • Markus Piro • Massachusetts Institute of Technology • Massimiliano Fratoni • Matt Thompson • Matthew A. Hertel • Matthew C. Thompson • Megan Casper • Michael Martin • Michael Trinh • Michael Van Loy • Mike Kurzeja • Mike Laufer • Mike Safyan • Milos Atz • Mintz Levin • Mitch Negus • Modeste Tchakoua • Morgan, Lewis & Bockius LLP • Nathan Gilliland • Nathan Gold • Nick Touran • Nikhil Bharadwaj • Nnaemeka Nnamani • North Carolina State University • Nuclear Economics Consulting Group • Nuclear Energy Consultants, Inc. • Nuclear Energy Institute • Nuclear Innovation Alliance • Nuclear Technology Innovation Laboratory • NuScale Power • Oak Ridge National Laboratory • Oklo • Ondrej Chvala • Oregon State University • Oscar Espinoza • Out Educated • Paul Lorenzini • Pavel Tsvetkov • Per Peterson • Peter Hosemann • Peter Secor • Phil Hildebrandt • Phil Russell • Planet • Positron Dynamics • Rachel Slaybaugh • Raluca Scarlat • Ray Rothrock • RedSeal, Inc. • Richard Pearson • Richard Vasques • Robert J. Budnitz • Robert Petroski • Roe Energy Consulting LLC • Ronald Horn • Ryan Falvey • Sam Brinton • Sama Bilbao y Leon • Samuel Brinton • SAP • Sara Harmon • Sarah Stevenson • SC Moatti • Sebastian Lounis • Senate Energy Committee • Seth Grae • Shane Johnson • Shannon Yee • Shrey Satpathy • Shyam Dwarakanath • Southern Company • Southern Nuclear • Stephen Clement • Stephen R. Booker • Steve Herring • Sutardja Center for Entrepreneurship & Technology • Suzy Baker • TerraPower • Terrestrial Energy • Texas A&M University • The Demo Coach • Third Way • ThorCon • ThreeBridges Ventures • Timothy Crook • Todd Allen • Tom Isaacs • Transatomic • Tri Alpha Energy • U.S. Department of Energy • UC Berkeley College of Engineering • UC Berkeley Department of Nuclear Engineering • University of California, Davis • University of Massachusetts, Lowell • University of New Mexico • University of Tennessee, Knoxville • University of Wisconsin, Madison • Virginia Commonwealth University • Walter Howes • Wendolyn Holland • Whitecoat, Inc. • Whitney Research Services • Will Boyd • Y Combinator • Yishu Qiu

Nuclear Innovation Bootcamp

- <https://www.youtube.com/watch?v=aicVAXorRq4>
- Multiple articles, blog posts, and features... still coming
- Large social media impact
- And the narrative continues!



Nuclear Innovation Bootcamp

- Full program Summer 2017
- Deeper content, bigger projects
- Expand to include professionals
- Partner with other campus initiatives
- Intellectual collaboration with other universities

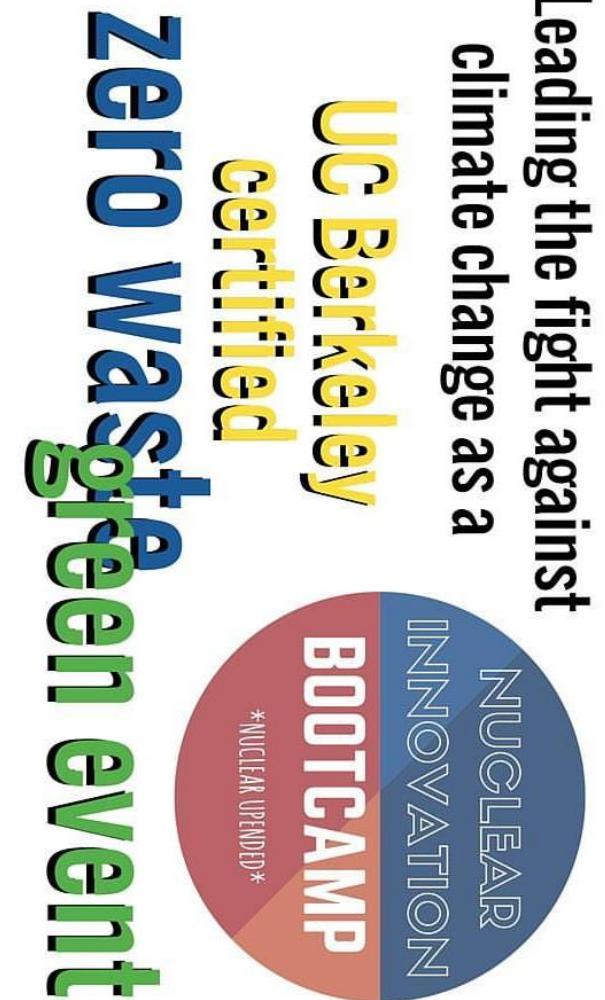


DEPARTMENT OF
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UNIVERSITY OF WISCONSIN-MADISON



Berkeley
UNIVERSITY OF CALIFORNIA

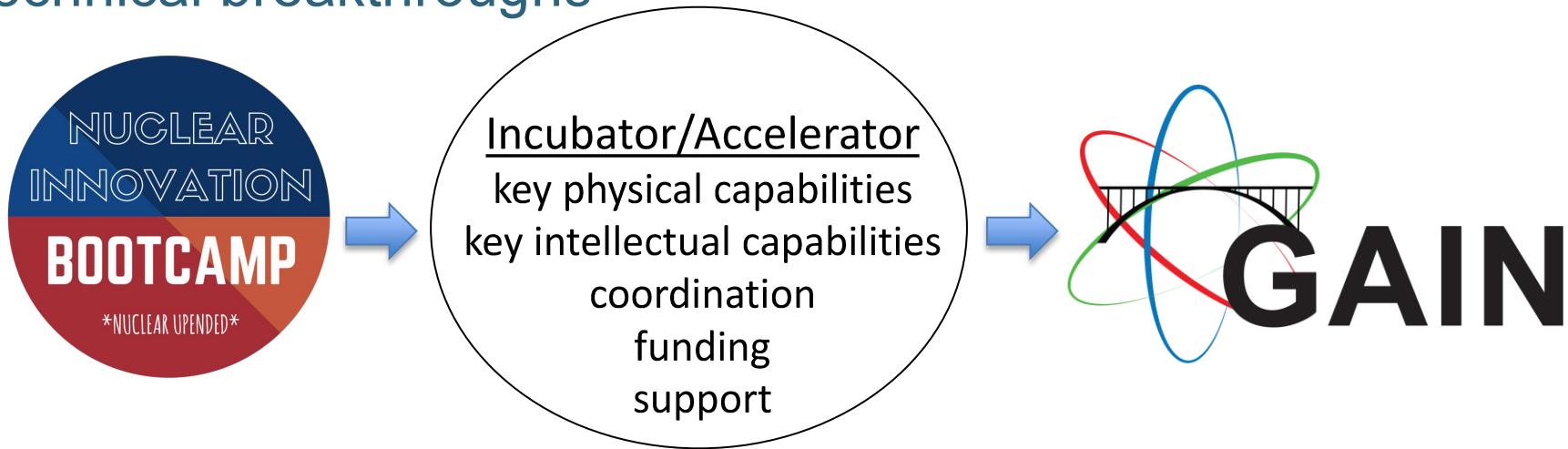
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Leading the fight against
climate change as a

Nuclear Innovation Pipeline

- Goal: reduce the non-technical barriers while enabling technical breakthroughs



- Global participation; expand model
- Beyond GAIN: need a coordinated interagency (U.S.) and international strategy for global deployment

Global Nuclear Innovation

Now is the time

Motivated by Global Health, Prosperity, and Environment,
we have the opportunity to **reinvent** the way we do things

What do we want the
world to look like?



How Do I Make a Difference?

Get involved with our 2017 Bootcamp

- **Sponsor!**
- Content development
- Spot mentors:
 - Provide expertise on specific issues
 - Define your terms of availability
 - Can be virtual
- Continuous mentors
 - Work with a team more closely through the program
 - Can be virtual, some in-person encouraged

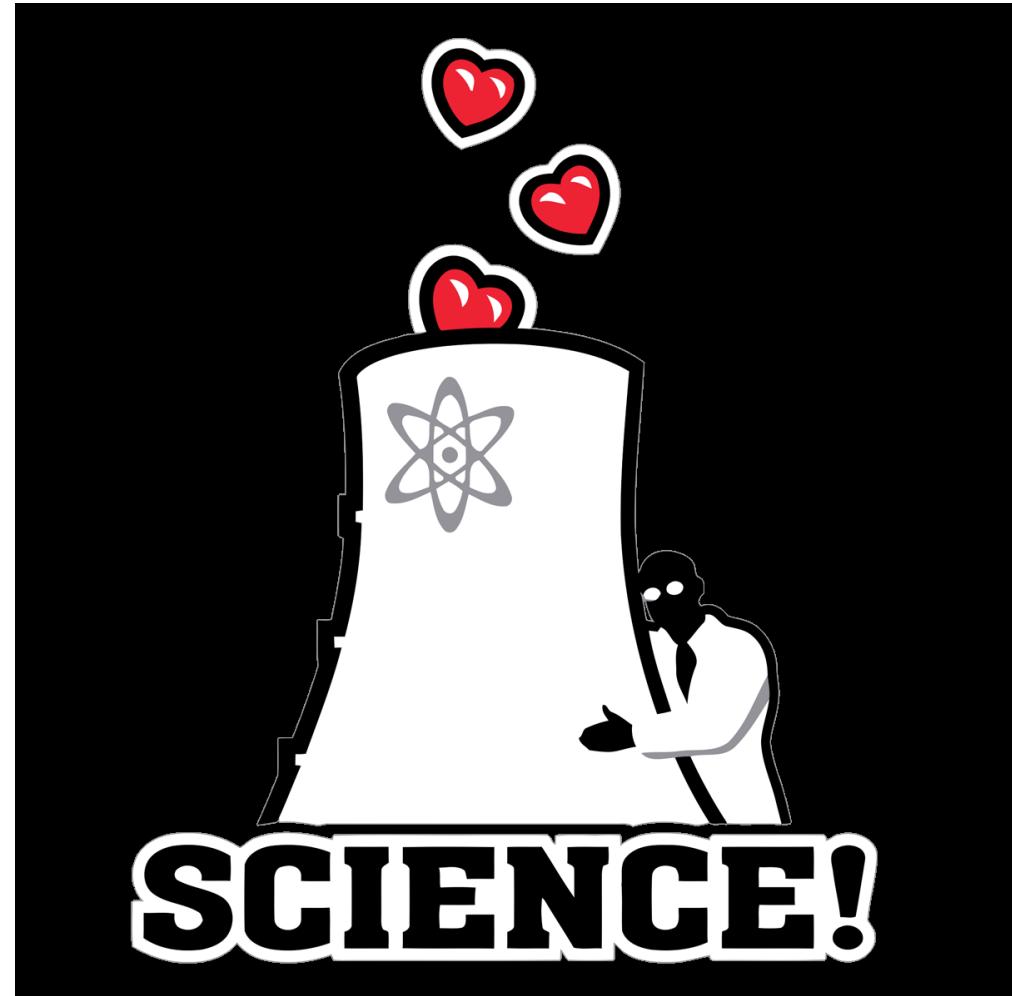
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Thank You

<http://www.nuclearinnovationalliance.org/bootcamp>

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