

Moonshots: Harnessing the Potential of the National Laboratory Complex to Address Critical National Priorities

Noël Bakhtian (INL/LBNL)
David Miller (NETL)
Erin Searcy (INL)
Jennifer Kurtz (NREL)
Despina Milathianaki (SLAC)

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For access to additional notes and information related to this effort (incl. literature review, etc),
contact noel@lbl.gov

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The national laboratory system was created in response to a national- and global-scale threat to our safety, security, and prosperity. Eighty years later, the national lab system has grown and expanded. Is there potential to even more fully harness the power of the evolved national lab system for maximum impact aligned with the future grand challenges or “moonshots” of today and tomorrow? This Oppenheimer Science and Engineering Leadership Program (OSELP) Cohort 4 Think Piece offers recommendations to create a national lab super-structure and framework to enable successful national lab system-led Moonshots, and provides next steps for executing on a climate change Moonshot to fully engage the national lab system for the Biden-Harris Administration’s climate goals.



Noël Bakhtian



David Miller



Erin Searcy



Jennifer Kurtz

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Adapting DOE lab system for future challenges

- Up to now
 - Born out of the Manhattan Project
 - Labs have come together to solve critical, timely challenges
- Today and our future
 - How can DOE and the National Lab system more effectively address current and future grand challenges?

17 National
Labs

\$30B Annual
Public
Investment

60K FTEs

Our Approach

- Broad perspectives: What has worked? What hasn't?
 - Leveraged OSELP mentors and contacts
 - Engaged the OSELP Cohort
 - Literature review
- Summarized key take-aways from deep-dives
- Developed characteristics & path forward
- NLCRO Feedback

Engagement & Feedback:

Adam Cohen

Arati Prabhakar

Bill Madia

Charles McMillan

Dan Arvizu

Henry Chesbrough

Horst Simon

Jill Hruby

Lynn Orr

Marianne Walck

Michelle Buchanan

Mike Knotek

Norm Augustine

Pat Dehmer

Paul Alivisatos

Peter Green

Sig Hecker

Steve Hammond

Teeb Al-Samarrai

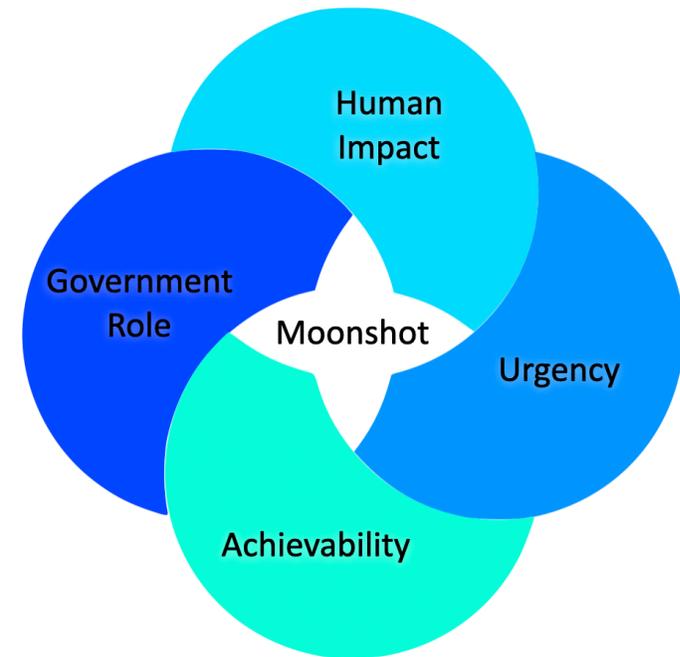
Tom Kalil

Our Concept: Moonshots

A **Moonshot** is an ambitious but well-defined goal requiring a multi-institution, multi-disciplinary effort to accelerate a solution to overcome an existential threat to U.S. security and well-being.

Create a National Lab super-structure and framework, applicable to specific Moonshots, which will:

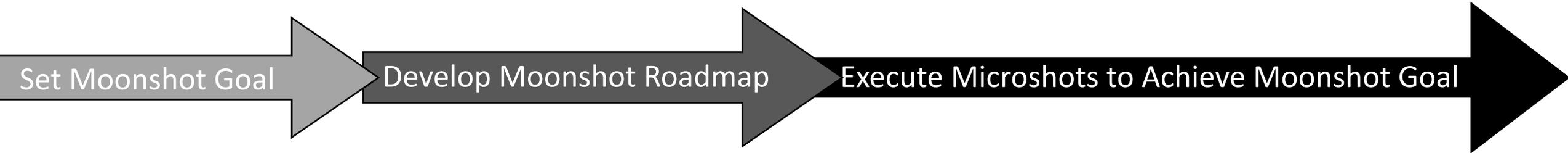
- Accelerate outcomes via tight **collaboration** of up to 17 Labs, beyond “sum of the parts” coordination (distinct from hubs, institutes, centers)
- Leverage core lab expertise/capabilities with **intentional integration** & knowledge transfer with industry, academia, regulators, & communities
- Develop a **roadmap** to achieve the Moonshot goal in a given timeframe
- Execute the roadmap “**Microshots**” ranging from science to technology to deployment
- Be funded and **championed by DOE**, with clear role within Administration’s masterplan



Critical Characteristics for Successful Moonshot

1. **Well-defined problem and a goal** that is ambitious, measurable, and achievable
2. **Clear communication** of challenge, vision, and goal for public understanding
3. Defining the **appropriate role for the Labs** based on capabilities, equipment, and expertise & **intentional engagement** with partners across TRL
4. **Broad buy-in** from S&T community (bottoms-up) & Administration (top-down)
 - bipartisan support
 - DOE champion with influence
 - buy-in across the Department and Labs, and beyond government
5. **Integrated roadmap** - from here and now to the Moonshot goal - to include manageable chunks (aka Microshots)
6. Ability to **“fail successfully”** and pivot agilely
7. **Competition** enhances innovation - enable multiple paths to success
8. **Clear leadership structure** and coordination
 - full-time, effective leader sub-DOE level
 - clear roles/responsibilities/accountabilities/authorities
 - clear DOE decision path and DOE-internal coordination
9. Substantial and **sustained funding** with balanced oversight
10. A **sense of urgency and collaboration beyond “business as usual”** – tied to Moonshot goal – is essential

Climate Change: Moonshot for the 21st Century

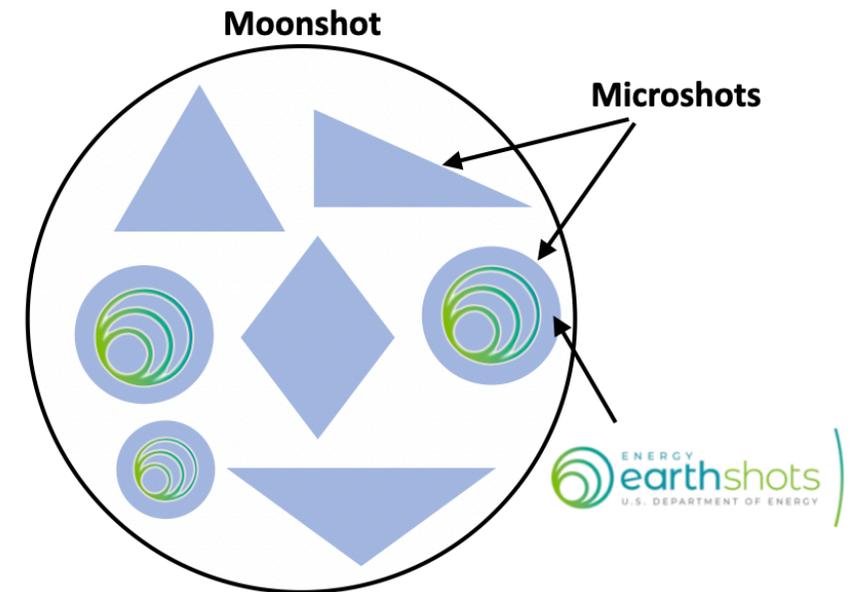


EXAMPLE

Moonshot Goal: Decarbonized electric grid by 2035 / Decarbonized economy by 2050

Roadmap: The plan to get from here-to-goal
i.e., energy transition by 2035/2050

Microshots: Strategic smaller goals that lead to
successful Moonshot



Recommendation

Establish a Task Force to develop a proposal to DOE on an optimal national lab system organization and strategy to address a climate change goal via Moonshot framework

- **NLDC Establishes Moonshot Task Force**
 - Clear leadership, resources, R2A2s
 - Diverse representation from interested Labs and invited key external stakeholders
- **Task Force formulates generic Moonshot framework (Months 1-6)**
 - Utilizes insights from OSELP Moonshots Team & incorporate Critical Characteristics
 - Define Moonshot structure/governance for “beyond BAU” (National Labs/DOE)
 - Identify integration/handoffs with industry to scale and deploy to market (deployment)
 - Identify ways to better manage cross office interests (DOE)
- **Task Force formulates climate Moonshot pitch (Months 1-6)**
 - Develop initial draft climate roadmap & Microshots (plan)
 - Identify opportunities for Congressional support (funding)
- **NLDC review & refinement**
- **NLDC pitch to DOE (S1)**
- **Labs refine plan & execute climate change Moonshot**



Title Slide

- To start, I've got a question - how many of you remember where you were on July 20, 1969, the day Neil Armstrong walked on the Moon?
- But that One Giant Leap for Mankind was kindled almost 7 years earlier - does anyone remember what occurred in 1962 on September 12?
- That's the day President Kennedy gave his nation-rousing "We choose to go to the moon" speech.
- Before I dive in, I want to start by saying we're excited to be here and we thank you for the opportunity to take part in the Oppenheimer Cohort and also to share this with you today.
- I'm Noel Bakhtian - when we started in OSELP, I was at INL (Idaho National Laboratory) and now I'm at LBNL (Lawrence Berkeley National Laboratory). I'm representing the Moonshots team today, comprised of Dave Miller at NETL (National Energy Technology Laboratory), Erin Searcy at INL, and Jen Kurtz at NREL (National Renewable Energy Laboratory). We also want to acknowledge our teammate Despina Milathianaki formerly of SLAC (SLAC National Accelerator Laboratory).
- Our team figured out early on - that like many others - we are part of the national lab system because we see the potential of this complex to address the most important national and global challenges.

Adapting DOE's lab system for future challenges

- This Oppenheimer program - with deep dives at all 17 labs - has really driven home our heritage and how we were born out of the Manhattan Project - a Moonshot in itself. Since then we've grown into a 30 billion dollar, 17-lab system that is often called the crown jewel of the US research and innovation enterprise, founded on invaluable infrastructure, capabilities, and expertise.
- The question we posed was: is there potential to even more fully harness the power of the national lab system for maximum impact, especially to directly address the scariest challenges or the most complex opportunities our nation and world are facing, head on.
- And our answer is yes - let's work together, at a scale beyond our business as usual, to execute on Moonshots as a national lab system.

Our Approach

- Our approach was to start by listening and learning - through a literature review and extensive interviews with senior leaders across the complex and beyond, some of whom we talked to multiple times. What we came back with was widespread enthusiasm for the Moonshots concept and a starting playbook for critical characteristics for success, which I'll share in a few slides.
- From that, we drafted our recommendation to you and also got in front of the NLCRO (National Lab Chief Research Officers) for further refinement.

Our Concept: Moonshots

- So, let's dive into the Moonshot concept.

- We defined a moonshot as an ambitious but well-defined goal, requiring a multi-institution, multi-disciplinary effort to accelerate a solution to overcome an existential threat to U.S. security and wellbeing.
- The focus here was twofold -
 - First, what could we do differently as a national lab system to be better positioned to tackle these. And we're talking at scale - think closer to Manhattan Project than EFRCs or the innovation hubs or the big ideas summits.
 - And second - what moonshot should be the first we go after together.
- This slide and the next address the first question of how to go after moonshots together:
- Our idea is to create a virtual national lab and DOE (Department of Energy) superstructure and framework capable of successfully executing on moonshots. Which means it would need to be able to accelerate outcomes via collaboration - but concentrating, again, on going beyond sum of the parts.
- Recognizing that moonshots will often go from early TRL (technology readiness level) all the way to deployment, this structure will also require intentional integration beyond our national lab bubble - partnering with industry, academia, all levels of gov, regulators, the finance sector, and communities.
- Moreover, we need to ensure that we're fully considering the role in the RDD&D (research, development, demonstration, and deployment) ecosystem where it makes sense for the national labs to play in whichever moonshot we're considering given our current and potential expertise and capabilities - and then be deliberate about partnerships and external collaborations. The superstructure and governance that helps bridge all 17 or a subset of the labs and external partners is extremely important - and what we posit is that this effort - which we've already put some thought into - would build on lessons learned from previous efforts – NVBL (National Virtual Biotechnology Laboratory), EFRCs (Energy Frontier Research Centers), energy innovation hubs, big ideas summit and crosscuts, grand challenge - but be different in its scale and collaboration model.
- So. With that superstructure in place, the idea would be to identify the goal for a specific moonshot, develop a roadmap, and execute on microshots to get there. When I coined the term microshots, I was thinking about how the original moonshot started with the Mercury program with sub-orbital and orbital flights around Earth, advanced to the Gemini missions, and ended in Apollo and a successful Moonshot.
- And of course this would require full buy-in from DOE and, given the scale of the moonshots we're considering, likely need to find a place in the Administration's plans - whether it stems from there, or lands there as a result of lab leadership.

Critical Characteristics for Successful Moonshot

- From our research and interviews, we developed a list of 10 characteristics critical for success in a Moonshot endeavor. We've already mentioned several, but I'll call out a few more here -

- #6 - Ability to fail successfully - and by that we're referring to the importance of taking risks, but also the ability to pivot agilely.
- #4 - Broad buy in is necessary for the scale we're talking about - both bottoms up from the S&T community and industry but also top down from the Administration and Congress - that leads to...
- #9 Substantial and sustained funding with balanced oversight.
- #8 Governance is a key to success - clear structure and coordination between the players, full-time effective leader empowered to make decisions, and a streamlined DOE decision path AND coordination between DOE offices at the budget level - are critical.
- And #10 can't be overstated: a sense of urgency and collaboration - not coordination - beyond business as usual.
- Now to the second question of what moonshot to go after first - what we quickly realized was that the four of us had something else in common - something that drives us every day - climate change.

Climate Change: Moonshot for the 21st Century

- Climate change is an existential threat, and even before the new Administration came in, there was of course a lot of national lab work in this space already, for decades. However, thinking through the Moonshot framework, we firmly believe there's opportunity for scale and integration for greater impact.
- So on this slide, using a climate-related moonshot simply as an example, we're double clicking on what we mean by a moonshot goal, roadmap and microshots and giving an idea of how this might go for a moonshot associated with climate change.
- The first step would be to set the moonshot goal - this would be done in combination with DOE and other stakeholders. The Administration has already announced their 2035 and 2050 decarbonization goals which are examples of what the moonshot goal could be, or the goal could be different.
- Then the labs would develop the roadmap, again with a broader community - the national plan to achieve the goal.
- And this would include a series of microshots - smaller but strategic goals that allow us to reach the moonshot goal.
- And by the way, the Earthshots that were publicly announced by DOE this month fit within that mold, and could well be examples of some of our future climate microshots.

Recommendation

- So those are the 2 ideas - a national lab superstructure and framework capable of better leveraging the lab system to execute moonshots - whether DOE is leading or supporting, ...and...launching the first one - a moonshot related to climate.
- So here's our recommendation to the NLDC (National Lab Directors' Council):
 - Establish a Task Force to develop the proposal over the next 6 months that would go to DOE around a climate change moonshot and the underlying national lab framework for this and future moonshots - leveraging the 250 pages or so of notes and ideas this team has put together over the last 18 months.

- To double click on this recommendation:
 - We propose a diverse, forward-leaning task force which would include representation from interested labs but - we also want to act on one of the characteristics we mentioned - and include critical key external stakeholders from the beginning - industry for instance.
 - The task force would work on 2 parts - the generic moonshot framework, so more fully developing answers to questions like:
 - What's the multilab structure and governance that gets us beyond BAU (business as usual) collaboration?
 - What's the intentional integration with academia, industry, regulators, and communities to ensure science to systems to market?
 - What would we need from DOE and Congress to be successful - everything from budget to alignment between offices, etc?
 - And then the Task Force would also develop the initial draft climate goal, roadmap, and microshots - simply as an example to the Administration - fully recognizing that if this is successful, the full plan would be a joint effort with DOE and external stakeholders in concert.
 - Then, with NLDC blessing, pitch to Secretary Granholm together, as a lab system.
- To close, I'll just say it's been quite a journey since the day this idea launched, back in January 2020, in a conference room during our first Oppenheimer visit in New Mexico.
- Since then, a lot has changed - the NLCRO and NLDC have put out the horizon scanning report, we got a new Administration 10 months in that has made it clear that climate is a priority across the federal government and in fact John Kerry came right out and called climate change our generation's moonshot, and like I mentioned, just this month the Administration announced the first of their Earthshots.
- It feels like the right time - DOE and the other agencies are primed and ready to execute.
- And the people in this room know better than anyone, the power that the labs can bring to this challenge.
- It's up to us to show the world what we can do together, and that we can lead the charge, and then execute.
- We need to stand up together and say - we choose to do this not because it's easy, but because it's hard.
- If we're the crown jewels, then how can we not. Because if not the national labs, then who.
- And with that, thank you again for your consideration, we look forward to your feedback, and we're standing by to support you on next steps to make this a reality.

Note: parentheses describe acronyms used in script

Note: underline implies verbal emphasis