# WELCOME! Energy Efficiency Computing Workshop
## "Cooling Compute Systems Efficiently, Anytime, Anywhere"

Peter de Bock, Program Director
Rakesh Radhakrishnan, T2M Advisor
Vivien Lecoustre, Tech SETA
Carlos Noyes, Tech SETA
Tom Bress, Tech SETA
John Gallagher, T2M Summer Scholar

# Energy Efficient Computing has many segments...
## This workshop will focus on cooling



CIRCUITS

DIFFERENTIATE

Software

ENLITENED

Power

Processor

Cooling

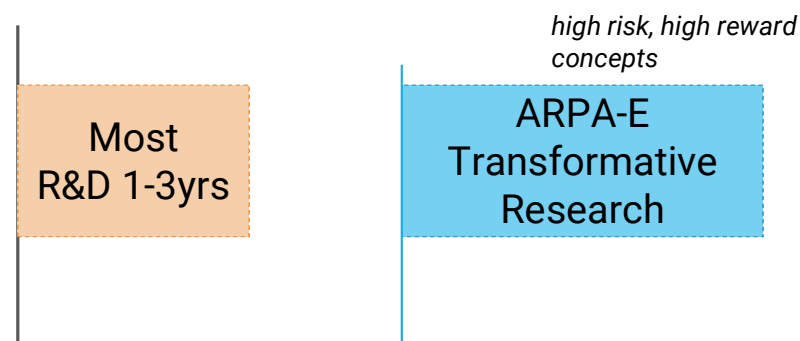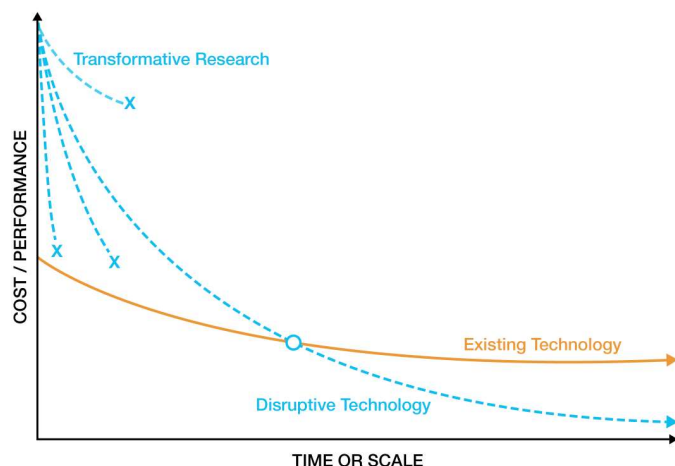Although we cannot predict the future compute systems, all energy going in will come out as *heat.*

We need to manage that as efficiently as possible

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CHANGING WHAT'S POSSIBLE

# What is unique about working with ARPA-E?

**1.** **Game-changing targets** – 2025 - 2030+ no overlap, career defining, multi-year support



- **Teaming** – breaking silos, system solutions

- **Community** –a community focused on a research topic for 3-4 years, fun!

**2.** **Impact - Tech2Market** – ARPA-E unique % funding to explore factors that would make your technology commercially successful, set-up for follow-on funding, spin-offs, etc.

## IF IT WORKS, WILL IT MATTER?

# ARPA-E Workshop – Early part of program definition

__What it is:__

1. An opportunity for an expert community to engage with ARPA-E and explore **transformational** 2025-2030 technology targets that will be impactful if accomplished.
   – *i.e., what parameters? And what targets*?

*What are the parameters?*
*Where does the endzone start?*



2. Discuss and set the framework in which such a technology target needs to be achieved to be impactful – *i.e., reliability, cost, teaming*

__What it is not:__

‣ There is no need to discuss or convince ARPA-E of your particular technical approach at this point. **Let's define the destination first!**

**LV(10** Changed discuss with interact
Lecoustre, Vivien (CONTR), 12/7/2021

**DP9** changed to engage to be consistent with Jenny's pitch
Debock, Peter, 12/10/2021

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**Day 1 Focus: Performance**

Breakouts
Cat A: Conventional
Rack-based architectures

Breakouts
Cat B: Modular
Edge Data Centers
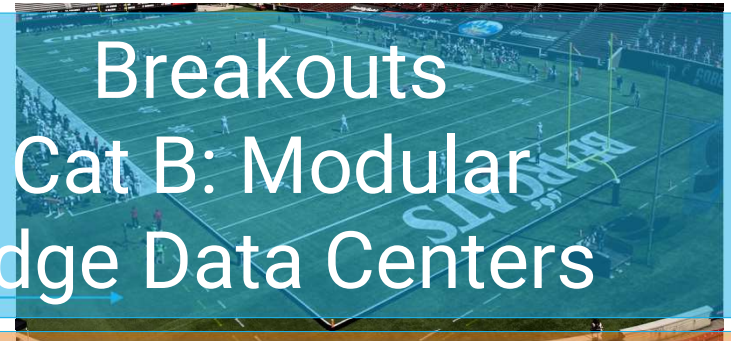
*What are the parameters? Where does the end zone start?*

**Day 2 Focus: Impact**

Breakouts

# Workshop Agenda: Presentations, Breakouts & Networking

*Thank you*

Breakout facilitators



Mario Garcia-Sanz
Carlos Noyes

Halle Cheeseman
Eric Carlson

Phil Kim
Tom Bress

Rakesh Radhakrishnan
Kathleen Lentijo

Dave Tew
Vivien Lecoustre

Bob Ledoux
Mirjana Marden

Doug Wicks
John Qi

| Time | Session |
|---|---|
| | *Dr. Peter de Bock, Program Director, ARPA-E* |
| 12:25 – 12:45 PM | **Invited Talk: "Cooling it where it's needed"** *Dr. Ravi Prasher, Associate Lab Director, Energy Technologies Area, Lawrence Berkley National Laboratory* |
| 12:45 – 1:20 PM | **Introduction to the Vision** *Dr. Peter de Bock, Program Director, ARPA-E* |
| 1:20 – 1:40 PM | **Invited Talk: "High Heat Density Single and Two-Phase Cooling of Data Center"** *Dr. Ali Heydari, Distinguished Engineer and Data Center Technologist, Nvidia* |
| 1:40 – 2:00 PM | **Invited Talk: "Opportunities and Challenges for High Efficiency Two-Phase Cooling of Electronics"** *Prof. Michael Ohadi, Minta Martin Professor of Mechanical Engineering, U of MD, College Park, MD.* |
| 2:00 – 2:15 PM | **Break (15 min)** |
| 2:15 – 3:45 PM | **Breakout Sessions Day 1 (90 min - 7 parallel sessions)** |
| 3:45 – 3:50 PM | **Importance of Teaming - Gatherly introduction** *Dr. Peter de Bock, Program Director, ARPA-E* |
| 3:50 – 5:20 PM | **Optional Networking and Introductions** *In Gatherly, Link:* https://coolingworkshop.event.gatherly.io |
| 5:20 PM | **End of Day 1** |

| Time | Session |
|---|---|
| 12:20 – 12:40 PM | **Invited Talk: "Non-Technical Barriers to EE Technology Adoption in Data Centers"** *Dr. Nichole Hanus, Project Scientist - Electricity Markets and Policy Department, LBNL* |
| 12:40 – 1:00 PM | **Invited Talk: "System Intricacies and Reliability Perspectives from Power Electronics"** *Prof. David Huitink, Assistant Professor of Mechanical Engineering, University of Arkansas* *Prof. Alan Mantooth, Distinguished Professor of Electrical Engineering, University of Arkansas* |
| 1:00 – 1:15 PM | **Break (15 min)** |
| 1:15 – 2:45 PM | **Breakout Sessions Day 2 (90 min - 6 parallel sessions)** |
| 2:45 – 3:00 PM | **Break (15 min)** |
| 3:00 – 3:45 PM | **Technology to Market Panel** *Mr. Tomas Rahkonen, Uptime Institute* *Mr. Michael Bell, Burns and McDonnell* *Moderator: Dr. Rakesh Radhakrishnan, Technology to Market Advisor, ARPA-E* |
| 3:45 – 5:00 PM | **Lab Showcase Panel** *Mr. Aaron Andersen, Advanced Computing Operations Group Manager, NREL* *Mr. Dave Martinez, Engineering Program/Project Lead Infrastructure Computing Services, SNL* *Mr. David Grant, HPC Mechanical Engineer, ORNL* *Dr. Christopher Payne, Department Head - Building & Industrial Applications, LBNL* *Moderator: Dr. Peter de Bock, Program Director, ARPA-E* |
| 5:00 – 5:05 PM | **Closing Remarks** *Dr. Peter de Bock, Program Director, ARPA-E* |
| 5:05 PM | **End of Day 2** |

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