

BREAKOUT Instructions Sheet:

Day 2: Program Pitch (Walk in the shoes of an ARPA-E PD)

- As a group formulate a program level pitch that answers all of the Heilmeyer Criteria, leveraging the content presented on Day 1.
- Nominate one group member to prepare the pitch.
- Convey all the information necessary for the moderator to present a reasonable pitch at the readout session
 - ▶ Justify your program metrics in the context of energy saving.
 - ▶ Build an exemplary system that can potentially meet the program metrics.



Breakout Group #1

First Name	Last Name	Company/Organization
Eric	Rohlfing	ARPA-E Moderator
Dawson	Cagle	Booz Allen Hamilton
Ed	Arens	Berkeley
Bill	Carter	HRL
Jintu	Fan	Cornell University
Alon	Gorodetsky	UCI
Saul	Griffith	Otherlab
Maurice	Gunderson	Gentherm
Craig	Heller	Stanford
Jeff	Muhs	Witricity
Evelyn	Wang	MIT
YuHang	Wang	Univ. of Maryland
Joe	Wang	UCSD
Patrick	Williams	NIKE

Adapted Heilmeier Criteria for Your PTM Program Pitch:

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- ▶ What are the challenges associated with improving building heating and cooling? What are limitations of current personal thermal management (PTM) that prevent its wide spread use to supplement building control?
 - Reduce legacy building control problems through decentralizing thermal control and thereby providing higher percentage of comfort in commercial and residential buildings.
 - Broaden the thermostatic range and reduce energy consumption without the need to modify building HVAC and control systems.
 - Support an array of enabling technologies to achieve this goal.
 - PTM systems at low cost don't really exist. PTM systems must be mass produced and smart – communicating with the building.
 - Current clothing solutions are uncomfortable and not stylish – will not be adopted.
 - Workstation solutions don't exist in with sufficient efficiency and low cost in mass market.

Adapted Heilmeier Criteria for Your PTM Program Pitch:

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- ▶ What is the structure of your PTM program? What technology areas would you fund? For each area, what is the deliverable? What are the metrics for each deliverable? How do these metrics correlate with building energy saving?
- ▶ Category 1: Energy transfer materials/systems, including human physiology aspects of comfort.
 - Deliverables: Efficient and dynamic thermal transfer to or from individual to optimize human comfort.
 - Metrics: COP greater than 1. Corrective power – delta T that system enables at equal comfort.
- ▶ Category 2: Advanced fiber, textile, and clothing technology
 - Deliverables: Swatch of fabric; garment
 - Metrics: Energy transfer capacity (W/m^2). Change in thermal resistance. Durability. Cost (maybe for fabric $< \$5/m^2$ but very dependent upon technology). Moisture control. Comfort.
- ▶ Target applications: Thermally managed clothing, thermally managed workstations, thermally managed workspaces (drapes, carpets)

Adapted Heilmeier Criteria for Your PTM Program Pitch:

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- ▶ What new innovations provide the framework for you to believe that your PTM program will be successful?
 - New understanding of intersection between human physiology (heat balance) and thermal comfort in local environment.
 - New techniques for moving power (e.g. wireless).
 - New material architecture techniques that can be applied to fabrics.
 - Complex, embedded devices.
- ▶ What are the technical and programmatic risks? What breakthroughs are we looking for?
 - Adoption (needs a “luxury” comfort aspect)
 - Safety/liability
 - Maintenance/durability
 - Benchmarking success (energy savings) in the real world.
 - Limitations imposed by existing building control systems.
- ▶ What is the expected composition of a project team?
 - Materials science, human physiology, textiles, designers, control systems

Adapted Heilmeier Criteria for Your PTM Program Pitch:

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- ▶ If your PTM program is successful, who will care? Who needs to care in order to reduce building energy consumption?
 - Stakeholders: Occupants, tenants, operators, owners, designers (clothing, workstations), industry.
- ▶ How mature can we develop PTM technologies with 3 years of ARPA-e investment? How long and how much will it take to further develop the technology to be ready for commercialization? What is your expected technology transition pathway to market? What are potential first/adjacent markets?
 - Maturity: beta testing prototypes
 - Further development:
 - Pathway: Brand (clothing, furniture, device) that will bring it to market (will put the chain together).
 - Textile manufactures
 - Clothing designers
 - Workstation designers
 - Measure and demonstrate corrective power and make case to building industry to realize energy savings.



ARPA-E Program Merit Questions

(Variants of the Heilmeier DARPA Questions)

- ▶ What is the problem to be solved, stated clearly so the educated layperson can understand?
- ▶ If successful, how will the proposed program advance the three elements of the ARPA-E mission: reduced energy-related emissions, reduced imported energy, and enhanced energy efficiency?
- ▶ What are the program goals and how will progress towards those goals be measured?
- ▶ What is the current state of R&D in this area and how is the proposed program approach transformative and disruptive relative to that state?
- ▶ What are the critical (three) scientific and engineering breakthroughs needed to assure program success?
- ▶ What research communities need to be brought together to create research teams to address the program goals? Is there a critical mass of experts to make the program successful?
- ▶ What will happen to the program results at the end of the program? How will the program transition, who will be the early adopters, and what is the path to commercialization?
- ▶ What are the policy and market barriers for successful deployment of the proposed technologies?
- ▶ How does the program fit within the overall DOE R&D portfolio? How does it complement other DOE efforts? Are other federal agencies attacking the problem and, if so, how?