Documentation of Proceedings at the

U.S. Department of Defense

Building Criteria Workshop

April 29-30, Washington D.C.

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Disclaimer

This document attempts to capture workshop proceedings as accurately and detailed as reasonable, with minimal distillation or elaboration, as illustrative of expert opinion for the consideration of DoD leadership. In limited cases where workshop discussions may have explored speculation or circumstantial considerations related to DoD activities, this document has attempted to avoid inadvertent misrepresentation and rather capture the intended themes and relevant pathways for further substantiation.

This document does not represent the opinions or policy of the U.S. Government and should not be considered representative of DoD activities or priorities— past, present or future.

Introduction

This document captures the proceedings of the U.S. Department of Defense (DoD) Building Criteria Workshop held April 29-30, 2024, at the Ronald Reagan Building and International Trade Center in Washington D.C. The workshop convened approximately 100 individuals from the DoD, other federal agencies, and the private sector who are experts in building codes and standards, including the topics of resilience, clean and reliable energy, electrification and indoor environmental quality. Private sector participants joined voluntarily and were engaged via an open Request for Participation process. The purpose of the workshop is described in the following sections.

This document was prepared by RMI, BuildingGreen, New Buildings Institute and Leidos, who facilitated the workshop, working under the Strategic Climate Sustainability and Resilience Services (SCSRS) contract.

Building Criteria Workshop Summary

Context and Purpose of the Workshop

The context and intention of the workshop was documented in the Core Purpose Statement and a series of associated "desired outcomes." To ensure that the workshop plan was aligned with The Office of the Secretary of Defense (OSD)'s intentions, the workshop facilitators drafted and iterated a Core Purpose Statement based on the brief they were responding to and preliminary conversations with OSD personnel. This draft was refined over the course of the planning process in response to direction and feedback from The Honorable Brendan Owens, Assistant Secretary of Defense for Energy, Installations, and Environment (ASD (EI&E)), and his office.

A near-final version was included in the Read-Ahead materials to participants, and the final version was presented at the workshop to help participants align their expectations and efforts.

The Core Purpose Statement of this Workshop is:

To: Convene a meeting of government and private sector building code experts to assess and benchmark DoD Unified Facilities Criteria ("UFC" or "Criteria") against existing and emerging codes, policies, and building performance standards in terms of resilience, clean and reliable energy, electrification, and indoor environmental quality, and propose an approach for continuing simplification and enhancement of DoD Criteria and surrounding systems and processes.

> **In a way that is:** visionary, welcoming, curious, rigorous, brave, and humble in the face of diverse perspectives
>
> **So that:** DoD installations continue to improve as places for service members, families, and civilian workforce to thrive and serve. These improved facilities will better support energy and supply chain resilience, recruitment, retention, and community relations to ensure mission readiness.

Desired Outcomes:

> **Tangible**
>
> 1. A set of core principles to guide the advancement of DoD Building Criteria and address resilience, occupant health and wellbeing, energy efficiency, electrification, and the transition to clean energy.
> 2. The outline of a strategic plan for the evolution of the UFC over the next five years and beyond, including UFC organization, update and change process, resource requirements, and immediate next steps.
> 3. Specific metrics, benchmarks, resources or key details from industry that should be considered for adoption into UFC to help achieve goals in 1, above.

Intangible

4. Enthusiasm and excitement for moving this agenda forward
5. Relationships and professional connections between participants from the military, other government agencies, and the private sector that can be tapped for follow-up
6. Solid understanding of the UFC change process and context among participants so they can better support DoD in moving this agenda forward

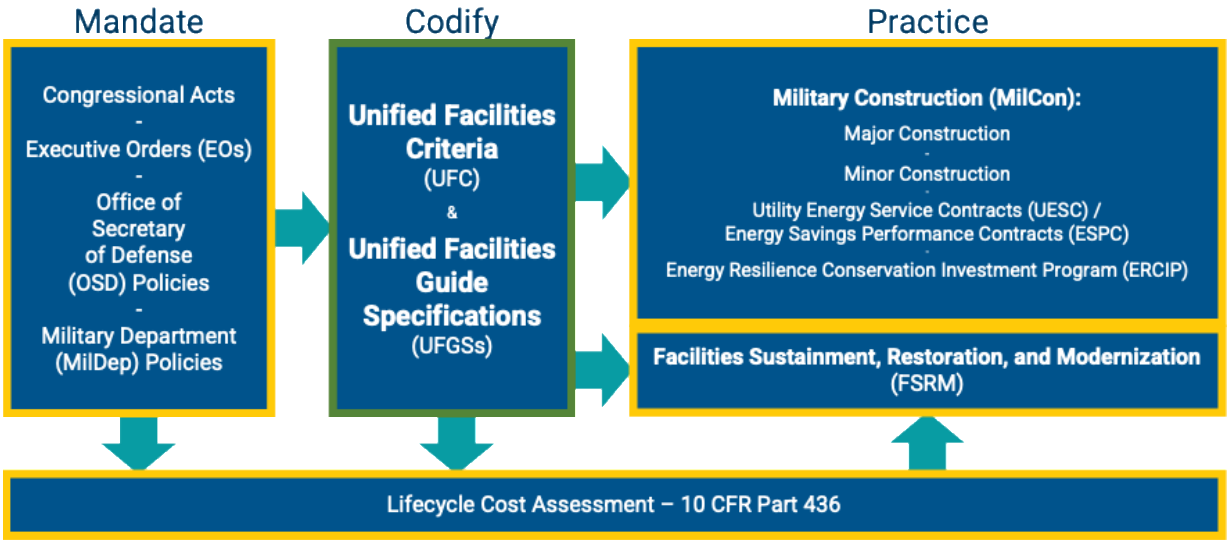
Workshop Problem Boundary

The Unified Facilities Criteria provide planning, design, construction, sustainment, restoration, and modernization criteria, and apply to the Military Departments, the Defense Agencies, and the DoD Field Activities. The workshop was conceived and facilitated with the Criteria at the center of discussion, recognizing its important role in the shaping of DoD's built assets and helping ensure achievement of the DoD mission through readiness and resilience.

The Criteria are part of a complex system (Figure 1). The Criteria reflect, delineate and make actionable a range of mandates, including Congressional Acts, Executive Orders (EOs), policies from the OSD and policies from the Military Departments (MilDeps). They have been created and maintained for approximately thirty years through a rigorous and formal process that leverages deep subject matter expertise and institutional knowledge. The Criteria serve DoD's large and diverse portfolio of over 280,000 buildings across thousands of sites worldwide, representing nearly every building use type, climate zone and operating environments. The Criteria are applied in practice in projects across the range of DoD project funding and delivery authorities. This complex system informed the workshop problem boundary

- The Criteria itself is the primary focus of this workshop, including organization, content and maintenance, and benchmarking best practices.
- The workshop can explore action pathways related to the surround system and processes, particularly their relationship to the Criteria.

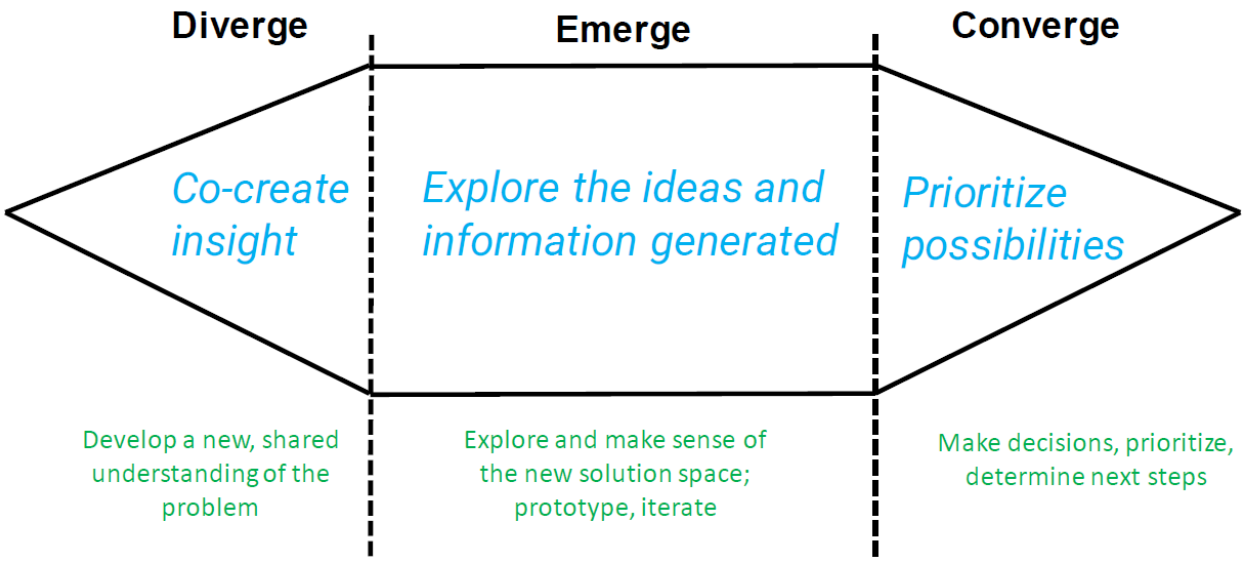
Figure 1: Workshop Problem Boundary



Workshop Approach & Agenda Arc Overview

RMI, BuildingGreen, and New Building Institute facilitated the DoD Building Criteria Workshop based on a common framework used by organizations that specialize in collaborative problem-solving and facilitation, known as "*Diverge*, *Emerge*, *Converge*" (See Figure 2). This process begins with expansion—co-creating insights—and developing new shared understanding of the problem(s). Once the group has had ample time to dive into the problem, they begin shifting to explore the ideas and information generated; they explore and make sense of the new solution space and iterate. In this phase, ideas and insights start to emerge. At this point, participants are moved to converge —prioritizing possibilities, making decisions and determining next steps.

Figure 2: Conceptual workshop approach and agenda



The Building Criteria Workshop opened with remarks from Honorable Brendan Owens (ASD EI&E), remarks from Cara Carmichael from White House Council on Environmental Quality (CEQ), a review of the core purpose statement, and foundation setting to bring all participants to the same baseline for critical working knowledge. See **Appendix A: Opening Keynotes**.

Beginning the *diverge* stage of the workshop, participants of the workshop were prompted to envision an installation of the future—representative of high-performance outcomes. Participants envisioned a future where installations have low-carbon and soldier/human-centered design surrounded by nature-based solutions to enhance health, productivity and climate resilience. Future installations were also envisioned to have top-tier security and protection, smart building technologies and community engagement and relations. See **Appendix B: Visioning an Installation of the Future**.

From there, participants were divided into breakout groups by key topics: resilience, passive design, electrification, grid integration, clean and reliable energy, health and wellbeing: indoor air quality, health and wellbeing: human comfort, health and wellbeing: moisture, safety and community, and

embodied carbon. Groups explored best practices, metrics, and benchmarks for their given topic, ideating what has been working well and what is still unresolved for both government and industry. Participants started entering the *emerge* phase as key themes started bubbling to the surface. See **Appendix C: Best Practices, Benchmarks, Metrics**.

After reporting out emerging themes for each topic, participants were encouraged to continue thinking about the collection of emerging themes and articulate—in a fun and creative way—guiding principles through pithy "bumper sticker" slogans. See **Appendix D: Core Principles**.

Day 1 closed with a plenary discussion and idea collection exercise, to record and begin organizing emergent themes to inform the work of Day 2, described in **Appendix E: Focus Topics for Day 2**.

On Day 2, workshop attendees entered the final stage of collaborative problem solving: *converge*. The facilitation team had processed outputs of Day 1 overnight and offered a set of synthesized ideas to focus efforts for the day, which received refinement from participants in plenary discussion. Participants then self-selected to opt into the topic of discussion where they had the most knowledge, expertise, or energy to contribute. The breakout topics included both action pathway deep dives on themes from Day 1 as well as cross-cutting themes, listed in Figure 3. Each group explored potential action pathways for their topic, including identifying what success looks like, how it supports DoD's mission, studies needed, metrics, policy, process, and proof points. Each group presented their findings to the full group of workshop participants, who in return provided feedback and coaching questions to support the refinement of action pathways.

Figure 3: Topics for Day 2 Action Pathways breakout work

Deep Dives on Themes from Day 1	***Cross-Cutting Themes***
1. Human-centric performance ○ Indoor Environmental Quality (IEQ) ○ Integrating "Customer" input on design process **2. Holistic climate adaptation and resilience** ○ Metrics ○ Bulk Purchasing ○ System Planning **3. Embodied carbon** ○ Standard ○ Market engagement **4. Electrification / Grid Integration / Load Flexibility** ○ Integrative design approaches ○ Incentive structure	**5. Long-tail Operations & Maintenance (O&M)** ○ Bridging design into operational performance **6. Performance standards** ○ Carbon/energy/other **7. Facilities Sustainment, Restoration, and Modernization (FSRM)** ○ UFCs in standard practice ○ Strategic prioritization and planning **8. Life-cycle Cost Analysis (LCCA)** ○ Improving current process ○ Incorporating non-energy benefits **9. Streamlining UFC maintenance** Note: Two additional cross-cutting topics were initially identified but did not receive independent breakout focus. These themes were encouraged for consideration with other groups: - Bulk purchasing - Best Practices become Practices

Action Pathways Overview

Action Pathway breakout work and feedback are documented in **Appendix F: Action Pathways** by breakout groups:

(1) Human-Centric Performance (HCP)
(2) Holistic Climate Adaptation and Resilience
(3) Embodied Carbon
(4) Electrification and Grid Integration
(5) Long-tail Operations & Maintenance
(6) Building Performance Standards
(7) Facilities Sustainment, Restoration and Maintenance (FSRM)
(8) Life-cycle Cost Analysis (LCCA)
(9) Streamlining the UFCs

Offers of Support and Closing

Participants were given an option to record offers of support, to help DoD understand opportunities for knowledge exchange and advancement of the Criteria and its surrounding ecosystem, leveraging expertise within and beyond DoD.

In closing remarks, Honorable Owens reaffirmed the three priorities of the Secretary of Defense, as expressed in his annual statement:

1. Defend the nation.
2. Take care of our people.
3. Succeed through teamwork.

The efforts and ideas of this workshop relate directly to these goals, and Mr. Owens emphasized the opportunity to support the second goal in particular— taking care of DoD's people. Achieving the ideas discussed in this workshop should be expected to be challenging, but the rewards are worth the effort and support the DoD mission. Additional excerpts in **Appendix G: Closing Remarks**.

Appendix A: Opening Keynotes

Excerpts from remarks by Hon. Brendan Owens, ASD EI&E:

- Deputy Secretary of Defense request: Put people at the center of everything we do. Support our people. The Criteria can help DoD create buildings that help people thrive.
- DoD currently faces around $134 Billion in deferred sustainment. This can represent a risk, and can take a toll on our people, but “our workforce has found a way to do the work despite that risk.”
- The recent Resilient and Healthy Defense Communities Strategy (RHDC) is a response to these circumstances and a key piece of context for this workshop.
- This opportunity can have a direct impact on performance and mental state and DoD mission.
- We should identify any slippage points between the aspiration of the Criteria and the delivery.
- All the prior work to develop and sustain the Criteria is foundational to where we've gotten. We want to continue resourcing that excellent work.
- Put people at the center of this.

Excerpts from remarks by Cara Carmichael, CEQ:

- The President set forth the most ambitious climate agenda in history. The U.S. Government is leading by example and DoD in particular is driving significant and lasting impact and setting precedent for other agencies to aspire to.
- Executive Order 14057 targets a net zero emissions federal buildings portfolio by 2045, including cutting emissions in half by 2032 by prioritizing efficiency and electrification.
- Today and over the next couple of days we have an opportunity to lift the status quo.

Appendix B: Visioning an Installation of the Future

Key themes: Human-centered design to enhance health and productivity, climate resilient and low carbon design, smart building technologies, security and protection, nature, community engagement/relations.

- High performing working teams (health, community, productivity)
    - Sensory experience: sight, sound, and smell are all informing a positive human experience that enables greater productivity
    - Installations are functional and support wellness and comradery
    - Enablers include adequate daylighting, fresh, clean air, ventilation, ergonomic workplaces, quiet flexible spaces, barracks that aren't cramped, community gathering spaces (indoor and outdoor)
- Advanced materials and technology
    - Materials and energy
        - Climate resilient development
        - Low carbon, buildings are electrified and have passive design
        - Onsite power generation; microgrids, self-generating
        - Backup energy supply
        - Concrete absorbing CO_2
        - Biochar facilities to supply power and enrich local agriculture practices
        - Designed for disassembly
    - Energy center
        - Energy dashboards, real time monitoring, fully connected, controllable buildings, grid flexible, AI controlled
        - Smart, digital technologies
        - Data-driven management
- Siting, density, and transportation
    - Easily walkable
    - Mobility options, including transit
    - All electric + EV charging
- Nature and green space
    - Using nature for resilience purposes, cooling purposes, and human comfort.
    - Blurring the lines between inside and outside
    - Shaded outdoor spaces
    - Regenerative agriculture within and around bases
- Secure / Protection – isolation of critical defense infrastructure
    - "Entrance" at a civic center with a tram to outlying base.
    - Few visible above ground facilities, base below ground, self-contained, forest layer above ground with exits
    - Passive security checks
    - Hidden parking and/or commuting

- Surrounding communities
    - Engagement with surrounding communities
    - Sensitive connections with neighbors
- Codes need to influence all parts of a building's life cycle
    - Regular building maintenance

Appendix C: Best Practices, Benchmarks, Metrics

(1) Resilience

What is going well in DoD?

- Security
- Fire protection
- Emergency power
- Adapting commercial standards
- Sea level rise awareness in planning
- Department of Defense Regional Sea Level (DRSL) – sea level rise model for DoD use
- Focus on building lifecycle – long term investment
- Force projection
- Response plans to past events
- Low impact development for water resource resilience
- Cyber security
- Criteria development for new resilience technologies

What is going well in Industry?

- Awareness that climate risk = financial risk
- Speed of execution (when supply is available)
- Minimum design standards
- Leveraging capital for infrastructure development debt financing
- American Society for Testing and Materials (ASTM) property resilience assessment
- Asset scale risk assessment
- Cloud-based solutions
- Environmental social governance
- Designing technical solutions
- Utilities work nearly all of the time
- Cyber security banks and data farms

What is still to be solved in DoD?

- Zero trust architecture
- Continuous monitoring Operational Technology (OT) Facility-Related Control Systems (FRCs)
- Industry perceives that DoD doesn't leverage private capital for resilience as much as they could.[1]
- Poorly defined what is extreme event such as rainfall or wind
- Facility and campus resilience

[1] Post-workshop note: Each Service has a sub organization dedicated to engaging with private entities to build community scale resilience projects on installations. For example, Army has leveraged over $600M or private capital to support installation resilience and energy surety.

- Indoor air quality – mold
- Consistent requirements for resilience
- Infrastructure maintenance for resilience
- Criteria development for new resilience technologies
- Analytics standardization / updated Utility Monitoring and Control Systems (UMC) adoption
- Support for off-base staff, families, etc. + ops and procedures
- Passive sustainability of buildings
- Consistent design solutions for sea level rise
- Healthy buildings
- Integration of renewable resources for resilience
- Availability, reliability
- OSD should standardize measures of resilience performance
- Education
- Future proofing design

What is still to be solved in Industry?

- Tracking and monitoring
- Batter storage systems
- Supply chain consistency
- How to get people to work during contingencies
- Future proofing design
- Cyber security
- Using renewables for anything other than the grid
- Passive sustainability of buildings
- Pricing physical climate risk
- Quantifiable metrics for success
- Outdoor design temps
- Healthy buildings
- Market scale risk assessment
- Electrification solutions for anything mission critical
- Materials for high seismic environments
- Consistent design solutions for resiliency
- Tends to short term infrastructure and investment

Additional Discussion Notes

- Climate change adaptability is needed for government
- DoD has buying power > Can take advantage of block buys
    - Defense Advanced Research Projects Agency (DARPA)
    - Federal Acquisition Regulations (FAR) inhibits this
        - If you can “see” AC as commercial equipment, you can get around FAR
        - FAR maintaining competition

    - Challenge: The way DoD is funded
        - Can potentially solve via a performance basis
- Execution challenges for DoD
    - No consistent design solution > adaptation measures must be custom fit > no 2 sites are identical (different hazards, different installation energy infrastructure)
    - Must be cost effective
- Building codes are focusing on tech which could stifle innovation
- DoD could focus on entire neighborhood scale
    - What does whole base/campus look like?
    - Debt financing could support build whole base of future
- Look at system and then narrow to buildings

Overarching Themes

- **Diversity in clean energy in codes**: backfire of electrification being codified versus decarbonization and air quality technology.
- **Not every building needs to be resilient:** Assess needs based on function and consequence.
- **Bulk buy** – to support holistic planning / make it more economically viable
- **Identify quantifiable metrics for resilience** to minimize requirements and performance unknowns quantified as zero in life-cycle cost analysis (LCCA).
- **More flexibility in solving resilience challenges.** They are not “one size fits all” solutions.

(2) Passive Design

Discussion highlights: The analysis highlights significant progress in integrating passive design strategies within both governmental and industry contexts. Government initiatives have effectively incorporated best practices, air tightness measures, and pilot projects, although challenges remain in adopting passive design into building codes and addressing cultural shifts towards energy conservation. Conversely, the industry has shown advancement through educating new designers, implementing retrofit projects, and conducting valuable studies on human health and behavior. However, cost barriers, behavioral changes, and the need for enhanced education and skills pose ongoing challenges. Overall, addressing these issues can lead to broader adoption of passive design, enhancing energy efficiency, comfort, and sustainability across buildings and communities.

What is going well in DoD?

- Integration of "Best Practices" into Criteria
- Focus on Air Tightness
- Clear Commitments and Incentives
- Energizing New Buildings Policy
- Emphasis on Thermal Envelopes and Passive Design
- Pilot Projects Implementation
- Efforts to Include Passive Design in Building Codes

What is going well in Industry?

- Education of New Generation Designers in Passive Design
- PHIUS as Basis for Affordable Housing Programs
- Industrialized Retrofit Projects
- Studies on Cognitive Function and carbon dioxide (CO2) Reduction
- Daylighting Studies
- Solar Panel Shading
- Research on Lighting and Health
- Use of Standard Alternatives like Energy Star, Zero Energy Home, Passive House Institute US (PHIUS), Indoor Air Plus

What is still to be solved in DoD?

- Lack of Life-Cycle Cost Analysis (LCCA) Co-Benefits
- Linear LCCA Approach
- Inability to Include Passive Design during Repairs (FSRM)
- How to optimize passive design, which is encouraged, but not mandated or statutorily required through criteria or adoption of code overlay (e.g. Phius)
- Need for Patience in Assessment
- Strategies for Cost-Effective Solutions in Existing Buildings
- Design Considerations for Safety Hours
- Cultural Shift towards Energy Conservation
- Improvement in Piping and Duct Design
- Challenges in Historic Building Envelope Design/Renovation

What is still to be solved in the Industry?

- Cost Barriers for Materials, Labor, and New Technology
- Behavioral Changes and Occupant Behavior
- Education and Training on Passive Design Strategies
- Lack of Critical Skills to Implement Passive Strategies
- Budget Constraints
- Importance of Life-Cycle Cost and Human Behavior in Design

Overarching Themes

- Changing the culture towards Building Design Construction and Use
- Integrated design and multi-discipline approach is critical
- Include all systems together (including envelopes) in lifecycle cost cap peak heating and cooling loads
- Marketing towards well-being and resiliency
- Integrate passive design specs and standards into government codes
- Education and training

(3) Electrification

Discussion highlights: There is broad-based support to integrate electrification more into building construction and retrofits, but current protocol and approval processes hinder the scaling of these efforts. For example, LCCAs have been used to validate gas-powered upgrades and systems when there could be an opportunity to incorporate electrification savings and benefits. The breakout group agreed that these electrification solutions are not "exotic" and industry actually has a great track record of electrification.

Overall, there was consensus among government and industry participants that the following can improve building electrification progress in the DOD portfolio:

1. Adjust the incentive structure for contractors to include operational performance (i.e. operations & maintenance (O&M) tail for 2-5 years post project completion), if possible. There could be an opportunity to tighten up the operations and maintenance of the DoD's portfolio with changes in contracts that make contractors accountable for high performance, although enforcement mechanisms are unknown and would need to be piloted.
2. Balance UFCs with more performance-based metrics in project assessments because criteria as it exists may be too prescriptive. Industry feels that requirements are too prescriptive and LCCA protocol is too restrictive on new energy technology and leads facility managers to default on fossil fuel systems.
3. Limited discretionary funds to address all requirements, which leads to selection of the most critical facilities in which to invest.

What is going well in DoD?

- Better collaboration
- Money/resources: DoD has resources
- Top cover from Executive Order and OSD policy
- Mature process to acquire/renovate buildings

What is going well in Industry?

- Procurement strategy – innovation/based on performance
- Effective electric hot water heating solutions
- Good at forecasting grid capacity needs
- Transparency on performance --> project awards
- Project awards have been based on past success
- Excel at advanced energy design
- Pairing efficiency/weatherization with heat pumps, in terms of:
    - Order
    - Design
    - Costs
    - Programs/initiatives

- Renovations using cost neutral approach: energy service company (ESCO)
- Private industry success stories in electrification exist

What is still to be solved in DoD?

- How do we be prescriptive enough for industry partners while figuring out the most effective implementation strategy?
- LCCA is being used for non-electric projects (example shared: LCCA has been used as a tool to validate gas projects)
- How to integrate LCCA into electrification projects
- Change past performance qualification (PPQ) to include building performance
- LCCA guidance could be improved
- Forecasting demand and growth
- Raise the construction industry floor – make consistent across the "mom and pop construction shops"
- There is a problem preserving scope
- How to tie military mission with electrification
- Attitudes + money + culture change (industry as well)
- Enact performance contracts for buildings
- Incentives for contractors could be improved
- Where to invest money regionally? Government should pursue prioritization study
- Prescriptive vs innovative approach – how does DOD balance the two?
- How to be a savvy buyer
- Preserving funding for focused investments

What is still to be solved in the Industry?

- How to make the economics work for electrification projects in cold weather climates
    - i.e. cold climate heating
- Lack of UFC application and experience
- Costs/financing of electrification
- Attitudes + money + culture change (government as well)
- Refrigerant and greenhouse gas (GHG) impact

(4) Grid Integration

Discussion highlights: The Best Practices, Benchmarks, and Metrics 2x2 analysis highlighted both successful implementations and ongoing challenges in grid integration across the Department of Defense (DoD) and industry sectors. The DoD has excelled in areas like technology pilots' successful commercialization, adoption of a GHG dashboard for enhanced energy planning, and efficient critical mission planning, showcasing a commitment to resilient energy solutions. Industry, on the other hand, has made significant progress in energy efficiency through Smart Building Automation Systems (BAS) and the deployment of Distributed Energy Resources (DERs), emphasizing sustainability and resource

management. However, both sectors face unsolved challenges, such as non-proprietary Utility Monitoring and Control Systems (UMC) enforcement and workforce training gaps in DoD, and issues with aging infrastructure and cybersecurity concerns in the industry. The overarching themes highlight the need for policy alignment, incentivizing infrastructure upgrades, strengthening business cases, matching technology advances with infrastructure integration, and addressing workforce readiness for emerging technologies like AI. These insights underscore the complexity of grid integration, requiring a holistic approach that encompasses policy, technology, workforce development, and cybersecurity considerations.

What is going well in DoD?

- GHG Dashboard for Existing Energy Planning: Implementation of a Greenhouse Gas (GHG) dashboard as a supplement to the Master Plan, enhancing energy planning capabilities and sustainability initiatives.
- Critical Mission Plans: Effective development and execution of critical mission plans, ensuring operational resilience and optimized resource utilization.
- Enhanced Use and Capacity: Utilization of resources at enhanced levels and capacity management strategies, improving operational efficiency and cost-effectiveness.
- Uninterruptible Power Supply for Critical Loads: Utilization of Uninterruptible Power Supplies (UPS) for critical load management, ensuring continuous operations during power disruptions.
- Microgrid Excitement: Positive reception and excitement around microgrid development, showcasing a commitment to resilient and distributed energy solutions.
- Efficient and Resilient Technologies: Existence and adoption of efficient and resilient technologies within the government sector, contributing to sustainability and operational reliability.

What is going well in the Industry?

- Technology Pilots and Commercialization Outside of DoD: Successful technology pilots and incubation efforts leading to commercialization beyond DoD, fostering innovation and market expansion.
- Smart BAS Improvements: Continuous improvement in Smart Building Automation Systems (BAS), enhancing building operations and energy efficiency.
- Deployment of DERs: Successful deployment of Distributed Energy Resources (DERs), contributing to sustainable energy practices and grid flexibility.
- Utility Demand Response Programs: Existence of utility demand response programs, promoting energy conservation and grid stability.
- Potential in Distinct Energy Systems: Recognition of the potential of distinct energy systems, fostering innovation and diverse energy solutions.
- Thermal Energy Storage: Adoption of thermal energy storage solutions, improving energy management and cost savings.
- Heat Pump Water Heaters: Adoption of heat pump water heaters for energy efficiency, reducing energy consumption and environmental impact.

What is still to be solved in DoD?

- Non-Enforcement of Non-Proprietary UMCs: Addressing challenges in enforcing non-proprietary Utility Monitoring and Control Systems (UMCs) requirements, promoting interoperability and standardization.
- Shared Building Systems: Resolving issues with shared building systems like HVAC controls, improving system efficiency and user comfort.
- Passive Strategies Utilization: Encouraging the utilization of passive strategies when feasible, enhancing energy efficiency and sustainability.
- Technology Adoption and Vetting: Streamlining the adoption and vetting process for new technologies, addressing cybersecurity concerns and promoting innovation.
- Microgrid Planning and Reliability: Developing a comprehensive microgrid reliability model and expanding planning focus beyond on-site and isolated scenarios, enhancing grid resilience and flexibility.
- Metering and Data: Improving metering, submetering, and end-use data collection, enabling informed decision-making and resource optimization.
- Top-Down Planning and Training: Establishing top-down planning models and providing training on building use and new technologies, promoting strategic alignment and workforce readiness.

What is still to be solved in the Industry?

- Upgrading AMI Systems: Addressing challenges with aging Advanced Metering Infrastructure (AMI) systems, improving data collection and analysis capabilities.
- Adapting to Changing Peak Loads: Developing strategies to manage changing peak loads effectively, optimizing energy usage and grid stability.
- Integrating Software Platforms: Improving software integrability and addressing challenges with proprietary versus non-proprietary operating platforms, enhancing system interoperability and efficiency.
- Workforce Training and Role of AI: Providing workforce training on new technologies and determining the optimal role of Artificial Intelligence (AI) in energy management, fostering innovation and operational excellence.
- Flexibility in Load Management: Balancing flexible loads without compromising comfort and operations, promoting energy conservation and grid flexibility.
- Enhancing Datacenter Information: Addressing gaps in grid versus standalone information for datacenters, improving operational visibility and efficiency.

(5) Clean and Reliable Energy

Discussion highlights: The clean and reliable energy group featured a strong mix of both government and industry representatives. The themes for UFC improvement generally represented the ideas well. These included flexibility, risk (when appropriate), outcomes/performance driven, and cost-effective. There was interest in exploring how flexibility and appropriate risk could be incorporated into the process. For example, how could we enable a project developer to substitute the latest in energy storage technology or look beyond the 1391 Boundary limits if the result would be better for the government?

There was a push from the industry side of the conversation for more accountability, and an outcome driven approach to the UFCs. The concern was that the government doesn't properly evaluate the project's results against the project's proposed performance. There was also a general interest from both sides to learn more from each other. There was a call for a "sector specific way to collaborate" along with a "lack of visibility in understanding the DoD/government needs and gaps."

Themes for Criteria improvement

- Flexibility
- Risk (allow risk when appropriate)
- Outcome/Performance Driven
- Cost-effective

What is going well in DoD?

- Energy Master plan (They are doing it.)
- Procurement power & Scale of implementation (the DoD can use it)
- EO 14057 defines clean Energy goals and allows time for Planning, Programming, Budgeting, and Execution (PPBE)
- Net-Zero Goals and Mandates show leadership
- Leadership + direction – a willingness to improve and iterate
- Base of the future – example Tyndall AFB
- 50001 Ready Benchmark for Energy, Resilience, Electrification (management system)
- Identified 3rd party contracting plus funding pathways Energy savings performance contracts (ESPCS); UESCs can be used for on-site generation

What is going well in the Industry?

- Industry doesn't do LCCA for firm decision making
- Integrating electronic system and using offsite configuration and testing to proof performance prior to installation
- Innovative technologies are coming to the market but being utilized by industry
- Energy storage Tech going well, rapidly growing.
- Industry held to accountability to win the next job based on performance, Design ESPC
- Tax Incentive's

What is still to be solved in DoD?

- 1391 Boundary limits offsite (e.g. I can go in later and put solar on the parking lot)
- Selects based on who did the last job, not on whether it done well.
- How to scale and handle the DoD footprint to meet resilience and other goals
- Rules for ESPC do not allow for non-building energy reductions (EVs, etc)
- Moving faster than industry – there needs to be more sector specific ways to collaborate and know you are integrating the latest and greatest

- DoD introducing new strategies Other Transaction Authority (OTA), Cooperative Research and Development Agreement (CRADA), Enterprise Software Agreements (ESAS), Utilities Privatization (UP)
- Holistic systemic planning for clean + reliable, including energy substitution/mitigation
- Nuclear Small Modular Reactors (SMR)/ Advanced Modular Reactors (AMR) have potential but major risks involved with community approval & timelines
- Maintaining performance of energy and reliability of system intelligence in systems to maintain performances
- Building infrastructure to withstand future extreme weather events

What is still to be solved in the Industry?

- Texas and California: Capacity issues with electrification goal and growth, AI, Data Centers, Weapons
- Human Capital
- Building infrastructure to withstand future extreme weather events
- Energy savings – the utility/firms always do the easiest thing
- Lack of visibility in understanding the DoD/govt needs and gaps – For example microgrids a priority in NDAA but industry doesn't know what actions came out of that.
- Problem Industry measure everything in $$$
- Social responsibility unless there is a PR concern, shareholder pressure.
- Performance Contracting – Technologically Conversative.
- Supply Chain and Rare Earth Metal supply concerns.
- Interest Rates, Supply Chain
- Scaling Clean Firm Power

(6) Health & Wellbeing: Indoor Air Quality

Discussion highlights: The group first acknowledged that the UFCs are helpful and there's no need to "ditch the entire system." However, there seems to be a lag between the UFC updates and the latest standards, including American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)'s recent updates to 189, 241, and the latest wildfire guidance. WELL and LEED may also serve as examples as DoD explores raising the bar on IAQ.

It would help project teams to bring more transparency to the update process so that the teams know the status of Criteria Change Requests (CCRs) and when things have already been considered. There are also currently gaps in the industry that DoD may be able to help fill with research and its scale, including: supporting a study/roadmap for implementing equivalent clean air principles, collecting Indoor Air Quality (IAQ) data, health surveys, and absenteeism data to further make the case for IAQ upgrades, and setting research-backed key performance indicators for IAQ that contractors and facility managers can be held accountable to. Finally, it was recommended that DoD find a way to better communicate its

aspirations, and not just minimum requirements, either through a good, better, best framework or guiding principles.

What is going well in DoD?

- Sustainable design practices are emphasized
- Enforcement of AHSHRAE 62.1 through UFC 3-460-02
- Existence of CCRs as a method to capture guidance/lessons learned

What is going well in the Industry?

- WELL rating system (especially with regards to pushing actual monitoring)
- LEED's req of 30% increase in outdoor air
- More off the shelf monitoring solutions than ever before
- Studies on health benefits, like Harvard's Cogfx study
- Pairing filtration and ultraviolet (UV) light to address viruses like COVID
- ASHRAE Standards
    - 241 Aerosol control
    - Wildfire guidelines
    - 62.1 updates to IAQP
    - Air cleaning efficiency standards (62.1 Addendum)
    - Shift from outdoor air to concept of "equivalent clean air"

What is still to be solved in the Industry?

- Lack of funding to pay for IAQ standards
- Ventilation rates based on data
- IAQP awareness and adoption
- Widespread benchmarking IAQ for existing buildings
- Lack of outdoor air making it into spaces (often dampers are closed manually)
- Standardized KPIs for IAQ (e.g. CO2, PM) --and agreement on a definition of IAQ
- Balancing tension of energy and IAQ
- Good sensor technologies for certain gases (e.g. ozone, benzene)
- Agreement on how to design ventilation balancing priorities of energy, COVID, and wildfires
- Missing information and research about other qualities of outdoor air, like how it affects our microbiome

What is still to be solved in DoD and the Industry?

- Climate adjustments for environmental factors
- Automatic detection systems for energy conservation
- Existing buildings (1/3 GSA buildings are not meeting ASHRAE 62 requirement for minimum outdoor air)

What is still to be solved in DoD?

- Airside economization

- UFC references the 62.1 ventilation role procedure but not the IAQ procedure (it is not clear whether the performance pathway is allowed)
- Have not adopted ASHRAE 241
- Lack of collaboration with other federal agencies
- UFC update timeframes lag behind the standard updates
- Direct to zone vs. Direct to space
- Life cycle cost analysis for IAQ measures
- Capturing health outcomes where ventilation rates were increased
- Integrated architectural solutions
- Upholding the UFCs—this is outsourced to the engineers
- Giving power to the installation commanders to prioritize IAQ retrofits and ranking their job performance on sustainability metrics

(7) Health & Wellbeing: Human Comfort

Discussion highlights: Participants advocated strongly for a circular design process with two-way information flow (and training, as appropriate) between designers, occupants, and O&M staff. This would be particularly valuable for government, but industry could also benefit from wider adoption of practices like O&M contracts with original contractors. There are also several areas where government could learn from industry (or DoD could learn from GSA), such as adopting existing standards and using advanced technological and sensor options to understand real-time performance and allow more customization.

Key themes

- Importance of individually customized comfort
- Create a circular design process with two-way information flow: occupant feedback to designers, training for O&M staff
    - GSA, WELL performance rating, (International Green Construction Code) IgCC O&M, (International Organization for Standardization) ISO 16218 as examples
- More organized and comprehensive cross-agency sharing of information and lessons learned

What is going well in DoD?

- [Existence of] UFCs and UFGS to address

What is going well in DoD and the industry?

- Defining temperature set points for spaces
- Resilience awareness
- Acoustic standards
- Vocational-use facilities – thermal, acoustic, visual comfort is good [I think this was incorrectly placed on the grid and belongs here]

What is going well in the Industry?

- Working to address by standards
- Advanced technology options available
- O&M contracts with original contractor
- Better sensors to understand real-time performance
- ASHRAE 241 responsiveness to events
- WELL performance rating

What is still to be solved in DoD?

- Conflicts between resiliency & "green codes" and mission
- Housing – there are issues with thermal, acoustical, and visual comfort
- Enforcing temp setpoints in spaces
- Enforcing design codes and specs
- Flexibility for change of space programming
- Maintenance and training of building professionals
- Views for everyone – glare resistance
- Creating systems that cannot be maintained
- Building controls maintenance, maintenance control systems

What is still to be solved in DoD and the Industry?

- Planning for a varied load
- Thermal vs visual
- Standards serve a narrow band of experiences and leave a lot of people out
- Cost and time to achieve high performance

What is still to be solved in the Industry?

- Occupant satisfaction economics (instead of value engineering)
- Lack of money (first cost) and budget
- Integration of future climate scenarios
- Artificial lighting remaining constant

(8) Health & Wellbeing: Moisture

Discussion highlights: This discussion group included design and engineering representatives from two service branches and industry experts in health and wellbeing, passive and sustainable design, standards and ratings development, compliance, and government buildings projects. Expanding on the theme of moisture management, participants framed much of the discussion around the need for improved practices and mindsets around robust maintenance, backstopped by relatively simple technology interventions. Participants agreed that industry and DoD may have different motivations around this topic, but that thoughtful framing and guidance could help drive it. The wide gap in resources, tools, and practice for moisture management (including high-performance and well-designed envelope systems)

between new construction (relatively well served) and retrofits/existing buildings (lacking) was repeatedly highlighted.

Key themes

- Need for increased awareness of building condition issues (including moisture problems) through human habits and investigation as well as foolproof instrumentation/sensoring (i.e., technology backstop)
    - Triggers for investigation or intervention are not always clear,
    - Within DoD, where mission readiness is prioritized above all, robust maintenance could be framed as an important contributor to resilience
    - An easy place to start is best-practice sensoring of new construction
- Whereas there is excitement and momentum within industry around emerging best practices for "health and wellness," DoD practice tends to lean heavily on incumbent standards and approaches, with less flexibility when specific requirements are not clearly called for (e.g., in UFCs and Form 1391 specifications)
    - Within DoD, framing improved moisture management and other health and wellness efforts through the lens of "quality of life" and recruitment and retention may resonate more
- Hope in new construction, where prevailing standards and guidance have improved; much opportunity for improvement in retrofitting buildings, where there is a lack of systematized, streamlined whole-system approaches that address a range of needs, including moisture management
    - Many tools and resources exist for good design and moisture management, but these are more consistently applied in new construction

What is going well in DoD?

- Reasonably strict new construction standards for good envelope design and airtightness
- New planning criteria use climate projections (not historical data)
- Separation and placement of mechanical systems/spaces is generally good as regards access for inspection and repair
- Practice can be driven fairly effectively when clear "marching orders" are provided
- Drinking water quality testing

What is going well in DoD and the industry?

- New construction standards and practices overall

What is going well in the Industry?

- Growing set of strong standards/tools for moisture, leaks, envelope design, etc., e.g.:
    - ASHRAE 160-2009 (moisture-control design analysis)
    - ANSI/CAN/IAPMO 1349-2021 (water leak detection)
    - ISO 13788:2021 (hygrothermal performance of building elements, condensation mitigation)

    - International Mechanical Code updates for more effective condensate management
    - Listed, proven Underwriters Laboratory (UL) building envelope assemblies for new construction that are straightforward to install
    - WELL building standard as a driver of effective maintenance
- Good availability of leak detection systems
- Increasing attention paid to resilience considerations like water tables and below-grade design (especially in residential)

What is still to be solved in DoD?

- Perceived lack of clear and effective standards for maintenance and of funding for consistent maintenance staffing, training, and practices
    - Especially as compared to weapons systems/technology platforms
- Roof system selection is seen as sub-optimal, and this can be exacerbated by inconsistent roof maintenance/sustainment practices
- Large glass envelope systems also have issues with water-tightness (and thermal gain)
- Renovation work is often done piecemeal without an overarching plan; this is seen as partly due to funding for assessment/planning vs. construction/renovation being zero sum
- Rapid adaptation to changing resilience needs

What is still to be solved in DoD and the Industry?

- Alteration/retrofit techniques to upgrade existing envelopes cost-effectively
- A habit of active investigation, e.g., routine plumbing device/system checks (these tend to be checked only after a problem becomes obvious)
- Balanced ventilation/pressurization (which can have a significant effect on driving or pulling moisture into wall assemblies)

What is still to be solved in the Industry?

- Minimization of thermal bridges in envelope design (which can have moisture and comfort implications) is still not universal
- Effective leak detection and management techniques for aging piping systems

(9) Safety and Community

Discussion highlights: This discussion group included experts in human health in buildings, the processes of consultants in DoD work, and most importantly, a depth of experience in the armed services and the living/working conditions over a wide variety of types and regions of the world. Although participants felt there is awareness of human health, safety, and community in the UFCs and processes of building and maintaining buildings and installations, some industry participants also shared their impression that there is lack of feedback loops affirming the needs of people, as well as a lack of data on both successes and lessons. Additionally, understanding the science of human health in buildings, including all aspects of human health, is vital to mission readiness and achievements, and that correlation can be strengthened and used. Resources are available and should be accessed and referenced throughout the UFCs, and human health impact costs are central to integrating health, comfort, quality of life, safety, and community in the work ahead.

What is going well in DoD?

- The Resilient and Healthy Defense Communities (RHDC) strategy established an amazing vision, aspirational and people-centric
- There are visionary leaders embracing the RHDC strategy all the way up to Dep. Secretary
- UFCs capture a general standard that supports this
- Standard installation security is well-done
- Set-based design ideas are established

What is going well in the Industry?

- Innovative psychological safety
- Update front end specs for alignment and current tech (hard copies versus digital)
- Sharing resources across boundaries (municipal, industrial, bases all to host community)
- Specifications to respond to environmental challenge/confidence that safety is paramount
- Performance versus prescriptive
- Current guidelines codes and standards focus more on what people should do to buildings and what buildings should do for the planet as opposed tp what buildings can do for people – their health, wellbeing, safety, and sense of belonging
- Defined process exists and helps to drive the conversation
- Environments and spaces that support population w/accessibility and/or ability challenges
- Outdoor spaces that support wellness
- Research and conversations are challenging the norms

What is still to be solved in DoD?

- The UFC standards are not flexible in varied climates
- How do we allow culture/locations specific solutions?
- Need to understand what people need, where, and when
- Lighting and built versus natural infrastructure that support safety/community/security
- True community values versus imported community values

- Need performance based versus prescriptive to allow innovative solutions
- UFCs reflect existing building codes and requirements to meet current needs; by nature, they are not future-looking or extensively human-centric
- How do we go beyond adequate?
- Restrictions to sharing resources among communities
- Mission redundancy is a risk to environmental risks and changes

What is still to be solved in the Industry?

- Need better clarity on High Performance Sustainable Buildings (HPSB) and e-notebook process and expectations
- The process/time on idea generation to implementation is too lengthy and sometimes outdated by the time it arrives.
- Need environments and places that feel safe while they also support various functions and scale of populations.
- Cultural sensitivity and definitions of community
- Huge gap in understanding about connection between place and safety...between place and physical health...between place and mental health
- Safety is also about shared responsibility and looking out for each other (not solely lock boxes)
- Gentle approaches to safety/ security (as opposed to force)
- Design QC – CQC to ensure UFC application
- Design standards and UFC are not always followed. There is limited oversight and accountability

Overarching Themes

- Ask people
- Ask them over and over
- Program for wellbeing
- Clearly share the “why”
- New UFC for human well-being w/intersystem synergies
- Start with the end goal (performance-based)
- Understand the cost of human health impacts

(10) Embodied Carbon

What is going well in DoD and Industry?

Discussion highlighted significant activity underway across government and industry in the realm of embodied carbon, including major efforts under Buy Clean and by the U.S. Environmental Protection Agency (EPA). DoD can benefit from these efforts and avoid duplication.

What is still to be solved in DoD and Industry?

- Benchmarking embodied carbon
- Requiring environmental product declarations
- Designing for reuse and disassembly

- Setting embodied carbon targets
- LCA <> LCCA integration
- Inconsistencies in reporting. Need to better define requirements of the reporting system.
- Education

Appendix D: Core Principles

The arc of the first day of the Workshop began with Context, moved into embracing a Vision of potential, assessed the status quo through the 2x2 Benchmarking, and then moved into identifying the revealed Guiding Principles.

This breakout session was approached by tapping into the creativity and fun in crafting the guiding principles that were identified in the Benchmarking session and open discussion into bumper-sticker like statements— easily understood and easy to remember.

> Process: Individuals jotted down ideas, reflecting on the Benchmarking session, followed by table sharing and refining, then report-outs of the top ideas from each table.

This dynamic process helps participants deeply engage in three distinct valuable ways: 1) They unlock their creative brain through work that allows them to see their deeply personal beliefs and experiences in a highly objective manner. Selecting words, sometimes creating little pictures, and identifying the humorous or ironic messaging that will resonate with a new reader gives distance and immediacy, 2) Collaboration is deepened through a product that is co-created, and wordsmithing can be that vehicle. Ultimately, revealing guiding principles about and yet beyond a long-standing system needs this co-creative approach to connect across perspectives and experiences, and 3) The connection to this workshop will sustain by this hands-on and minds-on crafting of language. The revealed Guiding Principles will stay with more participants for longer because their brains were able to interact at this often-underused and right-brain level of humor and artful communication.

Summary of Guiding Principles for the work ahead (Bumper Stickers)

Note that these are only some the ideas presented, highlights refined and selected by the tables. For all Bumper Stickers (and there are many more) please refer to photo documentation.

- Maintain to Retain
- Modern Buildings, Modern Military
- Build-in Quality of Life
- Mission Success is Worth the Risk
- Lifecycle Cost – But Whose Life?
- Create a Footprint that Doesn’t Leave a Mark!
- We Need a Better Ruler
- Sick Buildings, Sick People
- Got Clean Air?

- Did YOU Read the UFC?
- A Five-Year lag is a Decade Lost
- Data is Useless if it Isn't Shared
- Don't Question; Measure
- No Road, No Destination
- Firmitas, Utilitas, Venustas, ACH
- No Person Left Behind
- Soften and Harden (people first)
- Deferred Maintenance = Deferred Readiness
- Collaboration is a Force Multiplier
- Pay Now or Pay (2x) Later
- Embody Change, not Carbon
- One Size Fits None
- We Can't Build Our Way Out of This
- Mission: Wellbeing
- Healthy Buildings are a First Line of Defense
- Smart at Every Scale
- Utility, Will You Marry Me?
- Or...do we just Fix this Bridge?
- Right Size Resilience
- Design for the (Far) Future
- DoD – World's Largest Buyers Club
- 1+1 = 3
- DoD – Less Waste, More Fight
- Think ~~Twice~~ LOTS
- Resilient Buildings Do It Holistically
- My Resilient Building Shelters your Stick Family
- Better Views = Better Decisions
- Listen/Design/Repeat
- Stop Running Fast with A Blindfold On!

$$\frac{\text{People}}{\text{Buildings}}$$

Appendix E: Focus Topics for Day 2

The preparation for Day Two of the Workshop entailed a last Day One session about the topics that we would explore for potential action post-workshop, by DoD and selected partners.

The intent, here, was not to do any solutions work, or even unpack any of the depth of these issues. The work of Day Two is to begin the process of discovery and setting *Action Pathways* for future development and effort. The intent in this session was to mine the experiences of the day to determine the 6-15 topics that the group of ~100 participants felt held the most potential for defining and achieving improvement in the facilities and communities that DoD touches worldwide.

> Process: Individual time to write-down the topics, discuss in pairs, popcorn sharing around the room, pass all sticky-notes to table facilitator for capture on wall sheets. The facilitators, post-Workshop Day One, assessed the sticky notes, consolidated them into clear topics, listed the topics, and then refined these topics for discovery and further discussion on Day Two.

To illustrate the process, below is a short list of ten different seed sticky notes (out of hundreds) that were collected, with a reference to the grouping they were tied into by the facilitators team. The language on the sticky is *italicized*, the group follows in **bold**.

- *What are the human outcomes we are trying to facilitate with our standards, and how do we know we are successful?* **- Human-Centric or LCCA**
- *More rapid adoption of existing codes/standards (what are their timelines?)* - **UFC Maintenance**
- *Criteria for functions, not disciplines* - **Holistic Climate and Resilience**
- *Performance requirements for wellness, safety, and security* - **Human-Centric**
- *Flexibility of buildings for comfort and grid interactivity* - **Electrification or - Grid Flexibility**
- *Monitoring, data, and analysis post construction* - **Long-Tail O+M**
- *Continual improvement forever* - **UFC Maintenance or - FSRM**
- *How can the HPBS be a catalyst for change instead of a min performance requirement?* - **Performance Standards or - LCCA**
- *Leverage DoD buying power to lower embodied carbon* - **Bulk Purchasing or - Embodied Carbon**
- *How can we stop doing solar hot water life cycle assessments?* - **Best Practices**

It is evident that nearly every Seed has relationships across several categories, as is the nature of a complex and integrated system. To address this complexity, we encouraged all attendees to think about the topics as they chatted over dinner, dreamed about the Vison that started off our day, and began to think about the work of Day Two on how to define the Action Pathways that could inform the work ahead for the DoD. Maintaining the broad lens of awareness while doing the work on Day Two raises the level of impact to a system-wide scale.

Below is the list of aggregated topics that the Workshop facilitators refined at the end of Day One. The start of Day Two continues the work by focusing on these topics, engaging participation and interest in the deep discovery work of the day, and refining this list further.

Deeper Dives on Themes from Day 1 Benchmarking Exercise:

1. **Human-centric performance**
   - Indoor Environmental Quality (IEQ)
   - Integrate "customer" input on design process
2. **Holistic climate adaptation and resilience**
   - Metrics
   - Bulk Purchasing
   - System Planning
3. **Embodied carbon**
   - Standard
   - Market engagement
4. **Electrification / Grid Integration / Load Flexibility**
   - Integrative design approaches
   - Incentive structure

Cross-Cutting Themes:

5. **Long-tail O&M**
   - Bridging design into operational performance
6. **Performance standards**
   - Carbon/energy/other
7. **Facilities Sustainment, Restoration, and Modernization (FSRM)**
   - UFCs in standard practice
   - Strategic prioritization and planning
8. **Life-cycle Cost Analysis**
   - Improving current process
   - Incorporating non-energy benefits
9. **Streamlining UFC maintenance**

Two additional cross-cutting topics were initially identified but did not receive independent breakout focus during Day Two. These themes were encouraged for consideration by other groups:

- Bulk purchasing
- Best Practices become Practices

Appendix F: Action Pathways

(1) Human-Centric Performance (HCP)

Highlights: There is consensus that DoD does not need to "reinvent the wheel" when it comes to buildings promoting human-centric performance. There are existing resources such as the WELL certification and other building standards that put people first in building design and maintenance. The DoD has an opportunity to identify what building aspects they want to prioritize. Many group members across government and industry stressed these building traits first for HCP: **good/natural lighting, ventilation, quality views, improved indoor air quality, and good building materials (i.e., natural material where possible)**.[2] DoD design prioritizes mission functionality of facilities first and can use HCP metrics and Post Occupancy Evaluation (POE) processes to deepen support of mission achievement through human health and performance improvements. Note that DoD has many atypical building types not represented in industry, and an HCP approach must understand those building types as well as the mission needs of the service branch, installation, and facility. Better incorporation of HCP into design and operations can yield improved health outcomes, enhanced job performance, and higher retention. There needs to be a leadership-supported effort for an assessment for HCP integration in design and building criteria, and education and training to gradually change the culture around HCP building design criteria use.

Action Pathway for HCP

1. Opportunity name: Incorporate Human-Centric Performance into DoD facility design and maintenance practices
2. What does success look like?
    a. Develop/adopt definition or standard of HCP
    b. Implement ongoing process to measure HCP Performance (i.e. survey, gap analysis)
    c. Integrate HCP data/criteria into UFC and other processes related to design and maintenance (LCCA, KPIs, etc.)
    d. In the end you would have buildings that are adaptive to human comfort (notably with good lighting, ventilation, IAQ, good materials) and enhance the occupants' experience and meets the needs of **all** end users
3. How can it support DoD mission?
    a. Better job performance
    b. Physical/mental preparedness for DoD mission readiness

[2] Post-workshop note: UFCs have criteria for air quality, water quality, ventilation, improved indoor environmental quality, and good/natural lighting. Each Service has a sustainability policy that identifies the required third-party rating system to verify compliance with the UFC criteria. The rating system LEED, for example, awards points for the above criteria and for open space, quality views, feedback for thermal comfort, access to transit and community services, acoustic performance, and low-emitting materials.

4. Proof points:
    a. Existing building certifications (i.e. WELL certification)
    b. Proven technology
    c. Resilient and Healthy Defense Communities strategy
    d. Data in GSA database
5. Metrics:
    a. Retention
    b. Readiness/productivity
    c. Test scores
    d. Satisfaction
    e. Engagement
    f. Performance Motivation
6. DoD studies/pilots needed:
    a. Needs assessment/longitudinal study for monitoring
    b. Economic analysis of HCP "losses" (i.e. what is the cost of low retention to DoD)
7. Policy: integrate HCP into
    a. UFCs
    b. DoD Manual
    c. DoD Instructions
8. Resourcing Needs:
    a. 3rd party certification/contractor (i.e. WELL)
    b. DoD champion and broad internal buy in
    c. Data collection and management solution
        i. Access to health assessments
    d. US Army Corps of Engineers (USACE), Commander Installation Navy Command (CNIC), MilDep Offices of Energy, Installations, and Environment (or equivalent name), Naval Facilities (NAVFAC)
9. Deployment:
    a. Update criteria to include HCP in design and maintenance
    b. Educate/train/share data with base commanders (cultural shift)
10. How can industry support?
    a. Create and manage a holistic 3rd party survey and measure factors such as:
        i. Air quality
        ii. Water quality
        iii. Occupant satisfaction
        iv. Productivity
        v. Mental health
        vi. Burn out
        vii. Sleep quality/alertness
        viii. Engagement
    b. Help develop HCP standard

c. Educate/advocate with Congress and policymakers
d. Provide expertise (don't reinvent the wheel)
e. Serve as a resource (long term)

11. Next steps?
    a. Package as military brief
    b. Identify a champion or "executive sponsor"
    c. Form a working group of DoD / industry
    d. Make this an implementation action in the Resilient & Healthy Defense Communities (RHDC) strategy

Notable takeaways

- DoD participant:
  - Buildings should meet all of the needs of the "end user"
  - Individualized spaces in buildings
  - Don't reinvent the wheel, industry has created wonderful models, let's get a DOD working group together to "militarize" something like the WELL certification
  - Need to develop education materials and training equipped with data on where and how buildings are leading to poor performance
  - Carefully consider the delivery of this information and ensure it meets needs of the audience
- DoD participant:
  - We should conduct a needs assessment and organize a longitudinal study for HCP monitoring
  - Human-centric performance is already in the Resilient and Healthy Defense Communities strategy – how do we make this more of a priority/mandate?
  - We should make this an implementation action in the RHDC
- Industry participant:
  - DoD should implement third-party occupant surveys to measure:
    - Air quality
    - Water quality
    - Occupant satisfaction
    - Productivity
    - Mental Health
    - Burn out
    - Sleep quality
    - Alertness
    - Engagement
  - WELL is ready for this and can work with DoD to select what factors might be most important for DOD human centric-performance standard

From the initial HCP chart

- Biophilic design

- Integrate customer input in design process
- IEQ (indoor environmental quality)
- Challenges in retrofit for daylight views
- Metrics? Sick days? Time for lead outs (?) or other tasks? Efficiencies in work processes, not just comfort.
- Encourage use of design methods like the 62.1 IAQ procedure that can improve IAQ and save money
- Design for individuals and how well that fits into the military
- Consider raising UFC lighting levels since LED lighting makes this a very low-cost benefit
- What are the needs of the soldiers? From the soldier's perspective!
- Cross-cutting long tail O+M and post occupancy evaluations and get human inputs into design features
- Active design
- Client engagements and post occupancy evaluations are critical

Coaching and Feedback

- Buildings are participatory, need ways for occupants to contribute to solutions
- Utilizing "happiness index" to identify installations that are high-performing and identify the factors of their success
- Factors to include:
    - Views: content, landscape, water, sky, distance, view angle
    - Daylight: Min(inum) Spatial Daylight Autonomy (SDA), Target SDA, Aspirational SDA
    - LEED and IWBI have daylight and view credits
- What building control system interfaces enable the best occupant participation
- Changing hearts to minds, making the connection
- Human centric: what are the IAQ, daylight, ventilation, etc. Metrics we need to put into UFCs here?
- What do soldiers value for quality of life? What are the cognitive benefits of fresh air?
- Brand and storytelling will be key in change management
- Are there standards we can reference?
- New construction or existing building? How would this work in existing building retrofit prioritization?
- How will you delineate happiness and retention from other non-building influences?
- Consider measurable metrics: retention numbers, health metrics, readiness; happiness is great but is not meaningful (comment from industry participant)
- Need champions for healthy resilience ready occupants
- Must be able to differentiate gripes and complaints from legitimate concerns and feedback when considering user input on facility requirements
- DoD Soldier Happiness Index
- Mission --> human centric goals

- How is human-centric performance actionable?
- Feedback loops
    - Need process for feedback, surveys, or post occupancy reviews
    - Engagement and feedback loops, satisfaction surveys, pre/post/annual assessments are helpful
    - That's great, now/so what? How do we get there? Resources, funding for studies? How to establish feedback loop?
- What research do we need to make this happen?
- How do you measure happiness?
- Need more details on how human centric is incorporated into UFCs
- Need study to establish metrics

(2) Holistic Climate Adaptation and Resilience

Highlights: The group hypothesized that climate resilience measures are most likely to be supported if they are justified through the lens of ensuring mission continuity. This requires that DoD engage in a system planning exercise that identifies which assets have to maintain what level of operations in order to ensure mission readiness. Climate adaptation projects should be planned around those prioritized assets. (These should include assets like barracks—not just weapons systems.) Changes to the LCCA requirements would also be needed to support resilience planning and climate adaptation measures.

Action Pathway 1: System planning for mission continuity

1. What does success look like?
    a. System master planning for the mission
    b. Mission continuity
    c. Performance based
        i. System-wide planning to downtime metrics that lead to performance based UFCs (model off anti-terrorism provisions)
    d. Right sizing
    e. Bring together stakeholders for input on the design
    f. Existing buildings in addition to new buildings
    g. Grounded in data, cloud based, and measured
    h. Mission commander has data to make readiness decisions and resourcing decisions
    i. Identification of specific down time tolerances on asset-by-asset level to right size resilience
    j. Identifies resiliency criteria for individual facilities (application)
2. How does this pathway support DoD mission?
    a. People + Equipment + Readiness
    b. Align infrastructure to support mission commander
    c. Effective use of resources
3. Metrics

a. Incorporate resilience in LCCA
b. Mission execution Prepare to Deploy Order (PTDO) 24 hr
c. Nuclear deterrence
d. Troop health and effectiveness (food, water, materials)
e. Energy supply resiliency (food?)
f. Logistics smart warehouse
g. Security
h. Flexibly implementation of long-term plans
i. Cloud based digitalization (data)
j. Built environment to support mission
k. Water supply resiliency
l. Need physical climate risk analysis to inform new construction and mission installation resilience decision making at the asset level
m. Near, mid, and long term (50-100 years) risks
n. Time periods and tipping points
o. Smart flight line
p. Barrack Indoor Air Quality
q. Air conditioning is critical to resilience and adaptation. Also to decarbonization

4. Policy
    a. Mission system resiliency master / master planning for resiliency / require base level planning for resiliency
        i. Identify base and operational linkages
        ii. Identify buildings not key to mission for demolition
    b. Process
        i. 1) **Identify** operational risks (broad scale and local scale) >>
        ii. 2) **Develop** operational plan for critical events >>
        iii. 3) **X-REF** facility conditions/needs to resiliency operations plant >>
        iv. 4) **Prioritize** building performance upgrades based on resiliency of plan
5. Proof Points
    a. NIST: resilience planning guide
    b. New York State: Housing mobility study (learn from housing buy outs)
        i. This might be the connection to the bulk buy idea
    c. National Institute of Building Sciences (NIBS) – mitigation saves
    d. Task Force on Climate-Related Financial Disclosures (TCFD), Global Reporting Initiative (GRI), Sustainability Accounting Standards Board (SASB), Global Real Estate Sustainability Benchmark (GRESB) > may offer physical climate risk metrics to build from
    e. Risk management framework > model antiterrorism/force protection (ATFP)
    f. Vulnerability study should include floor elevations and ability to adapt 1st floor
    g. Navy current study: critical facility and downtime
    h. Learning from state and/or local government resilience plans
    i. Navy's climate change planning handbook 2019

Action Pathway 2: Develop and deploy metrics for inclusion in the LCCA that support resilience planning (implements the system planning to specific facilities)

1. What does success look like?
    a. Fewer "zeroes" in LCCA because fewer unknowns
    b. More accurate LCCAs
    c. Facilities with longer service lives, in a cost effective way
    d. Cost of continuous operation and event recovery included in LCCA
    e. Consideration: strategic abandonment – options for when resilience isn't possible (i.e. adaptation, decommissioning)
2. How does this pathway support DoD mission?
    a. Responsible use of taxpayer money
    b. Improved mission continuity
    c. Better decision making to support continued DoD operations
    d. Faster / cheaper disaster recovery
3. Metrics
    a. Viability of site at end of planned building service life
    b. Costs for facility down time – likelihood of specific weather / national events
    c. Future weather files, flood plain data
    d. Financial cost of down time
    e. Amount of storm water managed
    f. Amount of heat gain avoided
    g. Repair of replacement costs
    h. Amount of embodied carbon preserved if building can withstand hazard event
    i. Water use efficiency
    j. Abandonment criteria (how much is too much?)
    k. Viability of site versus building life cycle
    l. Cost to withstand peak events
    m. Require weather conditions in 50 (?) years
    n. Event recovery LCCA – include a no-build option
4. Policy
    a. Process for strategic abandonment / deconstruction of site cannot support full building service life
    b. Policy needed to define how/when to incorporate
    c. Develop base-level resiliency criteria/plan (note: Navy has a climate change planning handbook)
    d. Consistent application of LCCAs to all projects (new construction, renovations, repair, etc.)
    e. Definition of an extreme weather event (resilient to what?)
5. Deployment
    a. Define DoD priorities on resilience > establish resilience metrics > revise /create system planning master planning criteria > abandon facilities criteria OR > DoD establishes

master planning/installation system level plans > bulk buy out of systems / fixes/ of buildings repairs based off master plan

b. Priorities may include consideration of rising temperature, sea level rise, mission readiness, mission continuity, identifying critical facilities
c. NIST community resilience guidelines can feed into the system planning master planning criteria

Coaching + Feedback

- Resilience at the base level can make a lot of sense because it can engage larger scale solutions.
- Physical climate risk assessment value at risk (VaR) should play into LCCA calculations.
- Resilience metrics – based upon the mission not installation – using a common criteria
- Base level resiliency planning could leverage BPS group recommendations/ coordinate with climate GHG planning
- How are weapons tactics built into the process?
- How does electrification impact/support resilience?
- Define resilient to what (conditions, events)
- Incorporate health, retention, readiness into economics models.
- Cloud base analysis - role base dashboard
- Resilience measures to embrace non-mission critical facilities to drive passive, lower energy solutions
- Resilient kill chain systems approach
- Any CCR right now? Or super CCR?
- +1 to climate resilience base master plan
- How will criteria writers or project teams know the prioritization of each effort? (i.e. where does my mission rank in the list?)
- How do you incorporate good/bad/worse climate projections?
- Resilience and risk assessment should both be included in life cycle assessment
- National Renewable Energy Laboratory (NREL) and Oak Ridge National Laboratory (ORNL) have developed future weather and energy consumption models
- Strategic planning is system of systems planning. International Council on Systems Engineering (INCOSE) board to look at for guidelines.
- Resilience DoD has baseline DoD Climate Assessment Tool (DCAT) and Army has climate guide and strategic plan and planning guidance Installation Energy and Water Plan (IEWP) & Installation Climate Resilience Plan
- Emphasize campus level resilience. Should be integrated with electrification planning.
- In addition better LCCAs, there should be emphasis on tracking performance post occupancy to confirm effectiveness of LCCA.
- Can strategic abandonment be mitigated by retrofit?
- Consider planning individual build – achieve thermal and weather resilience – agree on the holistic approach, but being able to island is resilient.
- Need policy – driven resiliency metric goals

- How does mission integrate into UFC? This looks like master planning US criteria
- Sometimes need individual buildings to be resilient – mission critical facilities
- I agree with starting with key term establishing
- Reduction of utility usage requires less secondary resources for resiliency. Focus on reduction
- Resiliency guidelines similar to ATFP
- Resilience >health >efficiency > resilience loop
- Refining weather events – what's extreme?
- Resiliency isn't always weather related… how do we prepare for other threats?
- Holistic climate adaptation and resilience plays directly with how LCCAs or LCAs are performed
- Designers need guidance for which scenarios are important to evaluate against
- Emphasize campus level resilience. Should be integrated with electrification planning.
- LCCAs, there should be emphasis on tracking performance post occupancy to confirm effectiveness of LCCA
- How does resiliency relate to LCCA and LCA?
- Where does the systems engineer fit in our increasingly connected installation?
- Missions frequently change. Planning around mission is temporary. Would need to be re-evaluated frequently. Possibly at charette stage, by project (which is inherent in evaluation by mission)
- System engineer and operations research versus master planning
- Resilience must be applied at larger systems level (buildings, water, waste, energy supply, transportation, community, etc.)

(3) Embodied Carbon

Highlights: The discussion on action pathways and coaching focused on developing and refining solutions for embodied carbon (EC) standards and market engagement, particularly within the context of DoD-wide policy implementation. The key points revolved around the "What" and "How" aspects of this endeavor.

The "What" emphasized the need for a comprehensive EC policy at the DoD level, covering project-level considerations through design and procurement and focusing on holistic material impact categories. This includes aspects like human health, mission resilience, biodiversity, ecosystem health, climate impact, and common material procurement practices, leveraging government and industry engagement.

The "How" aspect outlined strategies for reporting, benchmarking, learning, standard development, and policy implementation, including catching up with existing standards, establishing intergovernmental working groups, using scorecards for carbon accounting, setting product and whole-life Global Warming Potential (GWP) limits, integrating with grid electrification and climate resilience efforts, and developing procurement requirements and reporting mechanisms to bridge the gap between specified and installed materials.

The overarching goal is to create a robust framework that not only tracks embodied carbon but also drives sustainable procurement practices and aligns with broader sustainability and climate resilience goals.

The What: EC Policy

- DoD-wide EC policy, project level, through design and procurement with focus on holistic material impact categories.
- Looking into human health, mission resilience, biodiversity, ecosystem health, climate, and common material procurement.
- Leveraging government and industry wide engagement in this space to not "reinvent the wheel."

The How: Reporting, benchmarking, learning, standard development, policy development, feedback systems

Reporting:

- Catch up to other government entities and industry embodied carbon standards
- Reference standards and proof points
- Establish inter government working groups (invite industry)
- Use updates and conversations around IgCC and 90.1 environmental product declarations (EPDs) and LCAs
- Create scorecards for branch reporting on carbon accounting
    - Like guiding principle scorecards
- Add embodied carbon provisions to guiding principles and Whole Building Design Guide (WBDG) (use metric inputs)
- Carbon accounting for every project – New Building, Reno, infrastructure etc.

Benchmarking

- Take carbon accounting data to assess bell curve trends
- Set product GWP limits
- Set whole life GWP limits per SF per building service life
- Whole life project impact assessment of labor, health, biodiversity etc.
- LCCA – non energy costs
- Integrates with grid integration / electrification / Long Tail O&M, Climate Resilience

Policy Development

- Procurements requirements
- Require as-installed material / product reporting
- Closing the gap between specified and as installed
- Build policies around comprehensive material / product metrics
- Setting GWP limits by project

- Setting GWP limits by material
- EPA – Inflation Reduction Act (IRA) grants to support EPD Creation

Feedback:

- Consider incorporating carbon costs into Life-Cycle Cost Analysis (LCCA) for more meaningful design comparisons.
- Standardize and expedite the process with an embodied carbon catalog of materials.
- Establish a carbon budget at the portfolio level and implement "cap and trade" mechanisms across projects.
- Set specific targets and goals rather than relying solely on benchmarking.
- Utilize the DoD's purchasing power to drive sustainability initiatives.
- Leverage existing working groups to support carbon reduction efforts.
- Include O+M activities in carbon reporting to ensure a comprehensive assessment.
- Develop a centralized database for data collection and analysis across the DoD portfolio.
- Explore the feasibility of an Embodied Carbon UFC (Unified Facilities Criteria).
- Consider adopting a benchmarking standard like Carbon Star for concrete choices and other materials in procurement processes.

(4) Electrification and Grid Integration

Highlights: While EO 14057, the Federal Building Performance Standard, and the DoD Electrification memo provide policy directive for electrification and clean energy procurement, there are still challenges and questions related to broad scale implementation and the opportunity combine energy efficiency, passive design and demand management strategies simultaneously to realize better outcomes. This breakout group identified workstreams and opportunities across several sub-themes:

- Prioritization and defining the problem set, especially for existing buildings
- Ensuring the electric supply capacity will be there
- Leverage Energy Savings Performance Contracts (ESPCs)
- Working “ahead of the curve” where DoD is leading industry standard development
- Incremental or “over time” approaches to electrification
- Workforce training and support at the installation level.

What does success look like?

i. For every electrification project:
    a. Users see no cost or functional performance difference from electrification.
    b. Electrical demand peaks do not increase.
    c. It is confirmed that power will be available.
    d. There is a path to clean electricity supply.
ii. Every electrified new construction and major renovation project also considers energy efficiency and demand management as enablers, in an integrated solution.

iii. A mechanism is created so that FSRM electrification projects are *able* to consider energy efficiency and demand management as enablers in a bundled approach, as appropriate and likely tied to investment trigger events.

Proof points / DoD studies needed:

i. DoD prioritizes projects ripe for electrification
    a. Consider nuances like electrical capacity, central plants, climate zone.
    b. Include mission and resilience considerations.
    c. Communicate results to industry.
    d. Note that the Deep Energy Retrofit Assessment Program (DERAP) is rolling out now, focused on *deep* energy retrofit project opportunities.
ii. Conduct installation level electric power capacity studies, possibly be part of installation utility master plans.
    a. Include resilience capability (e.g. 2X capacity requirement as applicable)
    b. Where utility privatization agreements are getting underway, power capacity for electrification should be included.
    c. A proof point may be private utilities in the northeast planning proactively for electrification
iii. Study load diversity of electric vehicles, HVAC, etc., in DoD to better understand real-world load impacts of electrification.
iv. Study to support Energy Savings Performance Contracting (ESPC) practice that is holistic and includes electrification.
v. Research the impact of electrification on specific mission critical equipment as needed.

Policy Opportunities:

i. Electrification “trigger event” guidance (in draft already). Include proactive approaches to equipment end-of-life.
ii. Eliminate the “outs” to electrification, possibly over time.
iii. ESPC policy for combined electrification, efficiency and load flexibility. Consider working with other federal agencies also solving this.
iv. Central plant policy approach, with nuances.
v. Policy support for bulk purchasing or standardized procurement, where applicable, in order to streamline electrification. Include any needed guidance for installation-level Justification & Approval (J&A).
vi. Write these policies *with* people at the installation level.

Resource/deployment needs:

i. Industry should support workforce development for electrification.
    a. Include integrated efficiency and demand management in training.
ii. Support those energy managers ultimately responsible at the installation level, e.g. who respond to urgent HVAC hot/cold calls.

Criteria considerations:

i. Allow for and guide electrification approaches that are partial, incremental or implemented over time.
    a. Where relevant and not done already in the Criteria, differentiate "over time" electrification approaches for new construction, major renovation, FSRM and central plants.
    b. Consider typical load conditions that represent the majority of annual energy consumption first; consider separately how to meet peak load conditions and when to electrify them.
    c. Consider load flexibility, such as modulation and storage, as part of incremental approaches.
ii. In some cases, there may be a need to work ahead of the industry curve, writing code where DoD is ahead of model codes or where there is not relevant industry-standard guidance, e.g. newer technology areas applied to DoD, DoD load diversity, DoD-specific fire safety.
iii. Clarify and deconflict cyber requirements

Industry support opportunities:

i. *Overlays* to the model codes.
ii. Guidance from Department of Energy on acceptable standards.
iii. Training and services *ahead of* the adoption curve, to prepare for implementation.
iv. General training for retooling of the broader industry. Support DoD in the transition.

Coaching comments/questions (only noting key themes not mentioned above):

- Planning ahead:
    - Regarding electrification over time, have solution ready to implement when existing equipment fails.
    - Conduct condition surveys of equipment to prioritize electrification across the portfolio. Be proactive.
    - Provide support guidance on planning for electrification, to be ready for replacements.
    - Create a standard operating procedure to prepare buildings for future electrification, before an equipment failure.
    - Require submission of "emergency electrification plans"
- Proof points:
    - Look to private programs for electrification examples, e.g. PHIUS.
    - Local Law 97 in New York City is a proof point.
    - Need a common data repository for sharing performance
    - DC Appendix 2 Stretch Net Zero Code is a proof point.
- Cost:
    - Balance what can be done against fiscal reality.

    - How will electric readiness pass LCCA? That's very important but may not meet LCCA requirements.
    - Buy-downs to assist the marketplace.
- Electricity supply:
    - Electrification should consider electricity generation efficiency.
    - Have concerns for electrifying everything, with one source for electricity.
    - Electrifying buildings does not preclude interim use of gas generators.
    - Consider both on-site and off-site electricity supply.
    - Make buildings microgrids to help each other.
- Technology specifics:
    - Battery storage is evolving more rapidly than DoD development process. Recognize that new technologies are rapidly coming available.
    - Are existing technologies meeting all electrification needs? If not, where are the gaps?
    - Are there impacts to electrifying all cooking?
    - Household electrification mandate for cooking to promote IAQ and cognitive development best practices.
    - Max heating and cooling loads in kBtu/SF for conditioned buildings.
- Maintenance
    - What kind of maintenance impacts are there with electrification? Can this benefit installations?

(5) Long-tail Operations & Maintenance

- What does success look like:
    - **Operate and maintain our facilities to the same standard they were designed and constructed**
        - Transition toward reliability centered maintenance and preventative maintenance
        - Maintain high performance design at project completion while maintaining steady or declining O&M costs
- How can it support the DoD mission:
    - Healthy buildings = healthy workforce
    - Continuity of facility operations supports mission readiness
    - Predictable O&M costs lead to:
        - More discretionary budget for other modernization efforts
        - Improved asset management from project completion to government building operation
- Proof points:
    - Case studies of high performing buildings from other agencies - internal and external to DoD
        - Navy pilot - total obligation authority (TOA)
        - WHS Mark Center
        - SOUTHCOM Headquarters Complex in Doral

        - Social Security Administration National Support Center
        - GSA case studies
        - Department of Energy's National Renewable Energy Laboratory Research Support Facility (RSF)
        - ESPC success stories
        - Deep Energy Retrofit case studies
- Metrics
    - Energy Use Intensity (EUI)/Water Use Intensity (WUI)
        - People forget about water, keep both intensity metrics at forefront
    - Year over year O&M funds for routine maintenance
    - Number of equipment repairs and costs
    - Durability of equipment, how often are replacements occurring?
    - Results from routine building occupant satisfaction surveys
    - Facility ready status that maintains a green condition
- DoD Pilots needed
    - Two key types of existing issues were first identified:
        1. Team Integration issues: Lapse in proactive management/ownership of maintenance tasks from construction turnover through building occupancy. Areas for improvement include:
            a. Scheduling: Commissioning personnel are not given enough notice to participate in key meetings
            b. Notification: Communication breakdown on project status to key personnel who support Commissioning
            c. Attendance: Insufficient attendance in key meetings throughout the turnover process resulting from items a and b
            d. Stakeholder issues: Unclear delineation of roles and responsibilities for personnel required to support O&M
        2. Data Integration issues: There are several computerized maintenance management systems (CMMS) being used across DoD that don't speak to each other. This results in trapped data and incomplete maintenance records. Examples of CMMS in use are: BUILDER, TRIRIGA, Maximo, GFEBS
            a. O&M manuals, real property records, and work orders should be incorporated in a holistic system and be queryable
            b. Other topics of importance that are key to advanced O&M data analytics but the group didn't get to discuss in detail: real time performance dashboarding, digital twins, predictive maintenance
    - Two pilot ideas were identified to address these issues:
        1. Deep dive pilot on construction and post occupancy Commissioning that includes:
            a. In depth training on turnover and final testing:
                - Trend logs
                - Benchmarking
                - Warranty issues
            b. Measure the success of executing an in depth Cx process and determine if it can be repeated across projects
        2. Incentivized performance-based maintenance contracts: add incentive in contract for maintenance provider i.e. O&M Contractor Performance

Assessment Reporting System (CPARS) to promote a higher standard of maintenance for at least a 2-year period after completion
    a. Goal is Design > Build > Operate > Maintain - with 2-year operation period
        - Design for maintenance
    b. Applies to Design Bid Build and Design, Bid delivery methods
    c. Maintain consistency with project delivery team - bring O&M provider in early
    d. Alternative delivery methods were also discussed:
        - Design competition with stipend
        - NREL's RSF is an alternative delivery method success story

- Policy
    - There are many Commissioning policies in place, but they are not being adhered to. Cx policies need to be prioritized and implemented.
    - Policy could be used to provide sufficient funds to support adequate maintenance for 2 years post construction
    - Existing policy:
        - 10 USC 2912 - redirects savings to new projects - motivator for high performing facilities
- Resourcing Needs
    - Funding - Need for reprioritization of funds to sustainment
        - 10 USC 2912 - Mechanism for funding
    - Training - high priority
        - Need to emphasize upskilling and reskilling workforce as technologies/systems change
        - Invest in training employees responsible for O&M (especially mechanical) and deployment
        - Category management - so staff can become specialized in a few systems instead of being responsible for all
- Deployment
    - Position descriptions should be written for cross functional disciplines i.e. electricians vs HVAC controls
    - Incorporate predictive maintenance in O&M strategies
- How can industry support
    - Provide key partnerships
    - Provide examples or proof points needed to justify implementation
    - Plan for typical parts for common faults, allows for flexible response to have parts available
    - Incorporate pre-negotiated unit costs, "temporary equipment"
    - Areas of research for replication in DoD:
        - How do hotel chains optimize O&M?
        - What metrics do commercial management companies like JLL and CBRE use?
- Coaching and Feedback
    - Strategies for facilities that are operated and maintained to the same standard they were designed and constructed
    - Transitioning towards reliability-centered maintenance and preventative maintenance can significantly reduce unexpected downtime and repair costs.

- Should be centered around mission readiness
- How can we measure the success of maintaining high performance design at project completion? Can this be a standardized pathway?
- Reliability-centered maintenance
- UFC specifically contribute guidance to ensure facility operations support mission readiness?
- Standardize the difference between predictable and outlier O&M costs
- How can improved asset management from project completion to government building operation really support the DoD mission and how can we make sure that that is a standard?
- More external case studies for best practices
- What lessons can we learn from the Navy pilot's total obligation authority (TOA) approach to high-performance building maintenance?
- WHS Mark Center and SOUTHCOM Headquarters Complex in Doral
- Can there be GSA case studies that work as guidance?
- Data collection for tracking year-over-year O&M funds for routine maintenance
- Facility ready status for crucial operational efficiency
- Data integration quickly is a big road bump.
    - Pilot projects?
    - Team integration issues?
- How can we ensure clear delineation of roles and responsibilities for personnel required to support O&M? Who directly supports / enforces this?
- Integrating O&M manuals, real property records, and work orders for data accessibility
- Implementing incentivized performance-based maintenance contracts

(6) Building Performance Standards

Action Pathway: Installation-Level Carbon Reduction Standards

Highlights: Early in the discussion, the group, primarily industry folks with one government representative, narrowed our conversation to carbon performance standards focusing on existing buildings. There was general alignment that the DoD had stronger provisions in place for new buildings and the need was greater for existing buildings. The conversation converged on an “Installation-Level Carbon Reduction Standard” after a discussion of the merits of individual project or building standards. The portfolio approach was chosen to allow installation commanders the maximum amount of flexibility while still reducing the overall emissions of DoD installations. The suggested implementation plan (Train, Equip, Clear Rules and Goal) or first steps are captured in the notes below, along with a few of the proof points from elsewhere in government and industry.

There were several open questions that the group didn’t answer including how much benchmarking data already exists for DoD buildings, how you would create alternative pathways for every installation to comply that would enable folks to still show progress even if they are expanding, etc.

UFC note: The group also converged around the need to add a "Good, Better, Best" framework to the criteria to incentivize folks to go beyond the baseline. One of the industry offers of support was to set up an advisory committee to help define what "Good, Better, Best" could look like for carbon building standard and beyond.

Opportunity Name: Installation-Level Carbon Reduction Standards

i. Align with EO 14057 (50% by 2032, Ne Zero by 2045)
ii. Portfolio approach – require folks get better every project.

Proof Points:

i. Institute for Market Transformation – Building Performance Coalition for Best Practices
ii. Regs for Carbon Intensity (NY)
iii. 20+ City/municipal benchmarking ordinances with annual reporting regs
iv. DC BEPS – applies to more (small) public buildings
v. Real estate owners have net zero goals across their portfolio
vi. Fort Knox – RFQ process to retrofit zero-energy barrack
vii. Canadian Model for federal building management
viii. GSA's own approach/program here in the us
ix. Local Law 97 in NY

Metrics:

i. Carbon reduction per installation, steps down to zero for 5-year increments, with an annual reporting requires
ii. Could consider and additional total energy reduction goal (10% by 2032 and 20% by 2050)
iii. Could also consider a metric per square ft and a project-by-project metric

Policy:

i. A change which could help is flexibility in the military budgeting (three buckets, if you reduce FSRM – do you get less next year?)

DoD studies needed

i. Pilot study needed (with congressional funding), this would include setting a standard for a few installations and seeing how the commanders would respond/implement.
ii. Need study to assess how much would this cost the DoD to implement.

Resourcing Needs / Deployment

i. 1. Train the team (retraining existing energy managers)
ii. 2. Equip: Create a center of excellence within the OSD to provide
    a. Training,
    b. Resources on things like passive house
    c. Example

    d. Implementation guidance
    e. Data
iii. 3. Clear Rules: installation managed to meet goal w mission critical needs + 5 year compliance cycle
iv. 4. Goal – EO 14057 50% carbon installation reduction by 2032.
v. Add Good, Better, Best to the UFCS, Pilot Better and Best to make them standard actions over time.
vi. Additional questions
    a. Benchmarking?
    b. How do we create a pathway for every building
    c. What are the alternative compliance/performance pathways that allow folks to show progress.

How can industry support

i. Advisory group
ii. Helping Define Good/Better/Best – what looks like with the UFCs on a building performance standard.

Additional overarching discussion topics

    a. Discussion of appropriate sticks to incentivize compliance
    b. Debate about installation level versus project level GHG goals/carbon goals.
    c. Robust conversation around the need for a metric per square foot. It was ultimately left out in favor of one portfolio level metric.
ii. Policy – funding changes
    a. Allow DoD to spend across their three budgets – MilCon, Repair – etc.

Feedback/Questions

- +1 to Base wide Carbon Portfolio Target – Make reference in UFC's to give allowance if there are base wide tradeoff platform
- Performance includes people happiness
- What is the mission commander's role in ensuring performance standards?
- Diversity of building age, use, condition, might be better served by performance tracking & improvement trends, rather than fixed targets for energy use
- Same theme as resiliency group, shift metrics and standard to installation or mission level planning and goals.
- +1 on A/E education at military colleges
- Rectify differences between DoD + regional BPS
- Flexibility is ideal, are goals able to make gradual/progressive to remain obtainable?
- Is 100% carbon free by 2045 a reality, can it be accomplished?
- Do we need another RCOE to implement this plan
- Codifying in the existing structure

- Leverage a mix of prescription and performance, IE mandate air tightness & have heating load performance target
- Carbon as a metric almost impossible to quantify for existing buildings and might run counter to resiliency goals,
- Even at installation level setting carbon target tough given diversity of DoD mission/portfolio
- Sustainability as part of officer training
- Need installation performance metrics by climate zone
- Emphasize education & training for installation-level staff on performance standards
- Center of excellence Resource Passive House as part of the Center of excellence at OSD or installation level

(7) Facilities Sustainment, Restoration and Maintenance (FSRM)

Action Pathway 1: FSRM multi-year strategic planning

1. What does success look like?
    a. Increase efficiency in spending
    b. Eliminate end of year hike
    c. Planning consistency
2. How does this support DoD mission?
    a. Optimizes FSRM spending
3. Proof points
    a. New construction
    b. Private portfolio owners
    c. OMB/GAO study price hike
4. Metrics
    a. Contract and execution over longer cycle
    b. # Bid busts/ re-approval
    c. Bid vs. Estimate
5. Studies
    a. Audit on implementation
    b. Interviews on how they would change behavior
6. Policy
    a. How to prioritize long term plan
    b. Example: “50% obligation rate by end Q2”
    c. Comptroller policy on execution
7. Deployment
    a. Legislature prop / NDAA (step 1)
8. How industry can support
    a. Consult on planning process
    b. Best practice phasing planning

Action Pathway 2: Incorporating Optimal ECMs into FSRM projects

1. What does success look like?
    a. Every FSRM project incorporates optimal ECMs
2. Proof points
    a. Ex. Presidio
    b. Private industry examples
    c. Existing 3rd party audits
    d. Audit template data
    e. Existing building standards and policies
    f. PHIUS data. Retrofit decision tool
3. Metrics
    a. % of projects compliant with mandatory standard
    b. Building performance vs. Baseline before work
    c. Savings seen by packaging ECMs (M&V)
    d. % contract execution by $ incorporating ECM DFARs Clause
4. Studies
    a. 1 study: DoD and private – ECMs, climate, category of work, ROI, and categorize them
        i. What kind of ECMs are most applicable (study)
        ii. Study an ERA of construction for applicable strategies
        iii. ECM FSRM ROI – how it was done previously
        iv. ECM by MAC/IDIA type by climate ranked by ROI
5. Policy
    a. Update DoD service – resilient buildings policy – sustainable design – electrification
    b. Triggers of what to incorporate when
    c. ACQ policy / DFARs
    d. Enforcement and enablement / codify
6. Resourcing
    a. Resolve APPN / 3rd party $ issue
    b. Base maintenance staff, base leaders support, base vendors / private industry
    c. Incentives
7. Deployment
    a. MAC/IDIQ templates w/ROI tools
    b. UFC changes?
    c. Incorporate into internal instructions be service
    d. Playbook/implementation guides
8. Industry support
    a. Standards, codes, guidelines
    b. Past experience to facilitate process
    c. Increase in vendor RFP responses due to scalable requirements

Coaching and Feedback

- Establish threshold for 3rd party compliance for SRM
- How can we leverage 3rd party financing with the good ideas shared?
- Can there be a pool of money to cover "unexpected" envelope upgrades during MEP system renovations? Grant based?
- FSRM is a team effort with installation management and designers
- Remove compart – monetization NC FSRM funding
- Support for studies first with clear data goals
- FSRM needs to be a major priority in the budget and decision-making
- Phius retrofit metric tool
- Need multi-year value-oriented FSRM resourcing strategy to enable consistent priorities

(8) Life-cycle Cost Analysis (LCCA)

Action Pathway 1: Process refinement

This action pathway seeks to make the UFC processes and methodology for inclusion of LCCA into all project work clearer and less debatable, better supported with data, and more consistent across the full portfolio of projects.

1) What does success look like
    a. LCCA used as a tool, not an excuse
    b. Clarity of intent and Clarity of deliverables
2) How can this support DoD mission
    a. Better buildings
    b. Consistent results
3) Proof points
    a. none mentioned
4) DoD Specific Pilots?
    a. Assess success and performance of A+E teams
        i. Provide sample appropriate LCCA template
        ii. Select several key projects to test/confirm
5) Metrics
    a. Base specific energy costs
    b. O+M data by service or by industry
6) Policy
    a. Create an "Appendix G" for LCCA
    b. Set discount rate of 3%
    c. Clarify DoD policy on electrification and role in LCCA – if electrification is preferred or required the cost discussion MUST change
    d. Account for the long-term benefits of and the long-term planning of electrification and resilience. This is not building by building but must be at installation-scale.

7) Resource needs
    a. LCCAs for similar building type, climate, and project type.
    b. Data sharing of this approach and the info from the LCCAs
8) Deployment
    a. Clearly defined roles and responsibilities for LCCA
    b. Improve timing of LCCA – earlier, earlier (and applicable appropriate templates will help)
    c. Criteria for baseline standards
9) How can industry support
    a. Define successful LCCAs with examples and templates DoD can use
    b. 3rd party certifiers (non-profit entities)
    c. Trainings for A+E (could be required for project work with DoD)

Action Pathway 2: Evolving from LCCA to only LCA

This action pathway has identified the need to fully understand the Full-benefits in each project decision, meaning inclusion of risk-avoidance, human health impacts, retention and support of great teams, and awareness of a rapidly changing environment along with flexibility in mobilization to new circumstances.

1) What does success look like?
    a. Clearly defined resilience and human health benefits for use in LCAs called for in UFCs
    b. Avoidance of the 90/10 syndrome (90% of our costs are the human aspects, 10% are the construction and ops)
2) How can it support DoD mission
    a. Better decisions (the only wrong number is $0, which is what occurs now for human health)
    b. Improved retention, satisfaction, job performance
    c. Full-benefit assessment puts people first
    d. Health of service members and families
    e. Informed decisions that understand the full-benefits of good building and installations, for the full-life of those investment
3) Proof points
    a. Crosswalk tools including health studies
    b. Existing research on IEQ and Cognitive function
    c. CogFX study from Syracuse CoE and Harvard, including “true costs” of ignoring human health in built environment
    d. See also the “Economics of Biophilia” by TerrapinBrightGreen
4) DoD specific pilots
    a. Study of the 480th ISR wing, Langly, Beale, Dsan
    b. Long-tail Program Office Estimate (POE) and other sustained awareness studies are needed
    c. Develop DoD study to assess correlation between DoD buildings and human performance

    d. Study buildings against each other
    e. Assess cool roof strategies, urban heat island impacts, and access to Nature.
5) Metrics
    a. Use aggregated anonymized VA data to understand health (mental, physical) impacts and begin to set $$ understanding of human health benefits
    b. Social Cost of Carbon
    c. Absenteeism data (anonymized)
    d. Include resilience metrics, for example, the embodied carbon and cost savings when a building survives a hazard event versus ending up in a landfill
6) Policy
    a. Daylight and view included in the envelope LCCA (and eventually LCA)
    b. Tie mission focus goals to human health support
    c. Mandate O+M cost assessments be included in LCCA and LCA over a real timeframe of building use
    d. Do LCA and LCCA on a project to understand the magnitude of differences
    e. Buildings that connect to Nature
    f. Current mech UFC nearly prohibits use of VRF. Deployment also needs to identify obstacles to success
7) Resource Needs
    a. Budget to measure and then manage performance
    b. Budget to manage deployment of LCCA and LCA structure and process
    c. Support from leadership for iterative attention to process changes (OSD COE)
8) Deployment
    a. Plug costs in through A+E work – it is currently not clear who does the work, and it also needs to happen much earlier
    b. Compare projects – LCCA outcomes with and without Full-Benefits
9) How can industry support
    a. Reach out to insurance companies for health outcome research
    b. Share/crowdsource human performance studies
    c. Creation of real, actionable, and usable templates for LCCA and LCA that include Full-Benefit data.

Coaching:

- Currently LCCA are focused on Mechanical systems.
- Template for bundling strategies into LCAs (multiple systems and interdependencies)
- National data base for water/gas/etc. Utilities
- In a 100% electrical setting how does any system compete ($$) with electric resistance heating?
- Why do we still have to do LCCA on solar hot water?
- One master LCCA template to rule them all
- Develop LCCA case studies to illustrate best examples (detailed)
- Consider how LCAs will be integrated into procurements

- Consistency is great and needed. How will enforcement be a part of creating consistency?
- Quantify the intangibles even if it is hard
- Need consistent data sources for LCCA. Need method to include and value other factors such as reliability, carbon, mold, safety, noise, size, comfort, health.
- What matters – worst case versus everyday case?
- Moving toward whole life-cycle thinking and analysis for social impact, biodiversity, etc
- DoD needs to set an appropriate internal carbon price to move projects forward
- Field Study? Compare estimated human cost benefits to measured performance over time (use PNNL/DOE H-Dat)
- How does the individual human experience conflict with creating unit cohesion and focus on the team?
- There are squishy outcomes. Need to standardize costs to allow for apples to apples comparisons
- Study what is not being done to electrify via ESPC
- Run to failure will be incentivized by emergency repair exception, always.
- Prohibit the use of FSRM $ to pay “must pays” to privatized system owners
- Eliminate inequities
- Include LCCA at installation level to gain resilience benefits
- Require a minimum level of survivability to/from #12 threat at each location
- Require govt owned systems and privatized systems to maintain or increase existing level of resilience impacted by electrification.
- Study impact of electrification on critical equipment within facilities not yet evaluated.
- Industry standards assume ideal conditions. Operations and maintenance that does not reflect accurately.
- Quantify the value of infrastructure resilience, human resilience and health (physical, mental, emotional, and psychological.
- Prioritize better balance policy to do things versus stated objectives to do other things. Electrification, Energy reduction, and Resilience.
- LCCE- what is the real value of the analysis since the primary value historically has been removed? (lease-own outsource) (value – nickels and dimes versus dollars)
- Bring equal value back into LCCE that was removed by fuel choice.
- No way to make a business case for alternative without cost of O+M of both systems. Environmental benefits are a given in the sustainable design UFC

(9) Streamlining the UFCs

Highlights: The discussion focused on streamlining UFC maintenance, aiming for transparency, speed, and industry alignment to improve standards and engage stakeholders effectively. Success indicators include transparent processes, searchable databases, and quick implementation of changes, while proof points involve adopting third-party standards and enhancing industry support. Next steps include workshops, research into needs, and feedback loops for policy improvement. Key metrics for success

involve completing strategies, reducing conflicts, and improving collaboration. Streamlining UFC maintenance enhances project outcomes, integration, cost data, and safety features, supporting the DoD mission efficiently.

What Does Success Look Like?

- Transparent + CCR process / status to outside parties
- Searchable database across all UFCs
- Increased Speed to implement changes including codes and criteria adoption and updates
- Aligned standard references in UFCs
- Clear understanding of criteria change and revision process (to help improve it)
- Ecosystem mapping of standards and process mapping to understand progress
- Align layers of standards to ensure consistency
- Understanding the impacts that changes have to the existing process
- Active exchange with industry
- Call for input-open call/open comments and feedback
- Committee like GBAC
- More process training for CCR and DWG/RWG
- Data Structure that supports streamlining

Proof Points

- Emulate rigor of third-party certification standards/ rating systems
- Enforce intellectual standards for URC
- Industry approach that that be emulated for knowledge management systems
    - Building database model
    - Spec interaction example
    - Master Format
- Overlay models for UFCs
- Allied partners and other standards (Example: Passive House)
- ASHRAE separate standards from commentary
- Research into pilots for UFCs
    - Roadmap for this process to include updated feedback loop
    - Retail prototyping model
    - Match making with startup tech
    - GBAC Process- Task Groups
- Feedback loop on Policy

How can Industry Support

- More interface with standards organizations
- Use RFI Process to put out a call to industry to improve the UFCs or aid in streamlining specs
- Use ANSI-like process for public review of UFCs
- Industry seats on DWGs
    - Non-voting members

Next Steps/ First Steps

- Workshop Report out
- DWG Workshop Next weeks
    - Continue the conversation happening from UFC Criteria Workshop
- Letter from Hon Owens to Standards org for participation support
- Researching for people to participate in committees and conferences
- Manpower study
- R&D funding – assessing success of pilot projects
- Database funding for ease of use
- Dashboard funding to support transparency
- 1-300-01 format review to allow code commentary
- Develop legislation/ policy feedback process

Metrics

- Completing implementation strategies
    - Implement knowledge management systems
    - Dashboard
- Speed of CCR Resolution / implementation and publication
- Reduction in Conflicts
- Improved legislative language
- Increased collaboration between standard makers and industry collaborators.
- Number of pilots
- Indicator and proprietary
    - market feedback
    - limits

How would Streamlining the UFCs Support DoD Mission?

- Move faster and create better project outcomes
    - Better integrated
    - Better cost data
    - Reduce conflicts in project
    - Reduce administration time to allow for better collaboration
    - Reduce confusion on projects
- Get safety features into projects faster as well as new and advanced technologies
- Reduce errors and omissions in UFCs and improve UFCs overall

Coaching and Feedback

- How can AI be used to help streamline UFC processes
- Need more stewards not named Brendan Owens
- Use AI to identify conflicts and overlaps in existing UFC standards and references
- Consider AI to cross check consistency across UFC's
- Creating a benchmark UFC maintenance process like ANSI, ASHRAE can help with maintaining a process standard
- How can digital engineering improve UFC body of knowledge

- Focus on continual instead of periodic improvements
- Create a method for process adoption or improvement for building delays
- DOE/PNNL discussion code simplification tool
- Should OSD fund UFC program in totality to ensure adequate labor
- Priorities ease of access and transition to revision of process, which will help with transparency with the industry.
- Potential to leverage same tools and standards developers use to manage their processes

Appendix G: Closing Remarks

Excerpts from closing remarks by Hon. Brendan Owens

- Secretary of Defense talks about his job by saying he has three priorities: defend the nation; take care of our people; (later learned third was teamwork)
- *People* is the door that this workshop got through. Over 3 million people are involved with DOD and reliant on us.
- Feel like there is a level of relief. These are not the conversations that we were having ten years ago. That eagerness is something I am excited to be a part of.
- The role that the built environment plays in supporting DoD's integrated efforts to combat Service Member self-harm is not fully appreciated.
- You wouldn't do codes if you weren't up for the grind; I hope these days have connected you to the purpose of why we are here.
- You have our office's backing.
- Chair of Appropriations recently asked what we were learning about low embodied carbon materials. There is leadership at the Senate level. They are interested in hearing from us and what we need.
- Favorite codes quote (Southpark): "I don't make the rules, I think them up and write them down." That's us!
- We have the ability to reduce harm but also enhance readiness. Requires a culture shift. That is outrageously hard work.
- Senior Enlisted Officer of the Army asked us what they should be asking of us. The curiosity there is something we can really support.
- There's a famous quote: "Show me your budget and you show me what you care about." The way we plan resources to design, build and operate our buildings is a significant opportunity to align our priorities with our actions.
- There has been a sea change of leadership in the OSD office. Civilian leadership will be the sustaining force that carrying this work through.