The webinar will start momentarily....

U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Barriers to Data Center Energy Efficiency: The Role of Organizational Behavior, Psychology, and Economics

September 2, 2021

FEMP
Federal Energy Management Program

Webinar Logistics

- This webinar is being recorded. The Q&A section will not be made publically available.
- Your phone will be muted throughout the webinar.
- Enter any questions in the Question Box throughout the webinar.
- Instructions to take the quiz will be provided at the end of webinar.
- Slides will be sent out afterwards to those who attend the entire webinar.

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CENTER OF EXPERTISE
FOR ENERGY EFFICIENCY IN DATA CENTERS

Webinar Agenda

- Introduction
- Overview of Components to Energy Efficiency Decision-Making in Data Centers
- Proposed Solutions for Overcoming Organizational, Psychological, and Economic Barriers
- Unique Problems and Solutions to Small and Medium Data Centers
- Future Research on Non-Technology Barriers to EE in Data Centers from the CoE
- Resources and Q&A

Introduction

Learning Objectives

- Educate data center stakeholders on **organizational, psychological, and economic drivers and barriers** to EE in data centers.
- Educate data center stakeholders on a **framework for understanding the role these barriers and drivers** play in EE decision-making in data centers.
- Educate stakeholders on **proposed solutions for overcoming these barriers.**
- Educate stakeholders on **future research** that is coming from the COE on this topic.

Methods

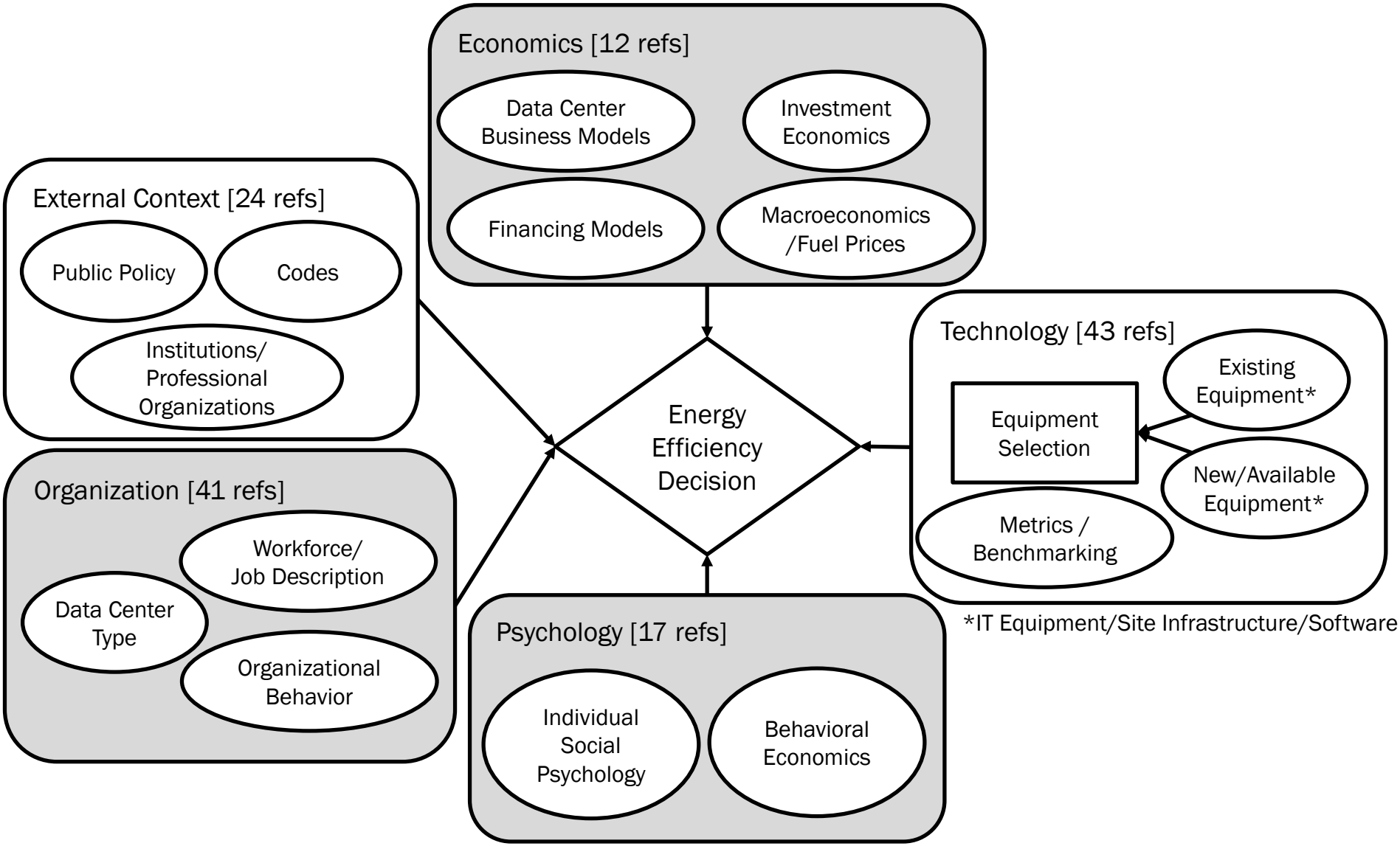
- **The Center of Expertise for Energy Efficiency in Data Centers (CoE) is completing a two-phase program of research for identifying key organizational barriers and implementation measures to increase data center energy efficiency**

- **Phase I: Literature Review (presented today)**
  - 87 documents identified and reviewed
  - Includes academic publications, DOE and National Lab Reports, professional organization and practitioner materials (e.g. ASHRAE)
  - 26 unique journals including Science, Nature, Applied Energy, Energy Efficiency, and Energy Research and Social Science

- **Phase II: Interview Study (future work)**

Overview of Components to Energy Efficiency Decision-Making in Data Centers

Components to EE Decision-Making



High-Level Definitions

External Context

- Influences outside of the organization that directly or indirectly affect energy efficiency (EE) decisions within the organization
- Examples: Federal and state goals, DCEP, and Energy Act of 2020

Technology

- These include the decision-maker's existing technology conditions and available options for new technologies, as well as the metrics and benchmarking available
- Examples: Discrepancies in PUE definitions, issues measuring energy consumption, and technology availability

Organization

- Influences related to the organization's structure and data center type
- Examples: Corporate social responsibility, dedicated sustainability team, and trained data center operators

Psychology

- Influences from the decision-maker's own set of individual differences and decision-making heuristics
- Examples: Attitudes towards energy efficiency, uncertainty and perceived risk, and time discounting

Economics

- Influences can be both internal and external and are related to project budgeting and benefitting parties
- Examples: Capital constraints, utility incentives, fuel prices, and split incentives

Why are we focusing on organizational, psychological, and economic barriers?

Barriers to EE decision-making in data centers are factors that prevent EE investments and upgrades.

- A lot of work has been done to study technological solutions to increasing data center energy efficiency
- Not a lot of work has been done to understand the decision-making process and the associated drivers and barriers to adopting those technologies
- Understanding non-technology barriers helps policy-makers, regulators, and other stakeholders find solutions to increasing EE in data centers

Organizational Drivers and Barriers

Drivers	Barriers
System Efficiency Design and Operation Focus (Shamshoian et al., 2005)	Lack of EE Champion (Seifert, 2018; Sartor and Greenberg 2018)
Aligning Practice with Values (Molla et al., 2009; CoE, 2020)	Emphasis on Uptime and Reliability (Howard and Holmes, 2012)
Meet CSR Goals, Demonstrate Excellence (Adjei et al., 2021; Hanus et al., 2018)	Low Strategic Priority (Hanus et al., 2018; Maiorano, 2018; Kaplowitz et al., 2012)
	Internal Silos (Schuetz et al., 2013)
	Lack of Skilled, Interdisciplinary, and Diverse Workforce (Sverdlik, 2018)

Reliability Emphasis Quote

"The extreme importance placed on uptime, reliability, and equipment redundancy results in data center staff being particularly averse to implementing new energy efficiency technologies or upgrades to their facilities. As one interview participant described, "No IT people get fired for not saving money, but they can get fired if their systems go down."

Howard, A. J., & Holmes, J. (2012). Addressing Data Center Efficiency: Lessons Learned from Process Evaluations of Utility Energy Efficiency Programs. *Energy Efficiency, 5*(1), 137–48. https://doi.org/10.1007/s12053-011-9128-4.

Psychological Drivers and Barriers

Drivers	Barriers
Ideology (Kaplowitz et al., 2012)	**Low EE Salience in IT Staff** (Klemick et al., 2019; Lansing, 2020)
Social Pressure (Cresswell and Sheikh, 2013; Johnston and Berger, 2011)	**Technical Risk Aversion** (Loper and Parr, 2007; Palm and Thollander, 2010)
Expertise and Individual Capacity (König, 2020; Schuetz et al., 2013)	**Lack of Knowledge, Bounded Rationality** (Bennett and Delforge, 2012)
	Time Discounting (Hanus et al., 2018)

Salience Quote

"My IT department, frankly, [is] not very concerned about the efficiencies and the technologies of the data center. They want a service, and they want it when they want it"

Klemick, H. , Kopits, E., & Wolverton, A. (2019). How Do Data Centers Make Energy Efficiency Investment Decisions? Qualitative Evidence from Focus Groups and Interviews. *Energy Efficiency, 12*(5), 1359-1377. https://doi.org/10.1007/s12053-019-09782-2.

Economic Drivers and Barriers

Drivers	Barriers
Reduce Operating Costs (Qureshi et al., 2009)	**Split Incentives** (Delforge and Whitney, 2014; Klemick et al., 2019)
Increase Reliability (CoE, 2020)	**High Upfront Capital Cost** (Morgenstern, Raslan, and Huebner, 2016; Bennett and Delforge, 2012; Palm and Thollander, 2010)
Utility Incentives (Howard and Holmes, 2012)	**Opportunity Cost of Capital** (Greenberg et al., 2006; CoE, 2020)

Split Incentive: Circumstance where the flow of investments (e.g. data center EE investments) and benefits (e.g. energy cost savings) are not properly rationed among the parties in a transaction, impairing investment decisions.

Split Incentive Quote

"Only 20% of organizations' IT departments pay the data center power bill...contractual relationships between colocation providers and their customers compound the split incentive challenge, with the data center owner paying the power bill, the tenants buying power blocks, and their IT purchasers separately specifying equipment."

Delforge, P., & Whitney, J. (2014). Issue Paper: Data Center Efficiency Assessment Scaling up Energy Efficiency across the Data Center Industry: Evaluating Key Drivers and Barriers. *Natural Resources Defense Council (NRDC)*. https://www.nrdc.org/sites/default/files/data-center-efficiency-assessment-IP.pdf

Proposed Solutions for Overcoming Organizational, Psychological, and Economic Barriers

Organizational Solutions and Resources

Barrier	Interventions	Goals
Lack of EE Champion	• Identify change agents and IT-related change management (Schuetz et al., 2013)	• Change managers should possess a wide variety of skills, including familiarity with company, business processes and technical software expertise
Emphasis on Uptime and Reliability	• Consolidate facilities and IT hardware groups under one manager (Schuetz et al., 2013)	• Centralize capital expenditure decisions, leading to improvement in data center design and procurement process
Low Strategic Priority	• Communicate with stakeholders (Schuetz et al., 2013) • Institutionalize the change within the C-suite (Schuetz et al., 2013)	• An important step in any IT related change is to first assess the stakeholders involved and their likely motivations • Lasting change and project success are correlated with the degree to which change management is institutionalized within the IT organization's policies and culture
Internal Silos	• Host cross-team meetings (Schuetz et al., 2013) • Implement systems design thinking (Schuetz et al., 2013)	• Improve crosscutting collaboration • Think outside of the box: Identify the goal and then optimize all pieces of the system simultaneously
Lack of Skilled, Interdisciplinary, and Diverse Workforce	• Training (York et al., 2017) • Certification and professional recognition (York et al., 2017) • Reference best practices guides (York et al., 2017)	• Increase awareness of and expertise in working with energy-efficient products, technologies, and services • Provide professional credentials that have value in job market; create market differentiator for potential customers

Psychological Solutions and Resources

Barrier	Interventions	Goals
Low EE Salience in IT Staff	• Institutionalize the change within the C-suite (Schuetz et al., 2013) • Certification and professional recognition (York et al., 2017) • Reference best practices guides (York et al., 2017) • Labeling (York et al., 2017)	• Lasting change and project success are correlated with the degree to which change management is institutionalized within the IT organization's policies and culture • Increase awareness of and expertise in working with energy-efficient products, technologies, and services • Create customer awareness of differences in EE among targeted products
Technical Risk Aversion	• Demonstration products and customer testimonials (York et al., 2017) • Educate other stakeholders as to how EE actions can actually bolster reliability and resiliency, and reduce O&M costs (CoE, 2020) • Initially prioritize low risk measures (CoE, 2020)	• Increase confidence in performance of products • Demonstrate a multitude of benefits from the EE measure • Demonstrate a proven process for implementing measures
Lack of Knowledge, Bounded Rationality	• Mass advertising (York et al., 2017) • Training (York et al., 2017)	• Increase awareness of products • Increase awareness of and expertise in working with energy-efficient products, technologies, and services
Time Discounting	• Bulk procurement and purchases (York et al., 2017) • Consider life-cycle cost analysis in decision-making (Shamshoian et al., 2005)	• Increase demand quickly and seek lower prices due to economies of scale • Life-cycle cost analysis can allow for the inclusion of energy price volatility, non-energy benefits, and product disposal

Economic Solutions and Resources

Barrier	Interventions	Goals
Split Incentives	• Factor energy performance into contracts (Delforge and Whitney, 2014) • Benchmarking (Hanus et al., 2018)	• Align contract incentives between multi-tenant data center providers and customers by moving toward actual space and energy use charge-back mechanisms, along with improved reporting and greater transparency • Owners/managers may be inclined to reduce energy consumption in attempt to signal CSR through benchmarking
High Upfront Capital Cost	• Manufacturer, utility and government incentives (York et al., 2017) • Government procurement (Brown et al., 2007) • Consolidate facilities and IT hardware groups under one manager (Schuetz et al., 2013)	• Reduce upfront cost • Government procurement programs raise awareness of new-to-market EE products and reduce costs of manufacture through economies of scale • Centralize capital expenditure decisions, leading to improvement in data center design and procurement process
Opportunity Cost of Capital	• Consolidate facilities and IT hardware groups under one manager (Schuetz et al., 2013) • Project Champions should identify all of the stakeholders vying for funds, assess the organization risk tolerance, and implement financial benchmarks for data center projects (CoE, 2020)	• Centralize capital expenditure decisions, leading to improvement in data center design and procurement process • Identify other initiatives and compare them with the data center project, prioritize measures that fit the risk tolerance, and analyze how the measure(s) meets the bottom line

Unique Problems and Solutions to Small and Medium Data Centers

Challenges in Small & Medium Data Centers

- **Small and medium data centers are often more resource constrained than their larger counterparts.**
- **Achieving energy efficiency can be challenged by:**
  - Limited budget and/or fewer dedicated staff
  - Less incentive to implement energy efficiency solutions due to smaller scale
  - Less visibility and (potentially) alignment to the organization's core mission
  - Operating in a space not intended for a data center
- **Despite these challenges, there are plenty of low-cost, high-win EE opportunities that are easy to implement.**

Small Data Center Webpage | Small Data Center Guide

Future Research on Non-Technology Barriers to EE in Data Centers from the CoE

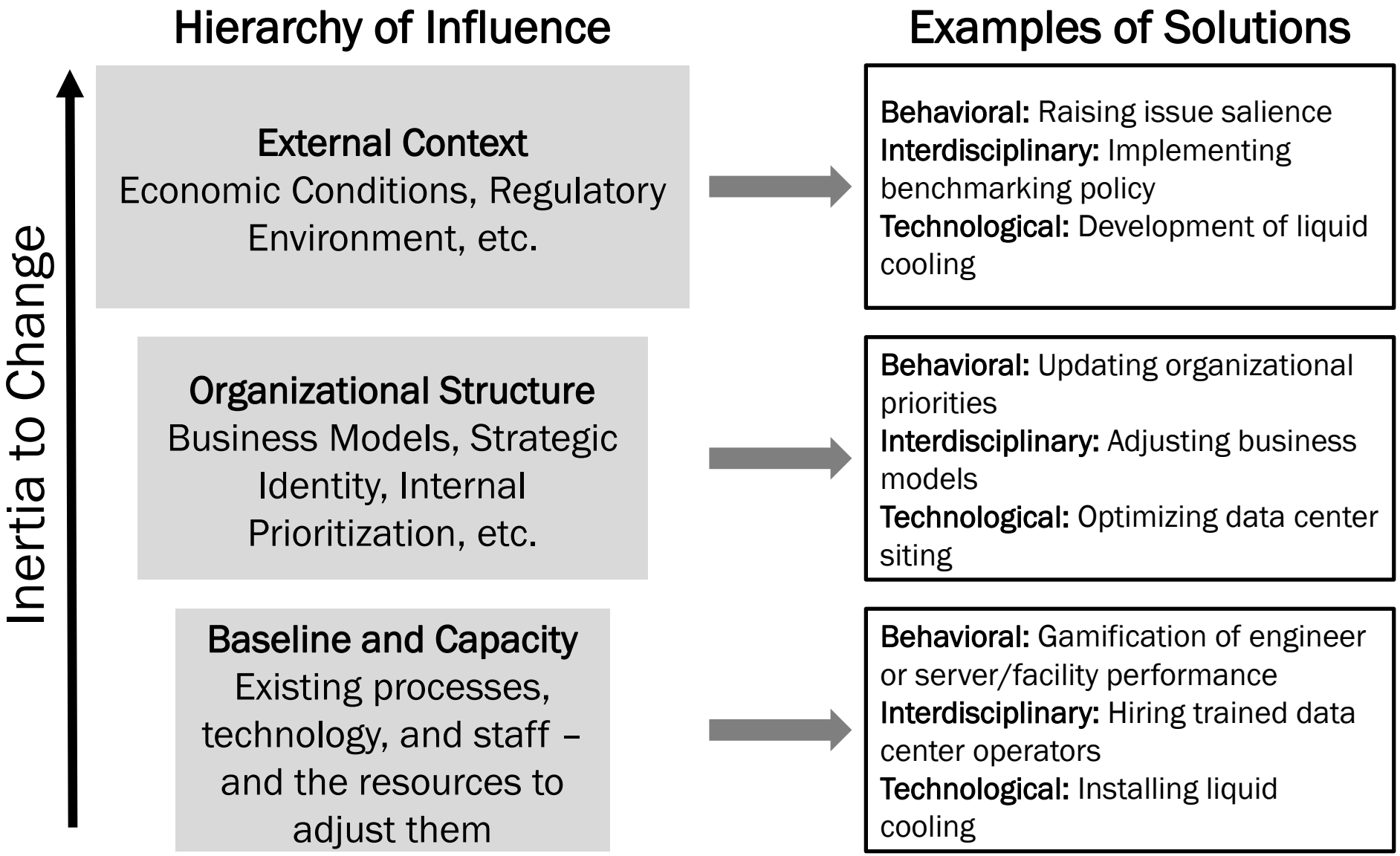
Phase II: Interview Study

- Phase II entails interviewing data center owners and operators, vendors, academics, and other data center EE experts

- The aim of the interview study will be to identify (1) the prevalence of barriers identified in the literature review across data center decision-makers and (2) effective policies for addressing these barriers

- The interview protocols will be based on our theory of a hierarchy of influences in EE decision-making in data centers, which is based on our findings from the literature

Framework for studying EE decision-making



Resources and Q&A

FEMP's Data Center Program

FEMP's Data Center program assists federal agencies and other organizations with optimizing the design and operation of data centers. design and operation of energy and water systems in data centers to enhance agency's mission.

Assistance

- Project and technical assistance from the Center of Expertise including identifying and evaluating ECMs, M&V plan review, and project design review.
- Support agencies in meeting OMB's Data Center Optimization Initiative requirements

Tools

- Data Center Profiler (DC Pro) Tools (x2)
- Air Management Tools (x3)
- IT Equipment Tool
- Electrical Power Chain Tool
- Energy Assessment Worksheets
- The Energy Assessment Process Manual

Key Resources

- Better Buildings Data Center Challenge and Accelerator
- Small Data Centers, Big Energy Savings: An Introduction for Owners and Operators
- Data Center Master List of Energy Efficiency Actions

Training

- Better Buildings webinar series
- Nine on-demand FEMP data center trainings
- Center of Expertise Webinars
- Data Center Energy Practitioner Trainings

Center of Expertise Website

Use CoE's Energy Efficiency Toolkit.

Choose from upcoming live webinars, pre-recorded trainings, and in-person Data Center Energy Practitioner (DCEP) trainings.

Explore the various focus areas of the CoE.

Filter CoE's many resources by type and topic.

Search resources by topics of interest.

We offer tools, technologies and analysis to enhance energy performance in datacenters.

Featured Work

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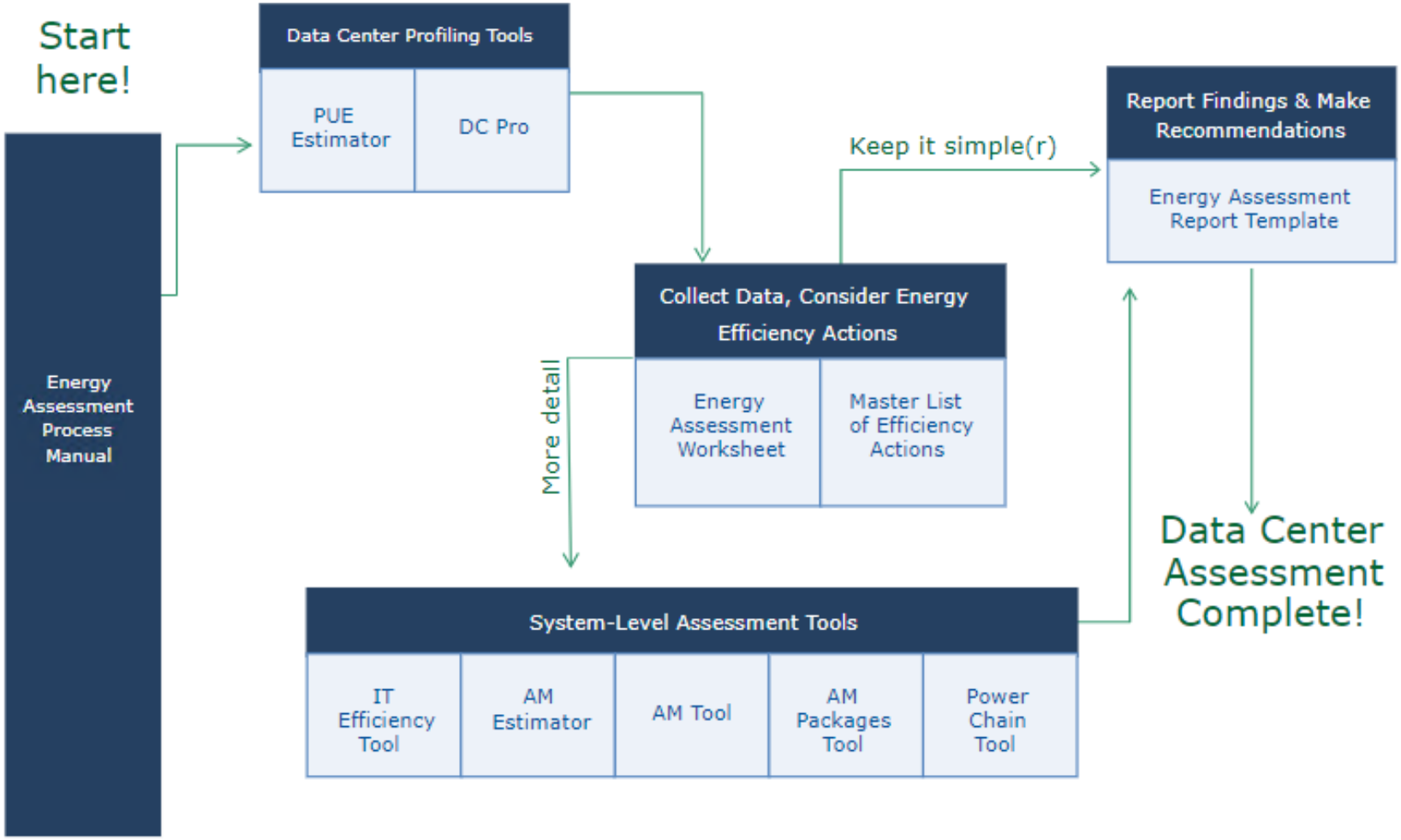
CoE Data Center Energy Efficiency Toolkit



Business Case for Energy Efficiency in Data Centers

- Interactive web resource enables users to identify stakeholders across an organization who are critical to a project's success and assess relevant drivers and barriers.
- Explore resources that can help overcome barriers and win over stakeholders – including successful case studies, CoE tools, training opportunities, etc.

Access the Business Case

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Questions?

IACET Credit for Webinar

WBDG WHOLE BUILDING DESIGN GUIDE *a program of the* National Institute of Building Sciences

ACCREDITED IACET PROVIDER

The National Institute of Building Sciences' (NIBS) Whole Building Design Guide (WBDG) hosts the FEMP training program's learning management system (LMS).

The WBDG LMS:

- Allows for taking multiple trainings from multiple organizations through one platform.
- Houses the assessments and evaluations for all accredited courses.
- Allows you to:
  - Track all of your trainings in one place.
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- Complete an assessment demonstrating knowledge of course learning objectives and an evaluation **within six weeks of the training**. A minimum of 80% correct answers are required for the assessment.

To access the webinar assessment and evaluation, visit:

https://www.wbdg.org/continuing-education/femp-courses/femplw08042020

If you have a WBDG account and enrolled previously, simply log in and click the *Continuing Education* tab on the user account page. Click *Proceed to Course* next to the course title.

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