EPRI

DCFlex

DCFlex

Data Center Flexible Load Initiative

PJM Connect and Manage Senior Task Force Meeting

April 10, 2026

Optimize Data Center Operational Flexibility to Help Strengthen the Grid

10+
demo sites

- ARIZONA, U.S.
- NORTH CAROLINA, U.S.
- PARIS, FRANCE
- VIRGINIA, U.S.
- ILLINOIS, U.S.
- TEXAS, U.S.
- LONDON, U.K.

DCFlex Workstreams

1. Flexible Data Center Design
2. Transformational Utility Programs
3. Grid Planning for Operational Flexibility
4. Data Center Informed Energy Supply
5. Distribution Data Centers

The DCFlex participant panel actively collaborates with regulators, academia, and industry stakeholders – both to share leading practices and insights, and to incorporate diverse perspectives that strengthen the initiative's direction and impact.

Learn More:
dcflex.epri.com

FLEX MOSAIC

Deliver a large load flexibility framework bridging data center capability to grid needs

DCFlex Participants

= PJM member

Developers

COMPASS datacenters

QTS

Hyperscalers

Google

Meta

Microsoft

IPP's

CALPINE

Constellation

nrg

RWE

VISTRA

ISO/RTO

California ISO

CENACE

CENTRO NACIONAL DE CONTROL DE ENERGÍA

ercot

ieso

smart KPX

MISO

NESO National Energy System Operator

pjm

SPP Southwest Power Pool

Technology Providers

CATERPILLAR

JENBACHER

INNIO

KRAKEN

NVIDIA

PADO

Schneider Electric

Advisory & Finance

EY

ING

KPMG

Engineering & Construction

CRIEPI Central Research Institute of Electric Power Industry

QUANTA

Ulteig

wesco

Utilities

aes

Alliant Energy

AMERICAN ELECTRIC POWER

aps

Bonneville POWER ADMINISTRATION

AEH

Dominion Energy

DTE

DUKE ENERGY.

EAST KENTUCKY POWER COOPERATIVE

ENOWA. NEOM

entergy

exelon

Georgia Transmission

ICEPCO

LES

LCRA

nationalgrid

Nebraska Public Power District

NEW YORK STATE OF OPPORTUNITY. NY Power Authority

OglethorpePower

PGE

ppl

PSEG

REC Rayburn Electric Cooperative

Rte

SKP

Southern Company

TVA

TENNESSEE VALLEY AUTHORITY

UNITED POWER Your Touchstone Energy® Cooperative

Flex MOSAIC™

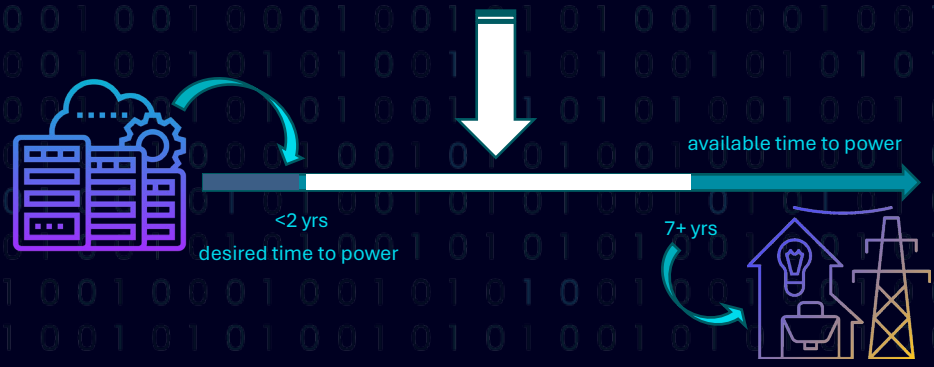
Large Load Flexibility Framework

Irene Danti Lopez

Strategic Lead, Workstream 1

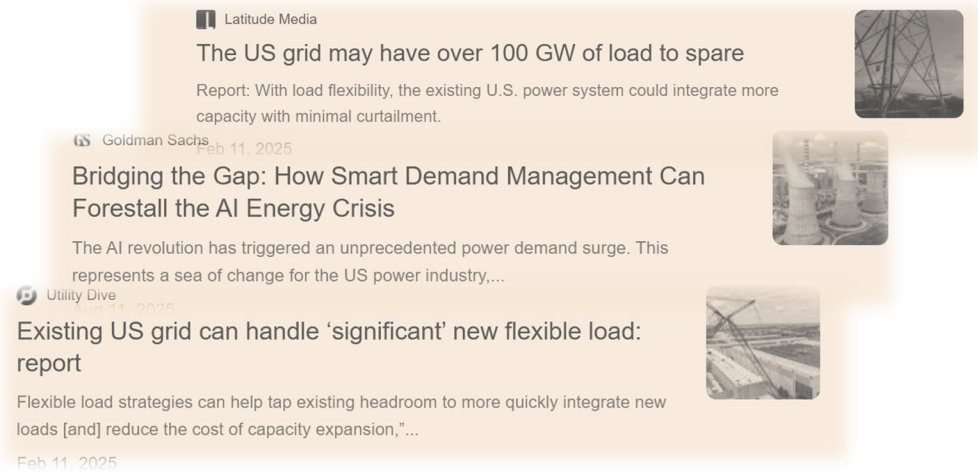
Powering AI Challenge

gap between data centers need & capacity availability



The Solution

Grid-integrated Flexible Load



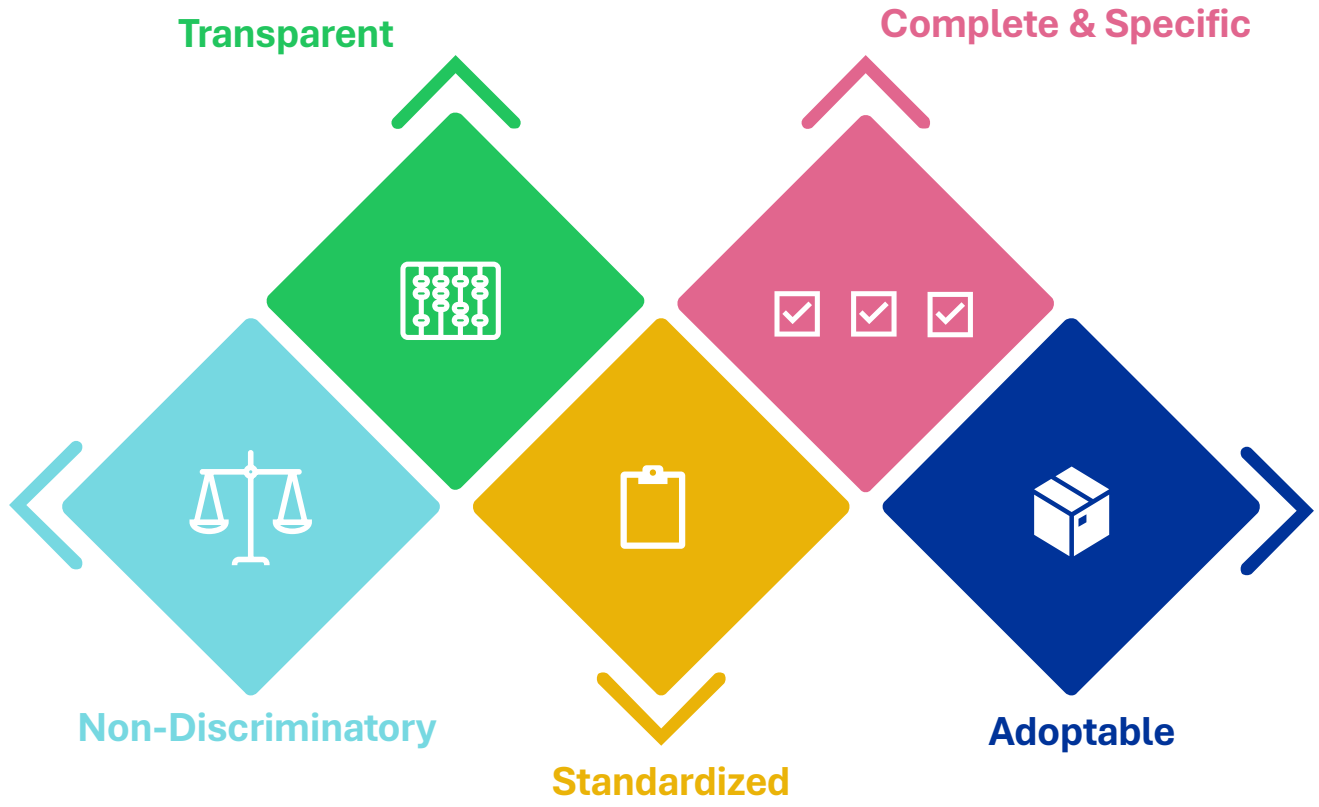
... but in the absence of *a **common language on flexibility*** grid capacity cannot be unlocked

FLEX MOSAIC

Framework Purpose & Guiding Principles

Create a common language for load flexibility

Accelerate speed to power while maintaining reliability

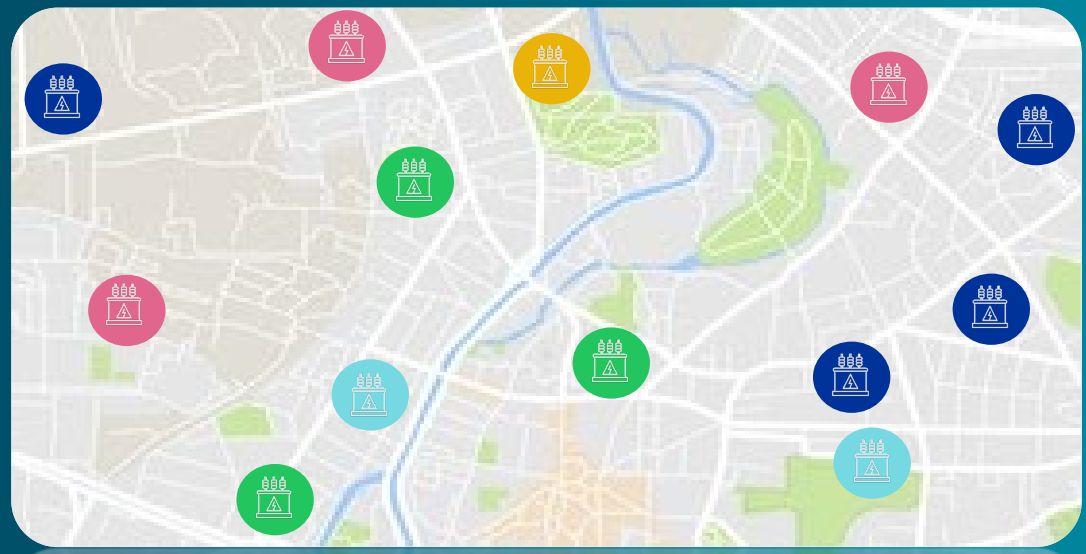


Standardizing Large Load Flexibility Characteristics to Unlock Interconnection

- **Class-certified large load profile**
- **Transparent & predictable flexibility capabilities**

Increasing flexibility

A	Critical Peak
B	+ Peak
C	+ Prolonged
D	/+ Fast
E	Fully Dispatchable



- **Transparent performance expectations**
- **Clear signals on flexibility needed**

FLEX MOSAIC

INCREASING FLEXIBILITY

CLASS A	CLASS B	CLASS C	CLASS D	CLASS E
Critical Peaking	Peaking	Prolonged	Fast	Fully Grid Responsive
Day Ahead	Day Ahead	Day Ahead	> 5 min	> 5 Minutes
< 5 Hours	< 5 Hours	24+ Hours	< 2 Hours	24+ Hours
~ 1%	~ 5+%	< 10%	> 8%	> 30%
respond to *rare* scarcity events 5 hours or less	respond to *frequent* scarcity events 5 hours or less	A + B + respond to *prolonged* events, up to 24+hrs	A + B + provide fast response with short notifce	Fully *grid responsive*

Notification Window
Activation Period
Annual Utilization

World's largest cross-sector collaborative on flexibility unveils

Common Flexibility Classification

to unlock grid capacity without compromising reliability and affordability

Proof It Works: Flexibility in Action

Flex MOSAIC™ was used to design test events in DCFlex demo site in UK

LONDON, U.K.

In December 2025, tests designed with FlexMOSAIC™ showed that high-performance AI data centers can operate as power-flexible, grid-responsive resources without degrading service levels.

Demonstrated that flexibility strategies tailored to the availability, scale, and duration of grid events may enable a practical pathway to faster data-center interconnection, reduced system costs, and improved grid reliability.

Flexible data center may be able to sustain 10–40% load reductions for durations ranging from 30 minutes to ten hours via the shifting of non-urgent workloads

emeraldai EPRI ELECTRIC POWER RESEARCH INSTITUTE nationalgrid NEBIUS

Broad Cross-Sector Commitment

Scan to learn more

Reliability & Standards Authorities

NERC

Financial & Advisory

ING

KPMG

Grid & Market Operators

California ISO

CENACE

IESO

KPX

MISO

SPP

Electric Utilities & Public Power

Alliant, APS, **Constellation**, DTE

Entergy, **Exelon**, Georgia Transmission

LCRA, LES, Nebraska Public Power District

NY Power Authority, PGE, **PSEG**

Rayburn Electric Cooperative, **RWE**

Southern Company, SRP, United Power

Technology, Data Centers, & OEM's

Compass

Google

Honeywell

Jenbacher

INNIO

Meta

NVIDIA

Siemens

Constellation, **Exelon**, **PSEG**, **RWE** = PJM member

Framework Path Forward

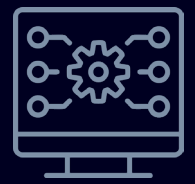
1. Pre-application

Base Framework*
- Locational signal by class enabled by headroom framework
- Design Evaluation Tool

2. Interconnection Application

- Certified large load Class
- Associated profile shape & resource characteristics

3. Interconnection Study



- Class based study dataset
- Transparent large load model and load shape

4. Interconnection Agreement

- Program frameworks

5. Project Commission

- communications protocol guidelines & related dispatch capability

* March 2026 announcement outlines the base framework. Rest of the capability will be rolled out in steps over the year

Development Evolution

Sprint 1
Define Framework

- Purpose of framework
- Value to each industry
- Base features

Dec'25

Sprint 2
Refine and Align

- Iteration with broad member input
- Tools and frameworks for base features

Mar'26

Sprint 3
Public Iteration and Tools

- Iteration with non-member, targeted stakeholders
- Reference design support elements

Jun'26

Public Use
Demonstration and Adoption

- Phased reference design rollout
- Structural incentive program design
- Tool availability for adoption

Oct'26

Partner with EPRI on FlexMOSAIC™

Scan to learn more

Questions?

Irene Danti Lopez, Ph.D.
Strategic Lead, DCFlex Workstream 1
Sr. Team Lead, Transmission Ops & Planning
idantilopez@epri.com

Headroom Project

Industry guidance for evaluating DC integration potential in regional power systems

Nidhi Santen

Strategic Lead, Workstream 4

INTRODUCTION

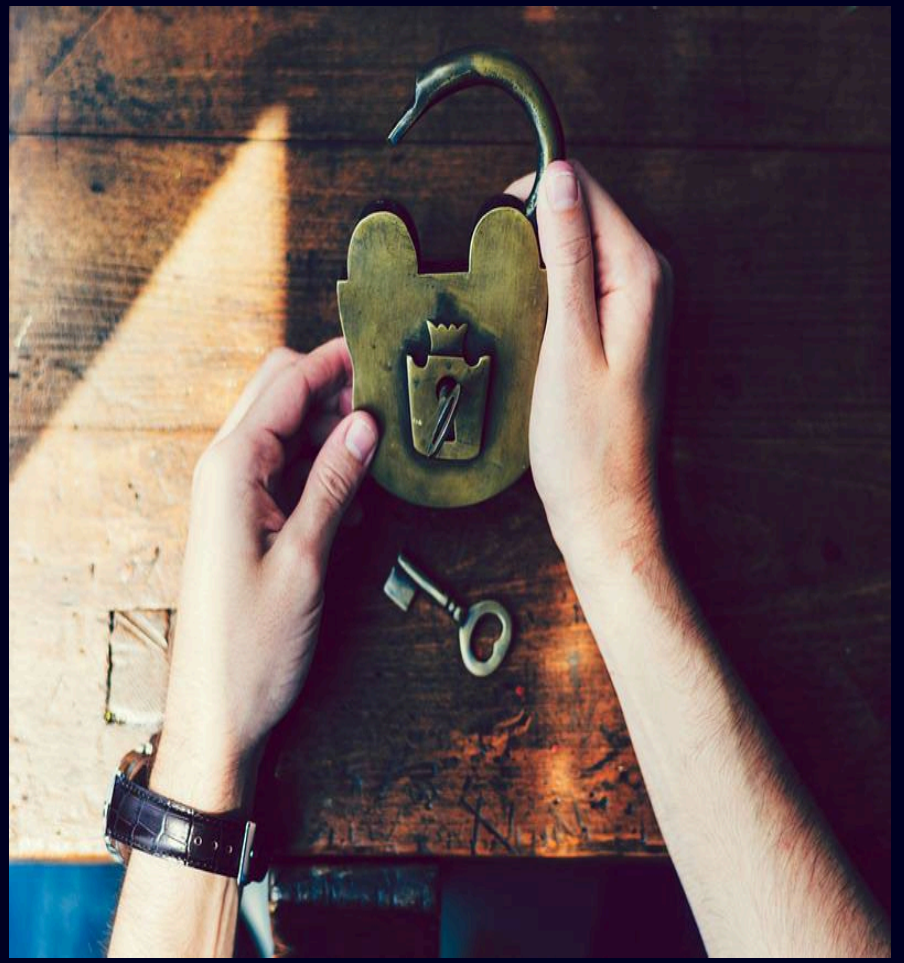
- As data centers (DC) continue to deploy and grid operators and planners assess options for meeting these new large loads, it is valuable to better understand:

  (1) how much additional load could be support by the existing system (i.e., no new supply or delivery capacity)**—i.e.,** how much **"headroom" there is on existing systems;** and

  (2) potential solutions to "unlock" additional system headroom to support DC integration—e.g., **how DC flexibility may be used as a grid asset to unlock hidden headroom.**

- **Headroom (at a given time) is a static feature of a power system** but affected by many dimensions of electric power system operations such as the level of flexibility DCs may provide, transmission constraints, curtailment rules, and other supply-demand interactions.

- This project is developing a **framework for comprehensively assessing headroom** in power systems and aims to provide **industry guidance on implementation**.



HEADROOM PROJECT ROADMAP

Apr 2026

HOW-TO DISCUSSION PAPER

"A Proposed Framework to Assess Technical Headroom for Integrating DCs: An Industry Playbook for Unlocking True System Potential"

June 2026

CASE STUDIES

5 North American and European case studies implementing the framework and illustrating the capability of Flex MOSAIC™ classes to unlock headroom in realistic power system settings

Sep 2026

THOUGHT LEADERSHIP ON ACHEIVABLE HEADROOM

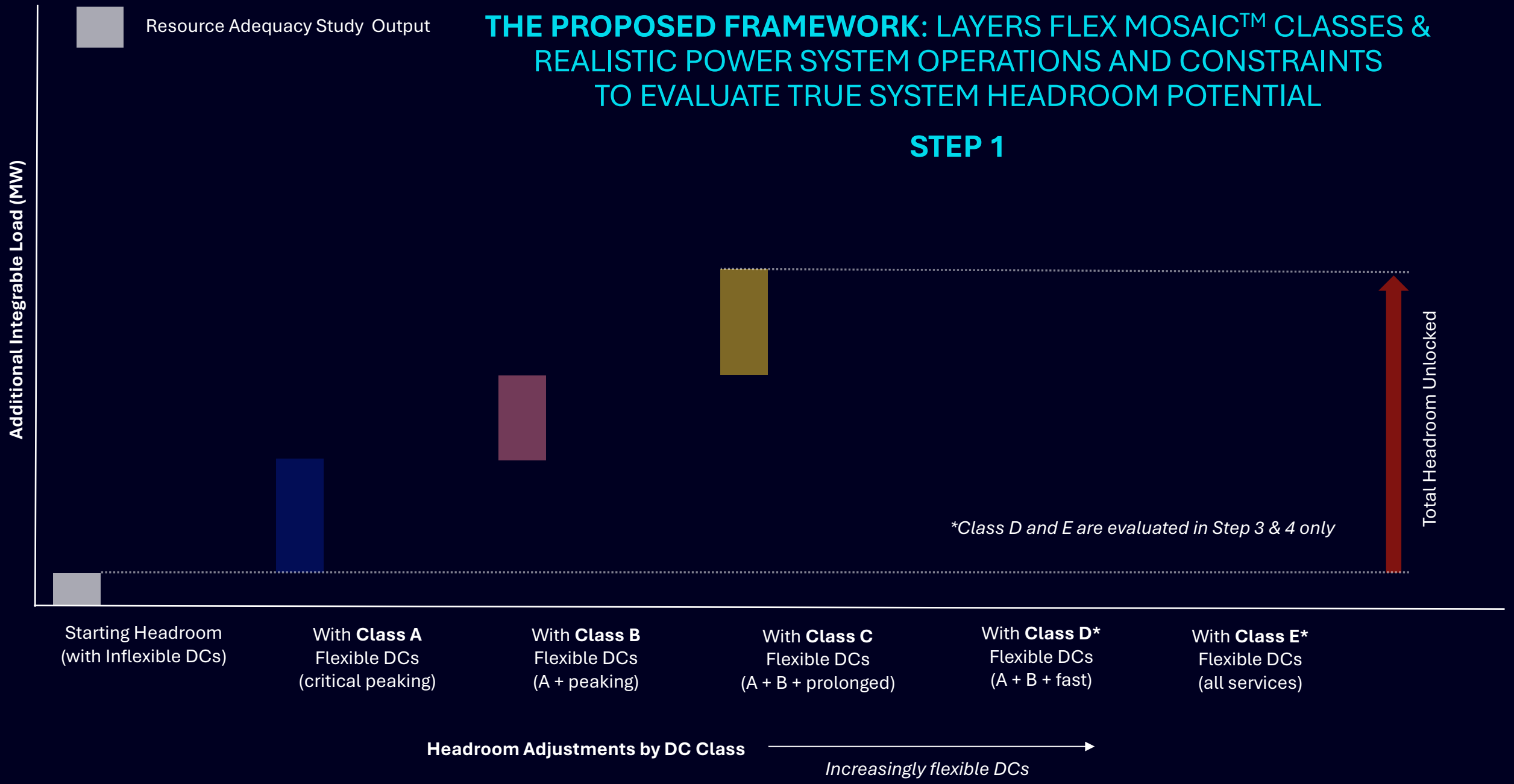
Generalizing headroom potential across a diverse range of power systems, highlighting key results and lessons learned from the case studies and offering updates to the framework.

DEVELOPING A FRAMEWORK & INDUSTRY GUIDANCE FOR EVALUATING DC INTEGRATION POTENTIAL IN REGIONAL POWER SYSTEMS

*"Uncovering **true system headroom** by considering realistic grid operations and the full range of DC flexibility archetypes."*

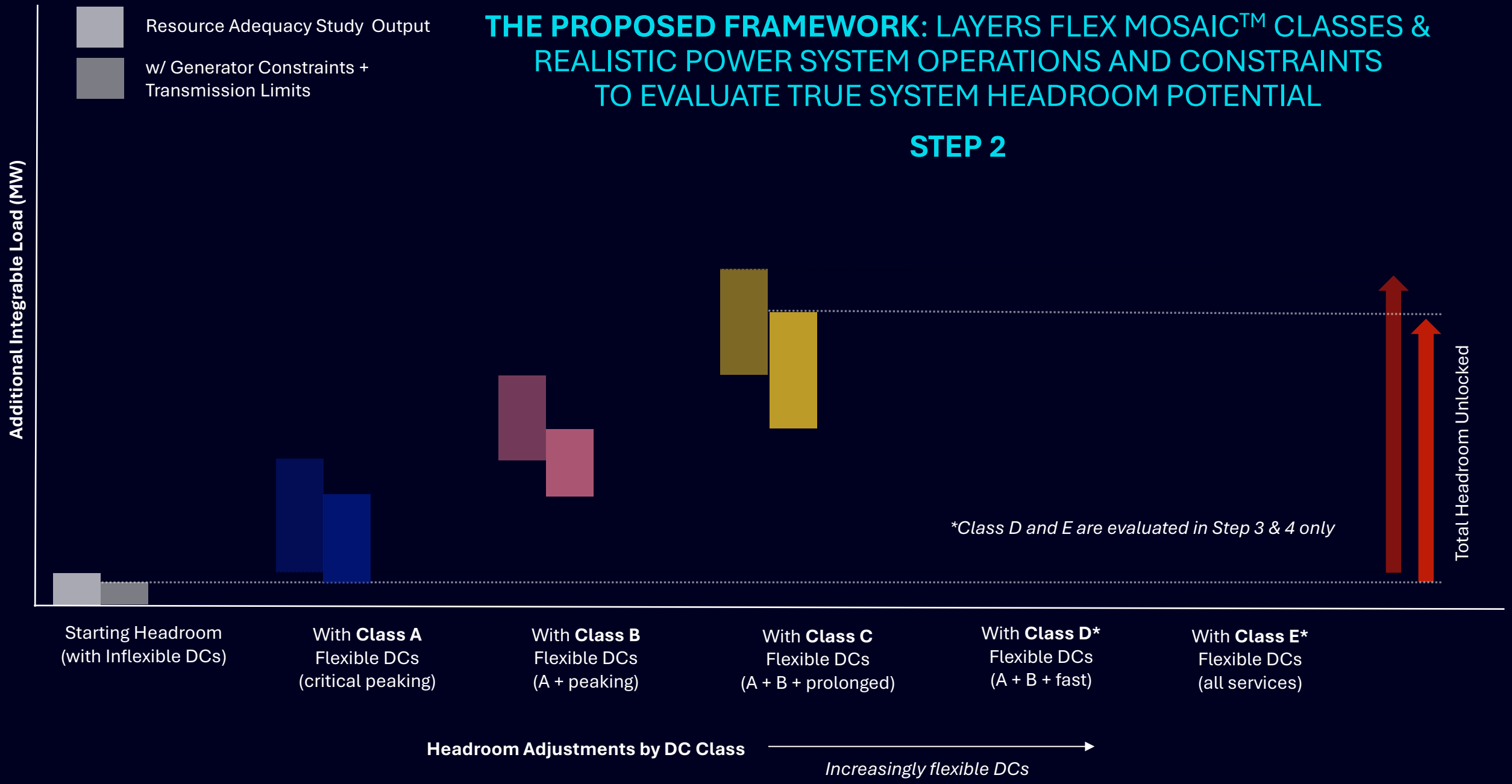
THE PROPOSED FRAMEWORK: LAYERS FLEX MOSAIC™ CLASSES & REALISTIC POWER SYSTEM OPERATIONS AND CONSTRAINTS TO EVALUATE TRUE SYSTEM HEADROOM POTENTIAL

STEP 1



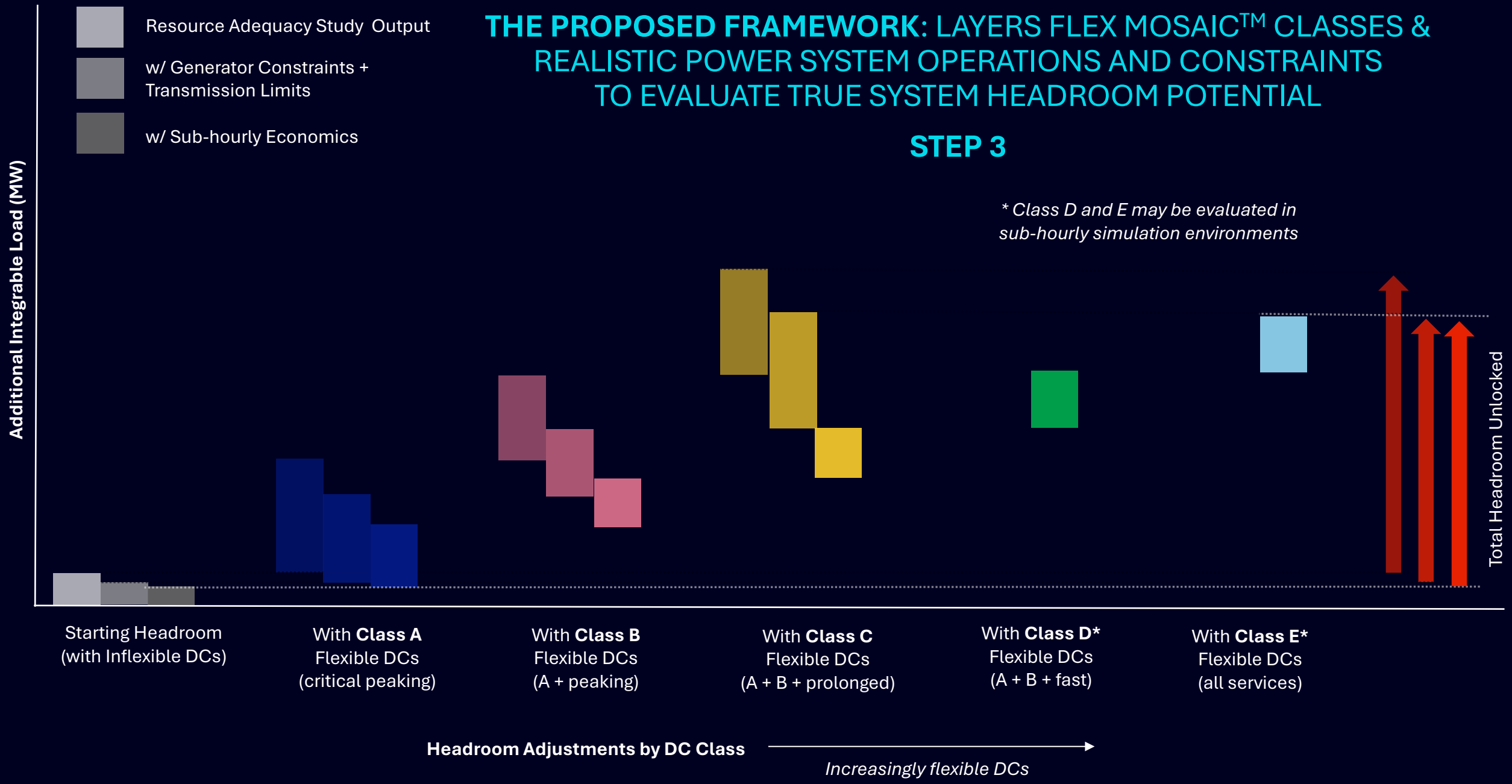
THE PROPOSED FRAMEWORK: LAYERS FLEX MOSAIC™ CLASSES & REALISTIC POWER SYSTEM OPERATIONS AND CONSTRAINTS TO EVALUATE TRUE SYSTEM HEADROOM POTENTIAL

STEP 2



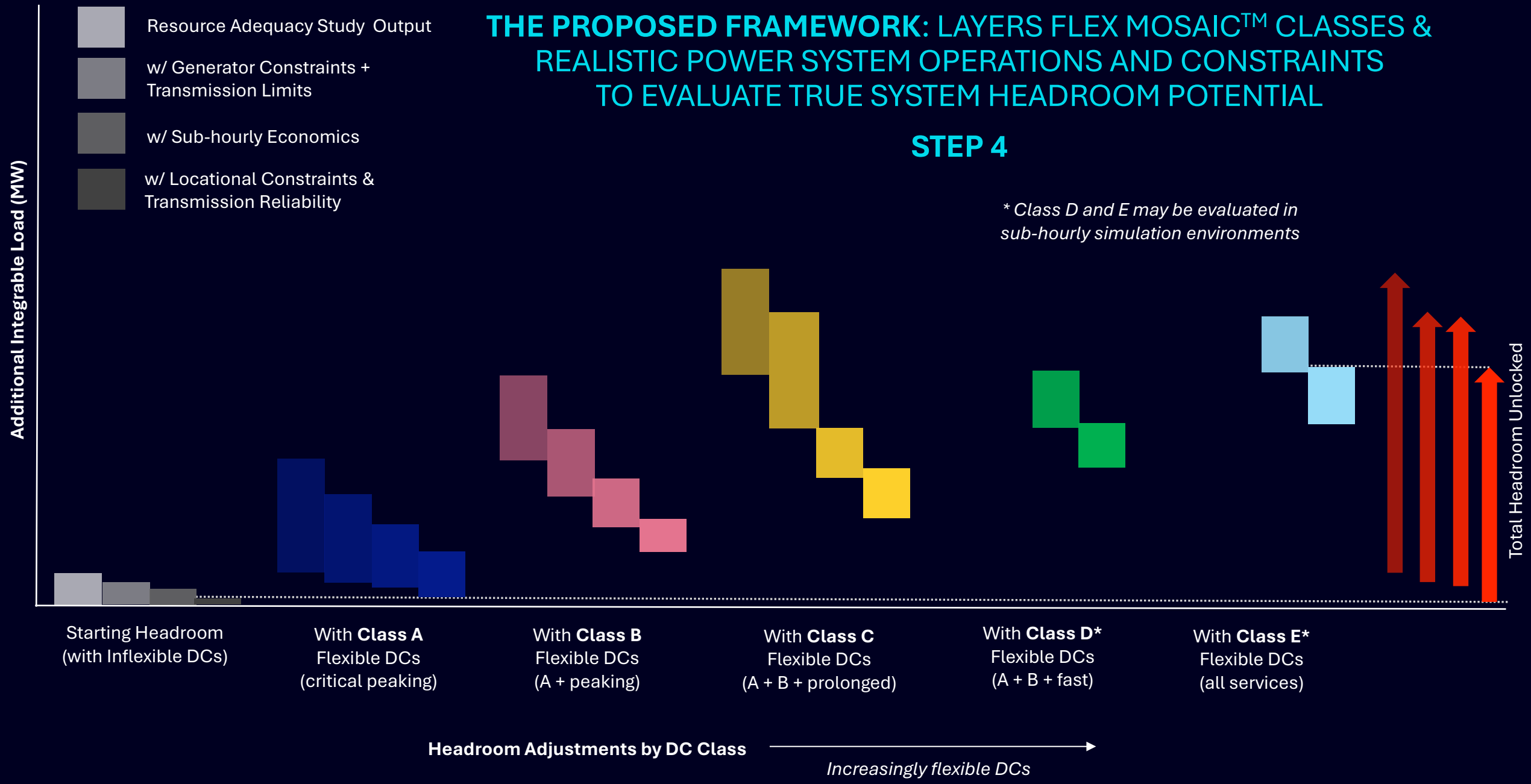
THE PROPOSED FRAMEWORK: LAYERS FLEX MOSAIC™ CLASSES & REALISTIC POWER SYSTEM OPERATIONS AND CONSTRAINTS TO EVALUATE TRUE SYSTEM HEADROOM POTENTIAL

STEP 3



THE PROPOSED FRAMEWORK: LAYERS FLEX MOSAIC™ CLASSES & REALISTIC POWER SYSTEM OPERATIONS AND CONSTRAINTS TO EVALUATE TRUE SYSTEM HEADROOM POTENTIAL

STEP 4



CASE STUDIES

DEMONSTRATING THE FRAMEWORK IN DIVERSE SYSTEM SETTINGS

CAISO

- Status: In Progress
- Collaborating with CAISO
- Demonstrating Full Framework
- Using PLEXOS & PSS/E
- This study will evolve into DCFlex's U.S. Integrated System Planning (Long-Term) Case Study

Exelon (ComEd)

- Status: In Planning
- Planned collaboration with Exelon/ComEd and Hitachi Energy
- Demonstrating Customized Framework (Steps 1, 2, 4) in PROMOD & TARA (TBD)
- Timeline: April – July 2026

ERCOT (TBD)

- Status: In Planning
- Demonstrating Framework Steps 1-3
- Using PLEXOS
- Timeline: May – August 2026

High Wind European System

- Status: In Progress
- Demonstrating Framework Steps 1-3
- Using PLEXOS
- This study will evolve into DCFlex's European ISP Case Study
- Timeline: April – June 2026

IESO (Ontario) (TBD)

- Status: In Planning
- Independent EPRI Study
- Demonstrating Framework Steps 1-3
- Using PLEXOS
- This study may evolve into DCFlex's Canadian ISP Case Study
- Timeline: April - July

CASE STUDY VALUE & EXPECTED RESULTS

EACH CASE UNCOVERS NEW INFORMATION FOR SCALING FRAMEWORK IMPLEMENTATION GUIDANCE

System Headroom Estimate & Associated Information

- Maximum additional integrable load (MW), by location (if modeled)
- Number of flexibility events (i.e., curtailment), by location
- Depth (MW) of flexibility events, by event and location
- Driver of curtailment events (e.g., congestion, reliability threshold)

Headroom Sensitivity to DC Flexibility Alternatives

- MW change of maximum integrable load by Flex MOSAIC™ class (A-E)
- Comparison of headroom effects across DC flexibility types

Headroom Sensitivity to System Representation

- MW change of maximum integrable load by power system “reality” considered (i.e., avoided risk)
- Understanding the features of a given power system that affect its headroom

Questions?

Nidhi Santen, Ph.D.
Strategic Lead, DCFlex Workstream 4
Area Manager, Integrated Energy Systems Planning
nsanten@epri.com

Demonstrations

Frank Sharp

Strategic Lead, Demonstrations

Cohort 1

ARIZONA, U.S.

Compute Flexibility
Artificial Intelligence

NORTH CAROLINA, U.S.

Compute Flexibility
Hyperscaler

PARIS, FRANCE

Grid Services
Co-Located

DCFlex demonstrations

Cohort 2

ILLINOIS, U.S.

Compute Flexibility
Artificial Intelligence

TEXAS, U.S.

HVO Backup Solution

VA/ IL , U.S.

Compute Flexibility
AI & Geospatial Load Shifting

VIRGINIA, U.S.

Large Scale Compute
Flexibility

LONDON, UK

Compute Flexibility

TEXAS, U.S.

Compute and HVAC Load
Flex – Paired with BESS

ORACLE · Rte · COMPASS datacenters · Dominion Energy · NVIDIA · Schneider Electric · exelon · pjm · comed AN EXELON COMPANY · Data4 SMART & SCALABLE DATA CENTERS · emeraldai · DUKE ENERGY · aps · Constellation · Google

EPRI

Demonstrations

Current Efforts

#	Location	Use Case	Tech
1	Phoenix, AZ	AI workload mgmt.	Emerald AI
2	Lenoir, NC	Cloud workload mgmt.	Google
3	Paris, France	PQ: fault ride-through in cloud / hyperscale environment	Schneider
4	**Chicago, IL**	**Scaled AI workload mgmt.**	**ComED, Emerald AI, Oracle, PJM, Constellation**
5	Dallas, TX	HVO fuel backup	Compass
6	**Ashburn, VA / Chicago IL**	**Geospatial compute shifting**	**ComED, Dominio, Emerald, NVIDIA, Constellation, PJM**
7	Manassas, VA	Commercial Scale Load Flexibility	Dominion, Emerald AI, Oracle
8	London, UK	Flexible AI workload mgmt. / Interconnection Analysis	Emerald AI, National Grid, NVIDIA, Nebius
9	Dallas, TX	Compute & HVAC load flex	PADO AI

- Multiple additional projects in discussion in the US and Europe
- Ongoing talks about evaluating new technologies and adding more DCFlex members
- Projects to be completed by Mid 2028

Demonstrations are Evolving and Learnings are Ongoing

- Interconnection time is the key driver for most sites
- 2025 demonstrations showed data centers can provide flexibility
- DCFlex demonstration ideas and concepts continue to expand via new DCFlex members
- On-site bridge generation offers the potential to transition to dispatchable grid generation long term
- PQ and BESS questions are occurring at many sites
- Concepts for new DC-focused utility programs are being developed

DCFlex member insights driving demo goals and test plans

Demo-04 - Chicago, IL (ComEd / Emerald AI/ Constellation/ PJM/ Oracle/NVIDIA/)

Use Case: Compute load flexibility with AI focus

- AI workload management in a cloud data center with realistic workloads
- Testing occurred in Late Sept / Early Oct 2025
- Initial analysis complete, but additional testing is possible
- **Key Learnings:**
  - AI clusters can act as dispatchable grid resources, offering flexibility without compromising mission-critical workloads
- **Impact:**
  - Validated dynamic, real-time power control in a production environment
  - Demonstrated grid services such as DR, sustained curtailment, and smooth ramping
  - Assessed economic viability and carbon reduction potential of flexibility

Demo-06 Ashburn, VA / Chicago, IL (Dominion / ComED / Emerald AI/ Constellation/ PJM/ Oracle/NVIDIA)

Use Case: Compute load flexibility with AI focus + Geoshifting

- Test plan finalized week of 12/8 and testing occurred week of 12/15
- Small scale demo showed up to 100% load shifting from one data center in Ashburn, VA, to another data center in Chicago, IL.
- Real-time monitoring occurred at both data centers to see if the intended load was completely reduced in the VA data center and added to the IL data center while maintaining equal customer experience / compute equivalence
- ***Results / Outcomes:***
  - Demonstrated the potential economic feasibility and DR benefits of geo-spatial shifting by controlling 32 nodes at each data center
  - Demonstrated compliance with grid and customer requirements, including DR, ramp rates, and maintaining AI workload performance

Key takeaways

Member-driven DC Flex demonstrations are providing value

- Past demonstrations built on each other and demonstrated that DC flexibility can occur while still maintaining DC performance
  - Future demonstrations will build and expand on these efforts
- *Demonstration findings have shown the potential for the development of DC-specific programs that leverage flexibility*
- Via active engagement and shared insights, Exelon (corporately and via individual operating companies) can help shape these demonstration efforts
- Active engagement in DC Flex resulted in demonstrations occurring and additional discussions about future DC Flex demonstrations potentially occurring in Exelon territories

Questions?

Frank Sharp
Strategic Lead, DCFlex Demonstrations
Technical Executive, Electrification & Customer Solutions
fsharp@epri.com