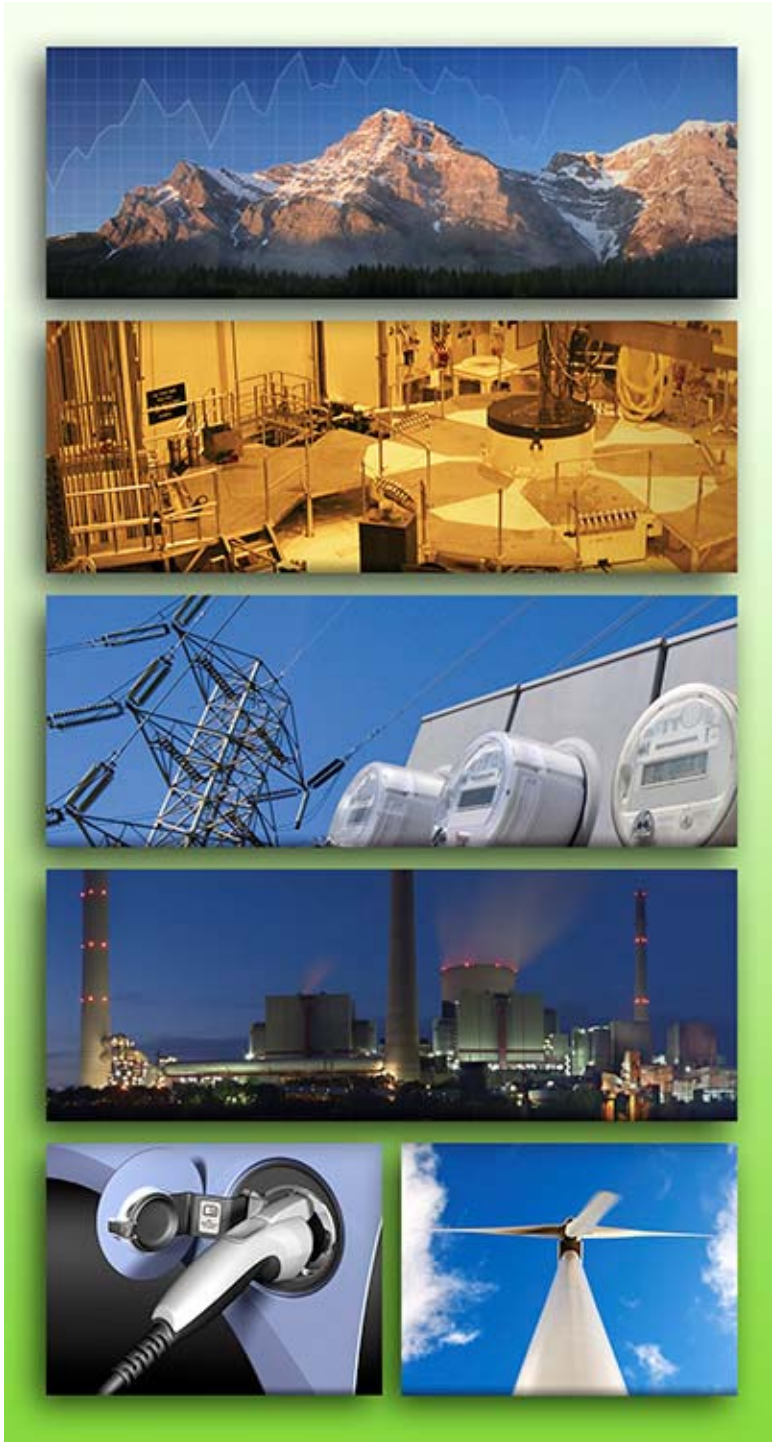

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380VDC Data Center At Duke Energy

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Duke Energy - Senior Project Manager

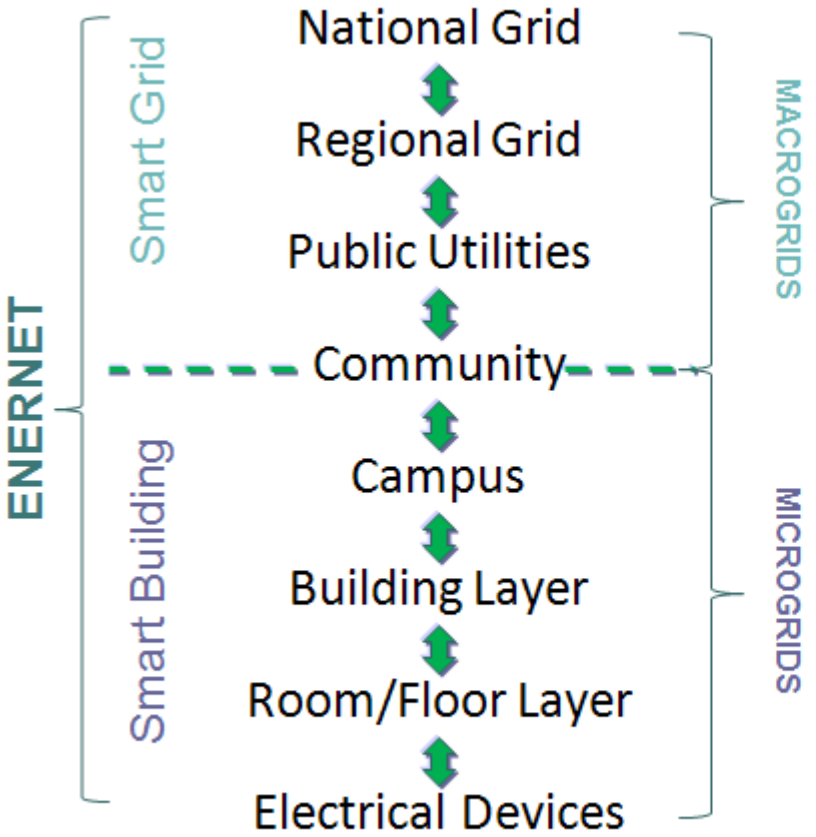
Emerging Technology (ET) Summit
November 9, 2010 – Sacramento, CA

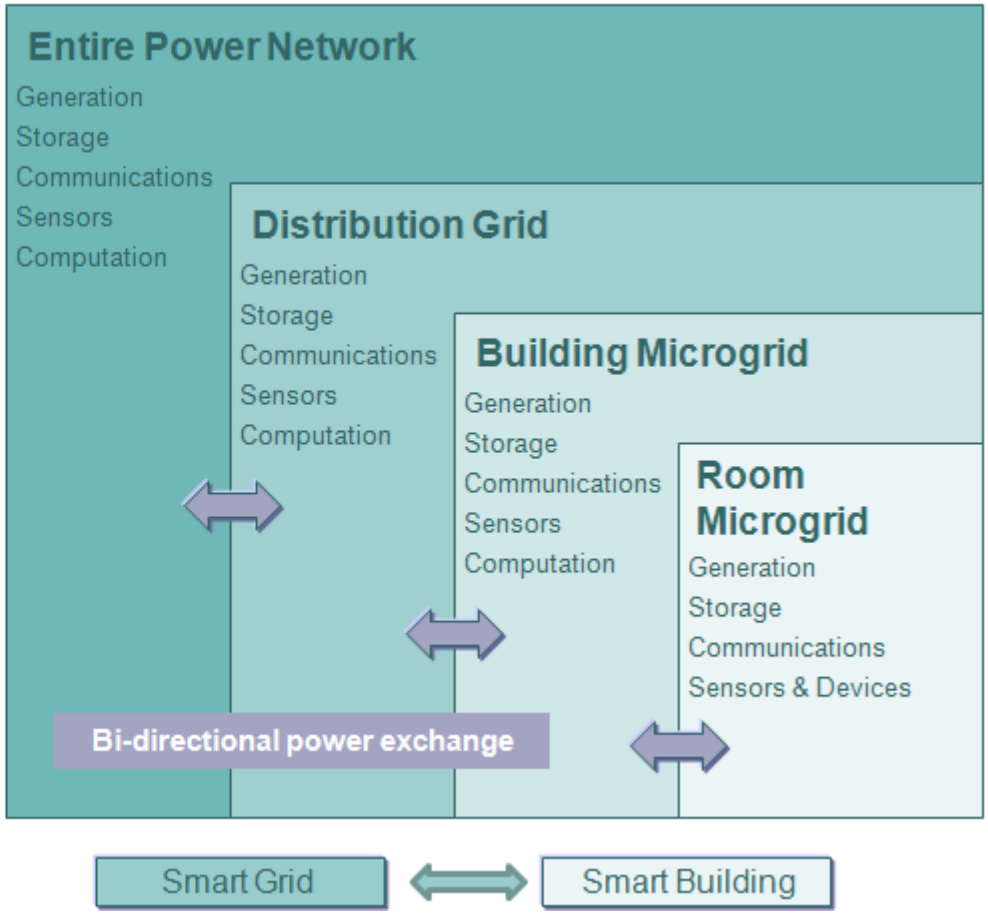
From Dept of Energy Secretary Steven Chu

- As Energy Secretary Steven Chu has noted, “America cannot build a 21st Century energy economy with a mid-20th Century electricity system.”
- Transforming the current grid into a dynamic, resilient, and adaptable Smart Grid will be one of the biggest technological challenges of our times. The rewards, however, may be dramatic, enabling consumers to better control their electricity use, integrating the next generation of plug-in electric vehicles, increasing efficiency, and better harnessing renewable energy.

Source: Department of Energy, Communications Requirement Of Smart Grid Technologies, October 5, 2010

Smart Grid to Smart Buildings





Source: EMerge Alliance Overview

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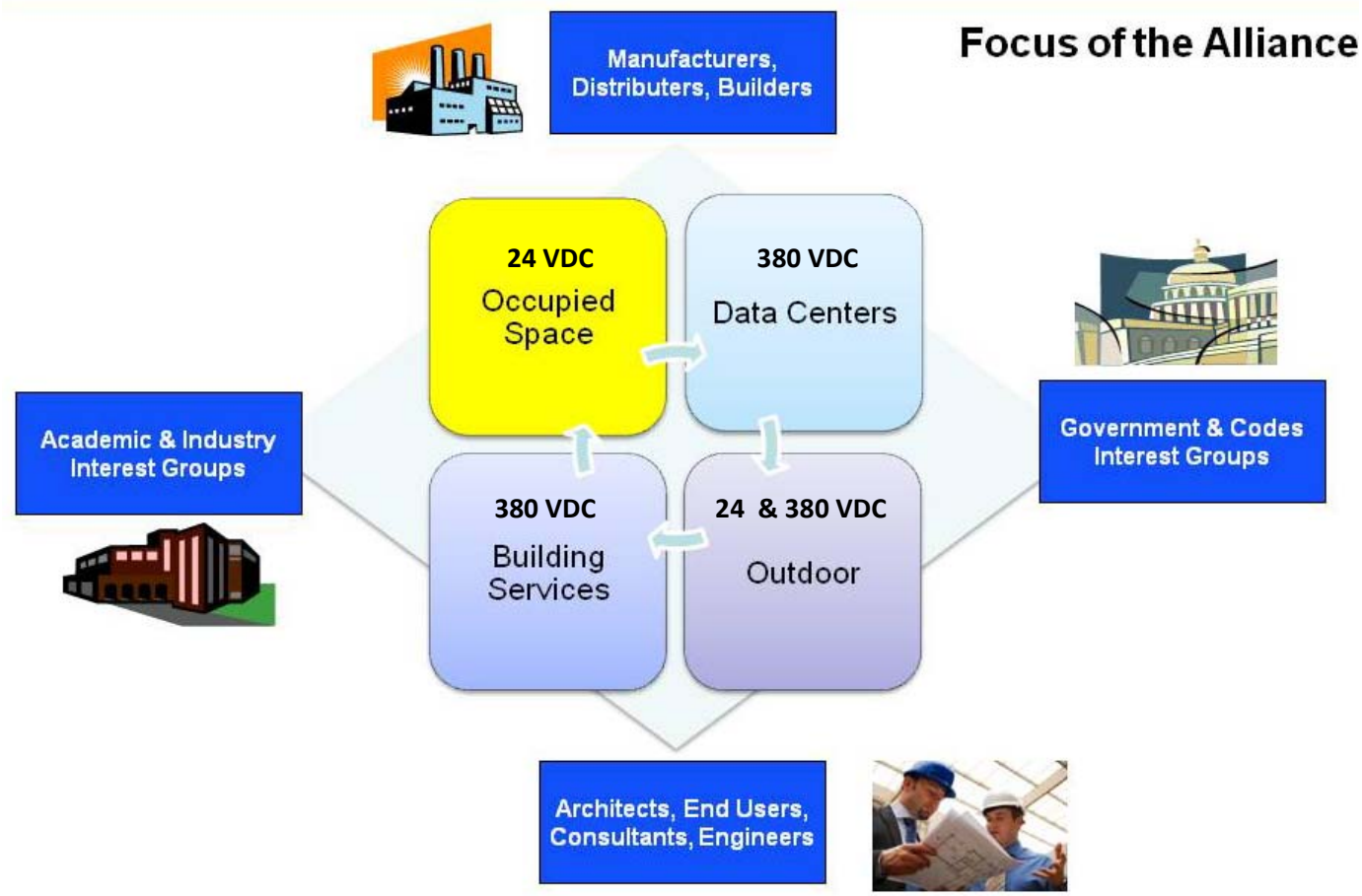
DC Microgrids Throughout Buildings

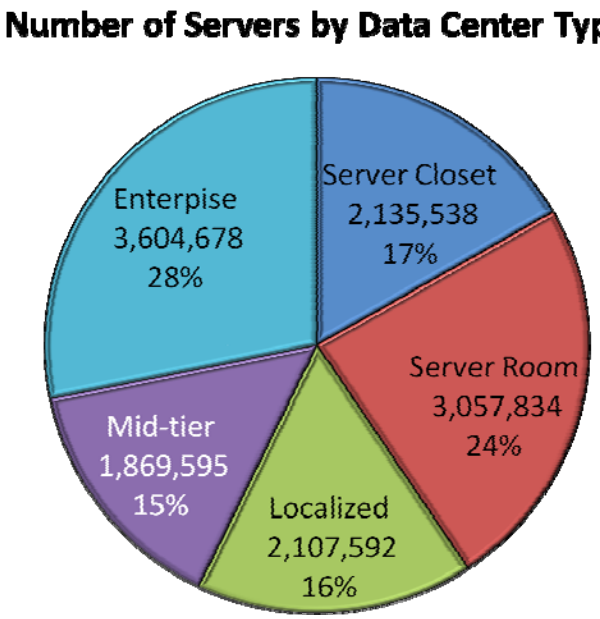


Source: EMerge Alliance Overview

Data Center Types, Sizes and Numbers

Type	Server Closet	Server Room	Localized Data Center	Mid-tier Data Center	Enterprise-Class Data Center
Scope	Secondary computer location, often outside of IT control, or may be a primary site for a small business	Secondary computer location, under IT control, or may be a primary site for a small business	Primary or secondary computer location, under IT control	Primary computing location, under IT control	Primary computing location, under IT control
Power/cooling	Standard room air-conditioning, no UPS	Upgraded room air conditioning, single UPS	Maintained at 17°C; some power and cooling redundancy	Maintained at 17°C; some power and cooling redundancy	Maintained at 17°C; at least N+1 power & cooling redundancy
Sq ft	<200sq ft	<500sq ft	<1,000sq ft	<5,000sq ft	>5,000 sq ft
US data centers (2009 est)	1,345,741 = 51.8%	1,170,399 = 45.1%	64,229 = 2.5%	9,758 = 0.4%	7,006 = 0.3%
Total Servers (2009 est)	2,135,538 = 17%	3,057,834 = 24%	2,107,592 = 16%	1,869,595 = 15%	3,604,678 = 28%
Average servers per location	2	3	32	192	515

Data Center Type and Server Population



0.7% of data centers (Enterprise & Mid-tier) contain 43% of all servers

(Amazon/Apple/Facebook/Google/Yahoo)

They have staffs of internal electrical & mechanical engineers to design & construct efficient data centers

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99.3% of data centers (more than 2.5 million of them) contain 57% of all servers

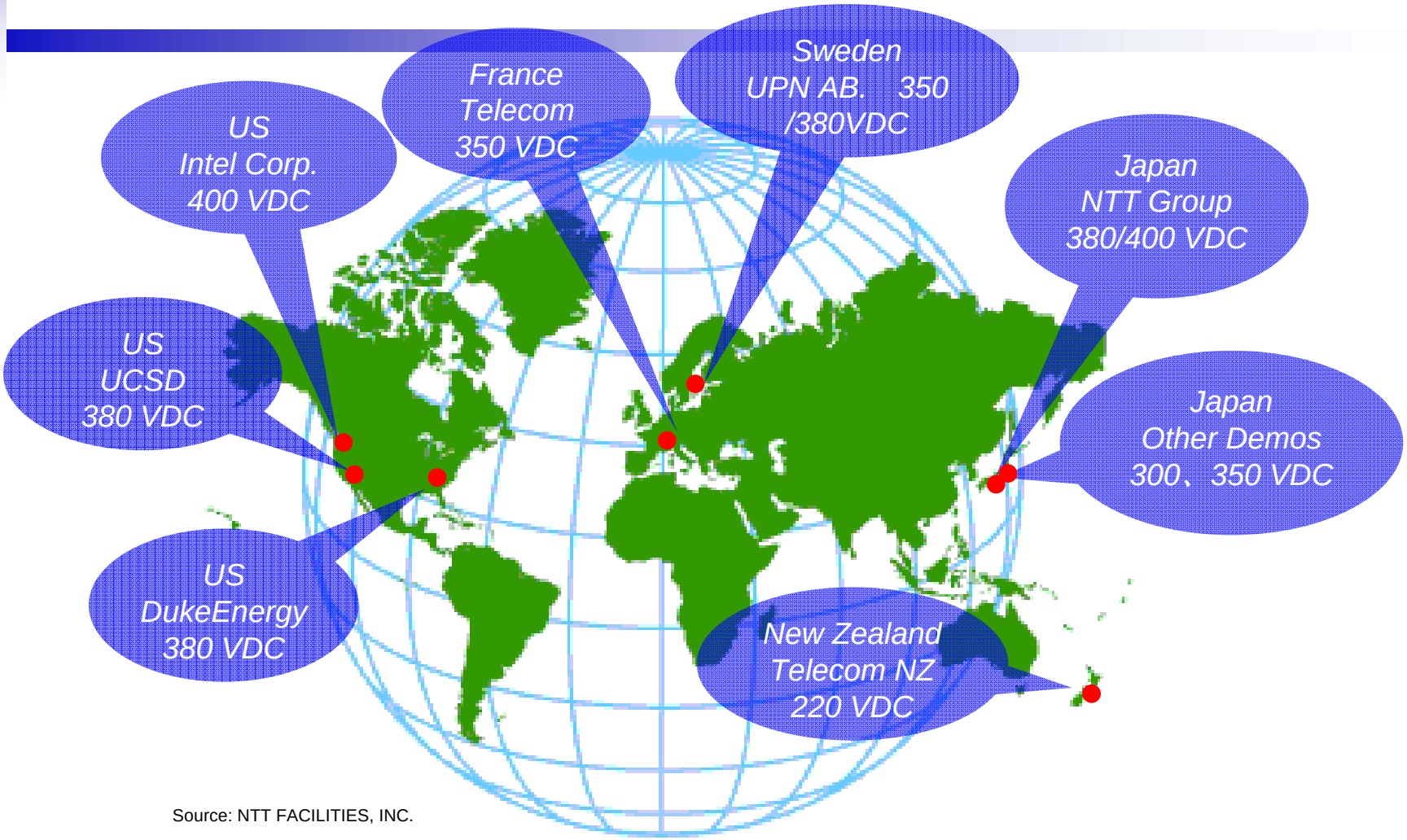
(Hospitals/Hotels/Universities/Utilities/Banks /City Halls/Supermarkets/Chain Stores)

These data centers operators struggle with heat/space/power problems without much internal expertise

380VDC Data Center Activity

- Involved With Multiple 380VDC Demos
  - Universities
  - Electric Utilities
  - Telecom Industry
- Harmonizing Multiple 380VDC Spec Efforts
  - DC Power Partners Joining EMerge Alliance
  - European Telecommunications Standards Institute
  - International Electrotechnical Commission (SG4)
- Working With Many Manufacturers
  - IT Equipment As Well As Facility Equipment

Worldwide ~380VDC Demos



Source: NTT FACILITIES, INC.

Duke Energy 380VDC Data Center Demo

HP Servers

IBM Servers

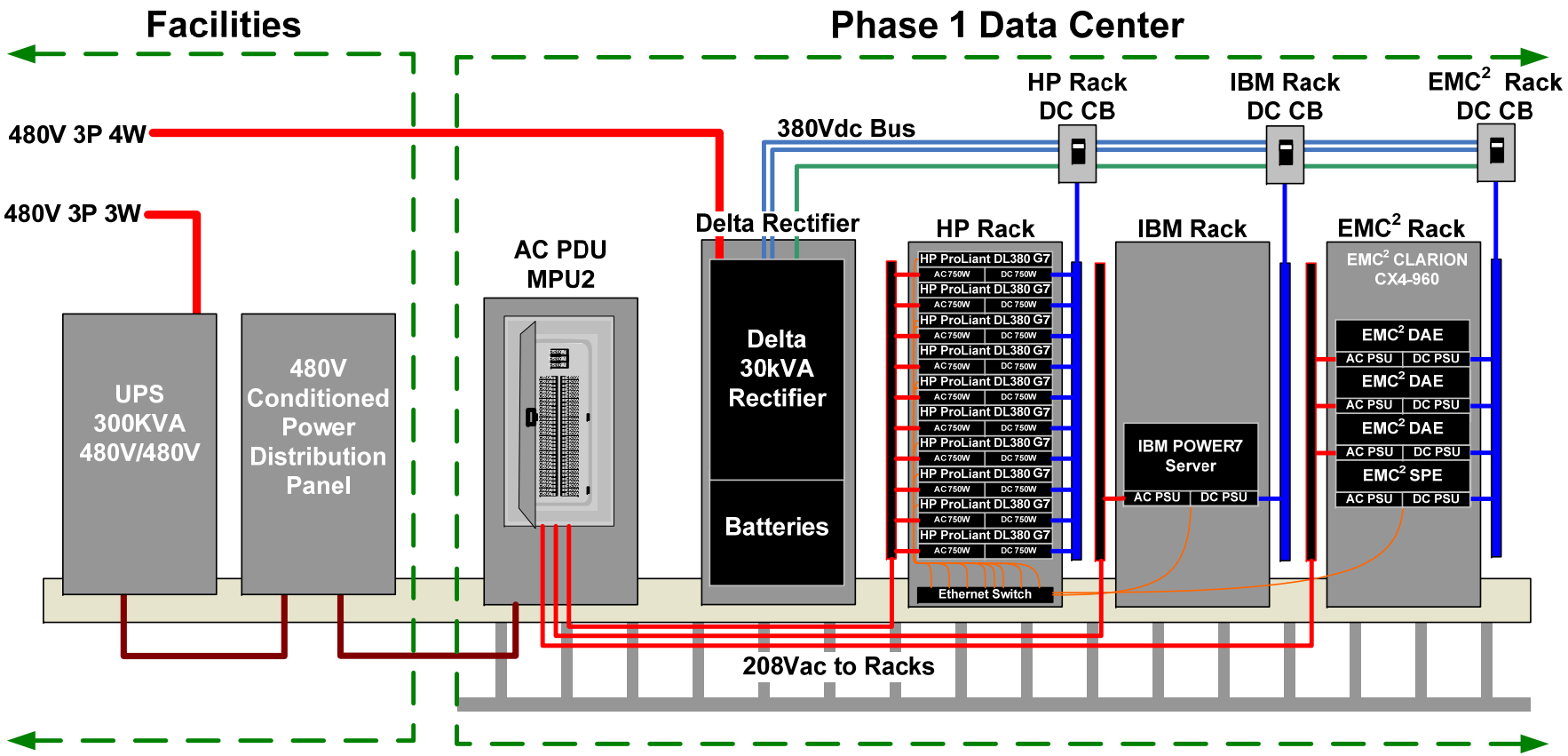
EMC Storage Arrays

Delta Rectifiers

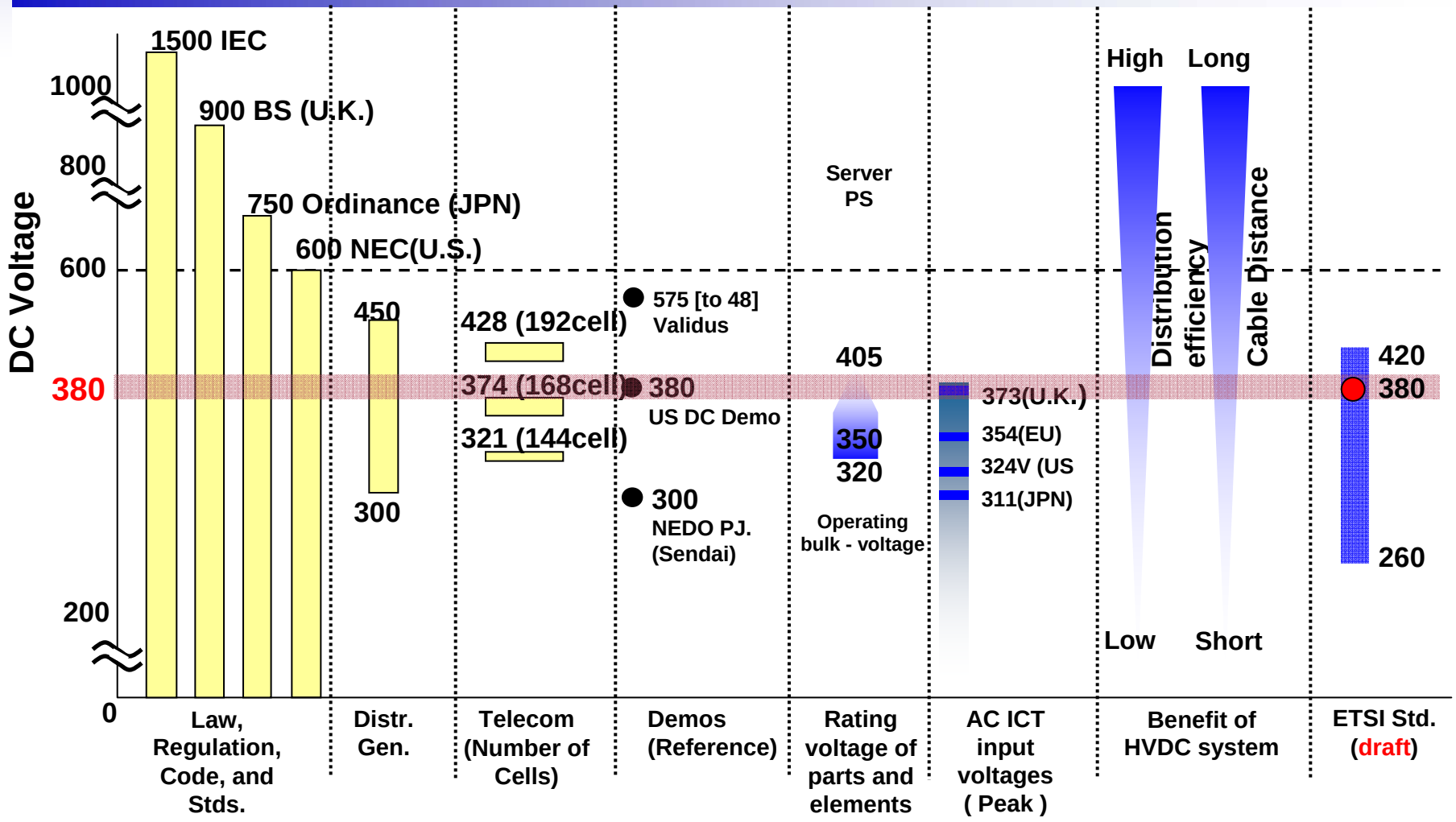
StarLine Busway

Dranetz-BMI Metering

Duke Energy Data Center Set-Up

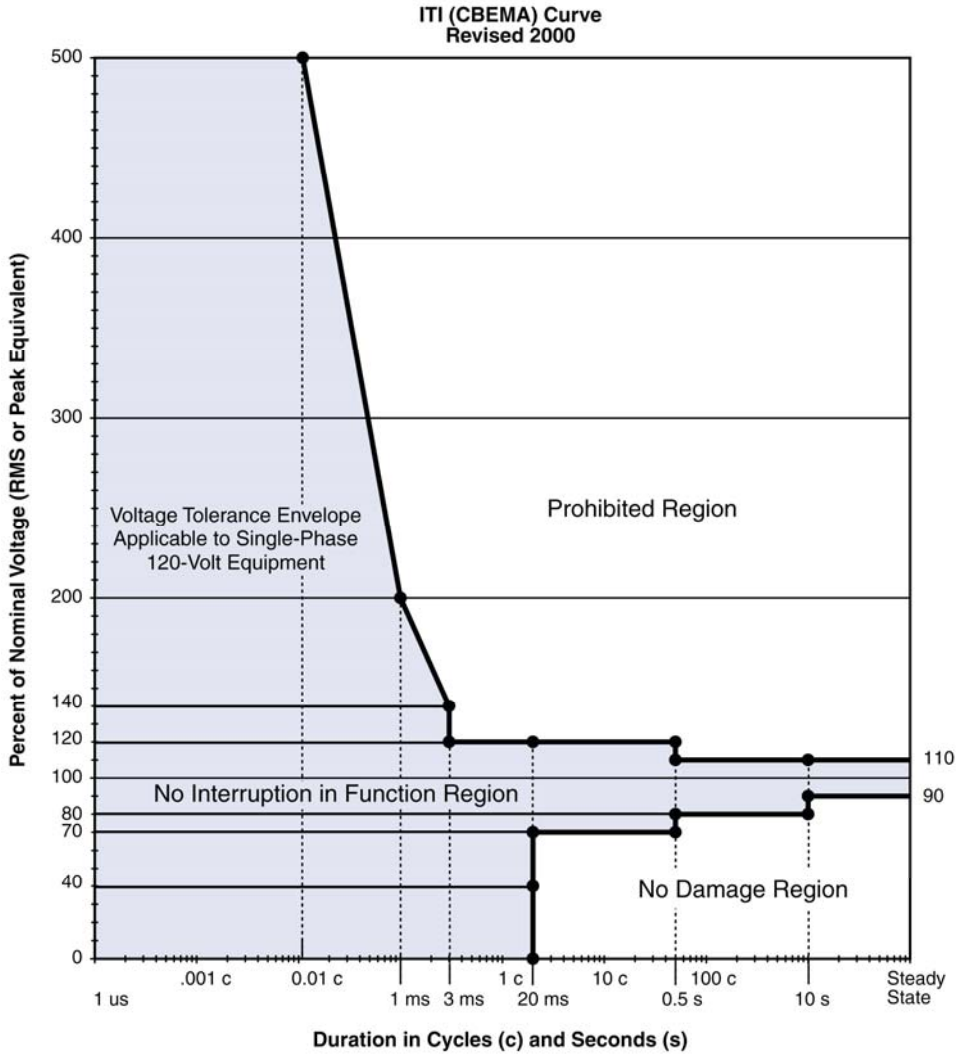


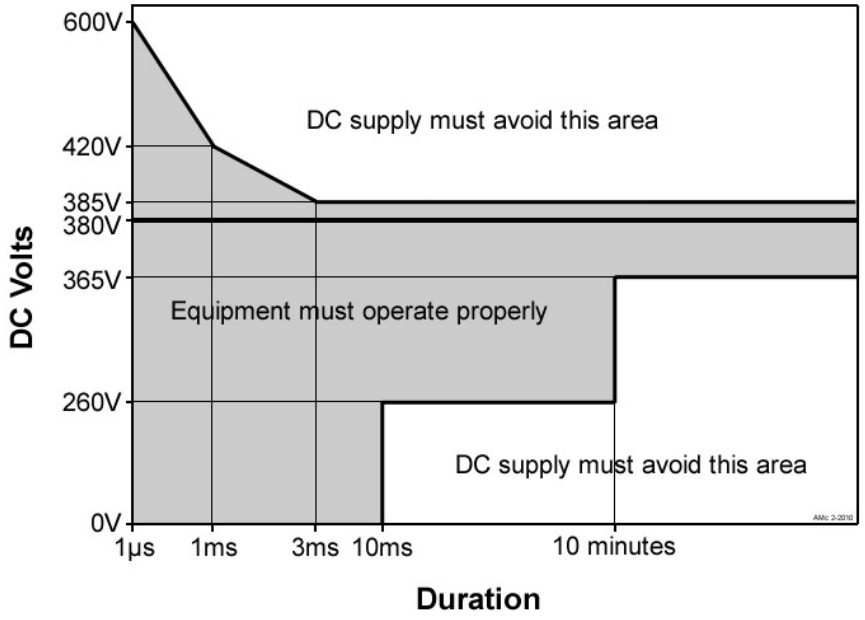
Why 380VDC? – "Sweet Spot"



Edited from source: NTT FACILITIES, INC.

380VDC vs ITI(CBEMA) VAC Operating Ranges





- Voltage Tolerance Envelope for traditional AC powered computers (left)
- New, DC version of curve, developed by EPRI with NTT and PSL (right)

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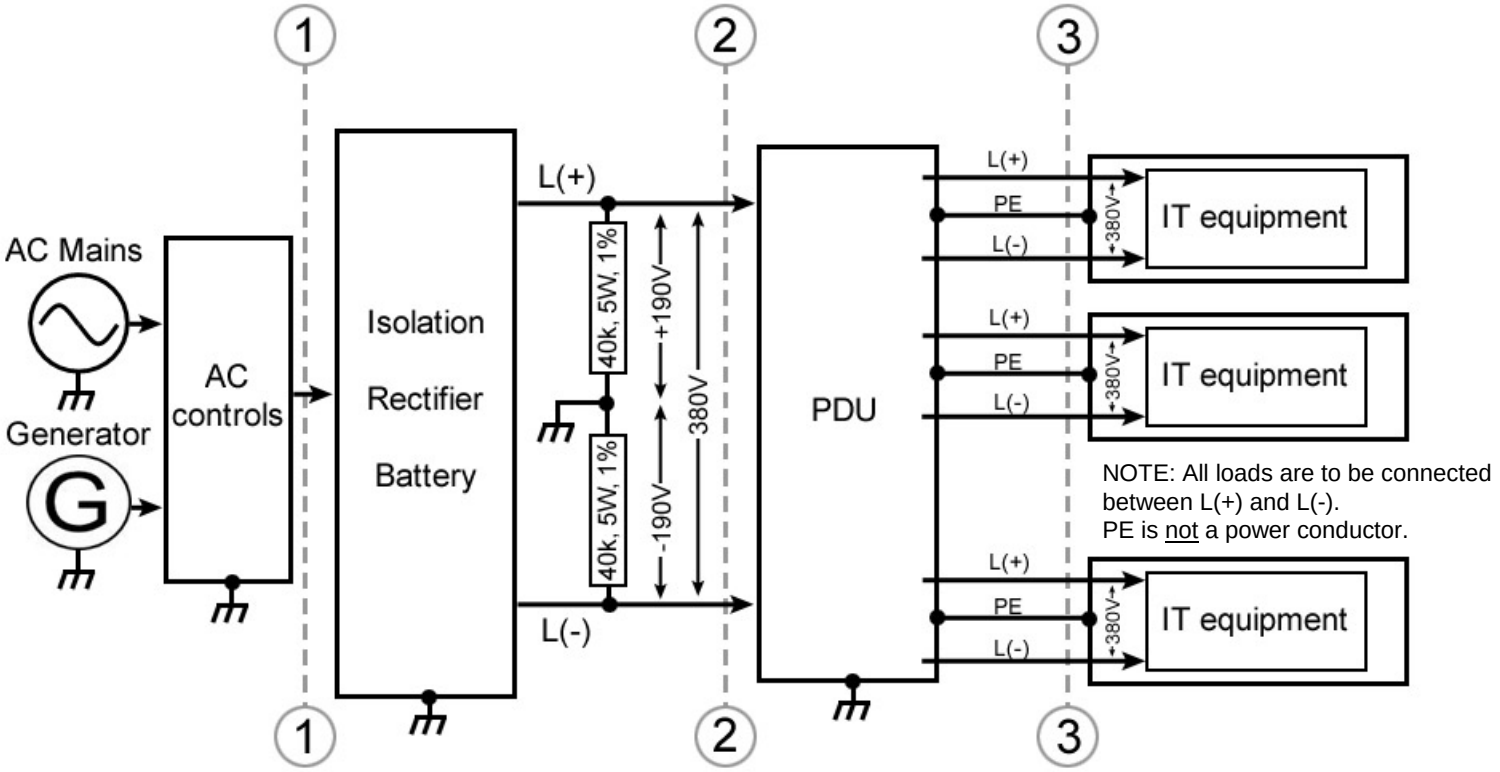
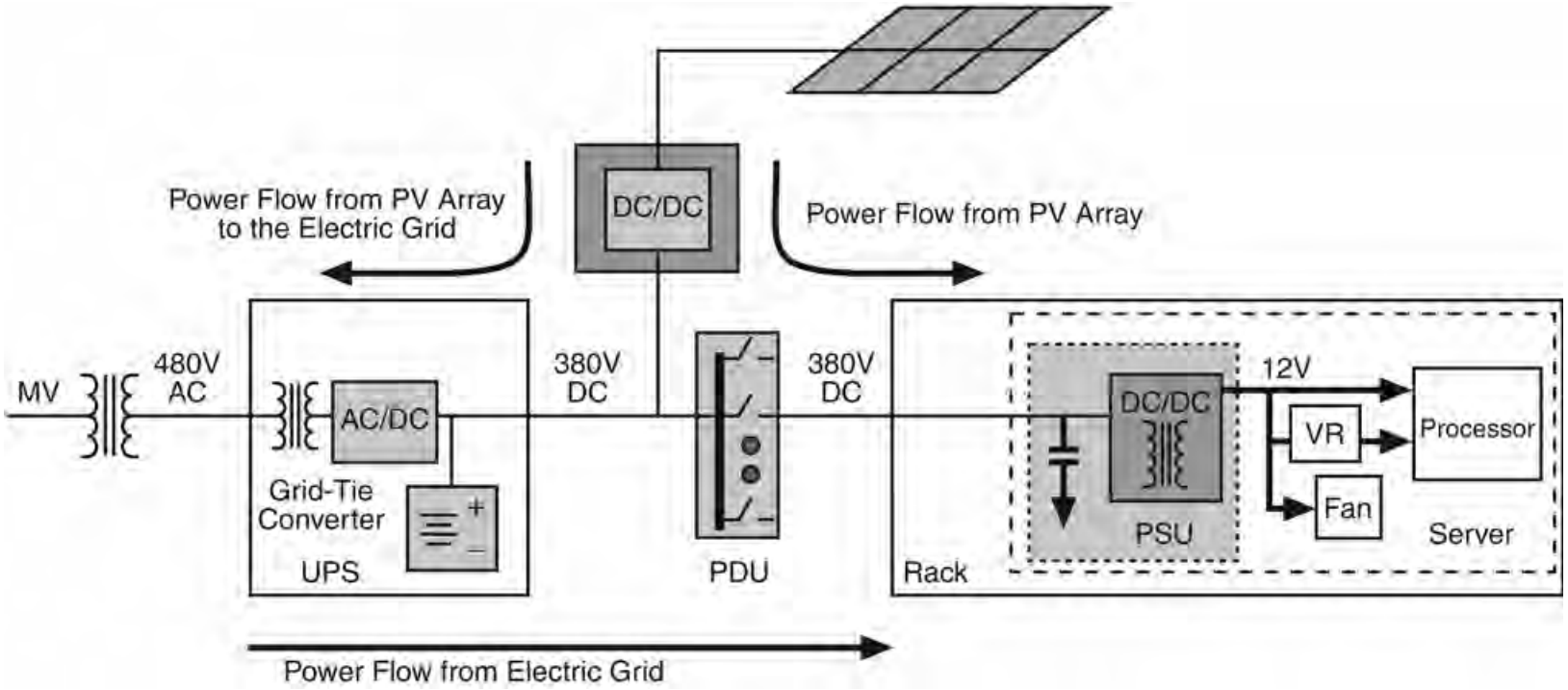
380VDC Power Distribution



Easier Integration Of Renewables



Benefits Summary Of 380VDC

- Higher Reliability
  - Fewer Conversions/Fewer Points Of Failure
- Higher Efficiency
  - Higher Efficiency Power Supplies & UPS
  - No PDU Transformer Needed
- Smaller Size
- Better Power Quality
- Easier Integration Of Renewable Energy

Other DC Applications

- 380VDC Uses
  - Telecom Central Offices (Operating Today At 48VDC)
  - Variable Speed Drives (Washers/Dryers/Air Cond)
  - Other Home Appliances (Stoves/Ovens)
  - “Rapid Charger” For Plug-in Electric Vehicles
- 24VDC Uses
  - Lighting
  - Consumer Electronics (TVs, PCs, Projectors)
- EMerge Alliance Members Working On Both Voltages

DC Challenges

- Safety Agency Approval/Listing (e.g. UL)
  - DC & AC Products Both Need These Approvals
- Paradigm Shift
  - Back To Some Of Thomas Edison's DC Ideas
  - We Are Used To The "AC" World Today
- Vendor Selection
  - Many AC Vendors To Choose From
  - Fewer DC Vendors Available --- At Least For Now

Utility Opportunities

- Possible new revenue opportunities
- Energy efficiency for new data center customers
  - Reduce electrical costs anywhere from 10 – 30%
  - DC O&M costs are on average 65% less than AC
- Conversion opportunities for existing data center customers
  - Approximately 2.5 million small to medium data centers in the U.S.
  - Component “swap out”, not a complete “rip & replace”

Utility Challenges

- Getting data center customers on board
  - Faced it with our test (decided to test our own facility)
  - Getting commitments

- Technology has to be proven, both in concept and financial feasibility
  - Able to preliminarily show test results in the Duke Energy facility
  - Conversions for brownfield sites key aspect of potential success

Potential Outcomes

- Based on preliminary results in the Duke Energy facility (which showed over 15% increase in efficiency)
  - Average small to medium data center consumes approximately 0.5 to 5 MW
  - Reduction possibilities of 10 to 30%
  - Major impact for these data centers that are not “enterprise” sized
- Reinforces commitments to energy efficiency
- Provides new opportunities to interact with customers to provide wider range of products/services

Together…Shaping the Future of Electricity