



DC- THE POWER TO CHANGE THE WORLD

From LED Chips, to Occupied Interiors, to Whole Campus/Building Microgrids and the Smart Grid

Brian T. Patterson – Chairman, EMerge Alliance
GM – Business Development, Armstrong World Industries

Meg Smith – LC, IES, LEED AP – Governing Member, EMerge Alliance
PRNA Lighting Solutions and Services
Senior Project Manager, Applications Solutions



DC

The Power to Change the World

Creating the Enernet

*DOING FOR POWER
WHAT THE INTERNET DID
FOR INFORMATION NETWORKING*



DC-The Power to Change Buildings

What is the EMerge Alliance?

- Not-for-profit 501c -Part 6
- Open application standards - DC platform
- Eco-system development and promotion
- 100+ Member organizations and growing!

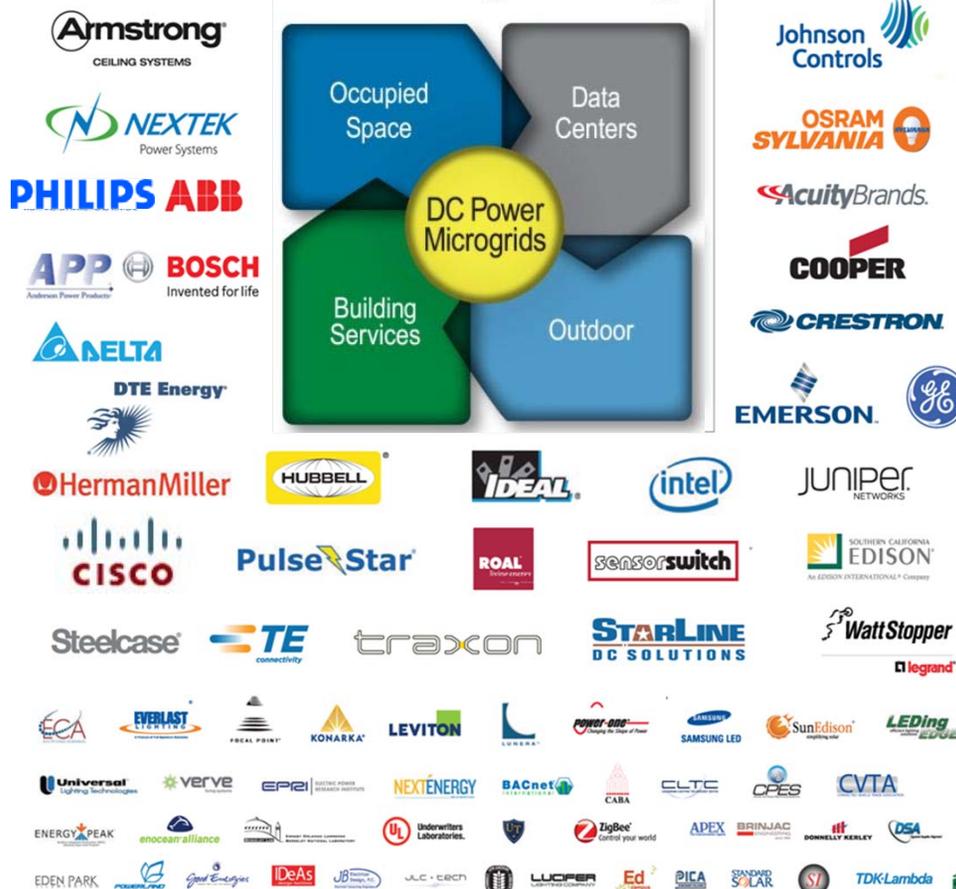
Who is the EMerge Alliance?

- Architects, Engineers
- Contractors/Builders/ Integrators
- Manufacturers - Service Providers
- Building Owners – Facility Managers
- National & Independent Labs
- Academic Institutions
- Codes & Standards Groups

What is an EMerge Standard?

- Commercial Applications Standards
- Subordinate to safety, equipment standards
- Physical, electrical, operational interfaces
- Application definition - listing requirements of other standards (incl. IEC)

Vision: DC Microgrids in Buildings



Members as of 9/15/2011

The Current Reality

PROBLEM: Mismatched AC and DC Power Distribution Requirements

ENERGY SOURCES – MIXED AC & DC



AC/DC Site Generation



DC Photovoltaic



DC Wind Power



AC Line Power



DC Campus Fuel Cells



DC Power Storage



ELECTRIC DEVICES – TYPICALLY DC



Electronic Lighting



HVAC Actuators Sensors & Controls



Electric Vehicles



AV/IT Devices



Data & Telecom Centers



Security & Safety

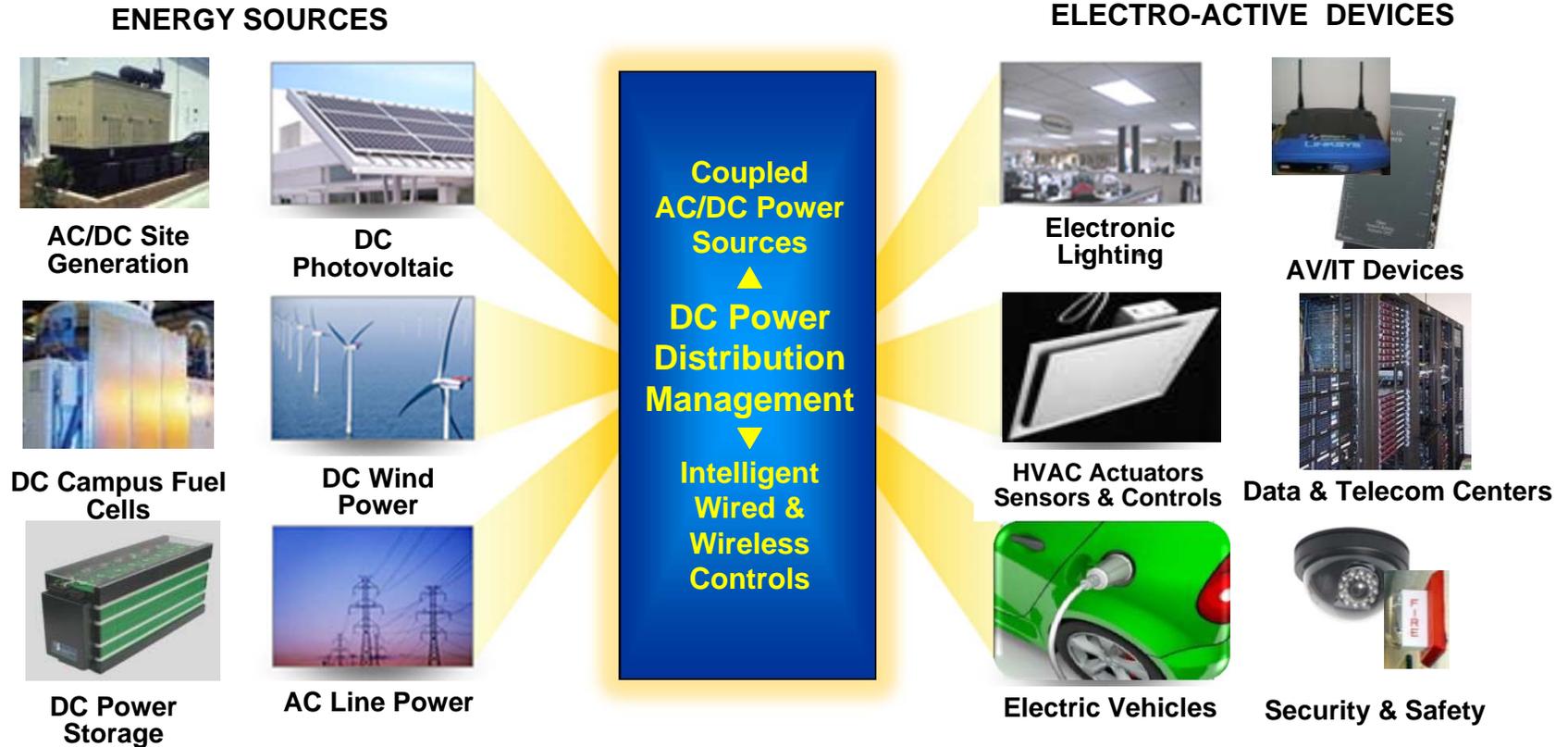
"80 percent of power used in commercial buildings must go through some form of power electronics so it can be converted to DC," - the Center of Power Electronics Systems at Virginia Tech.

RESULT: Lost Opportunity to Reduce Consumption, Improve Quality, Reliability



The Desired State

A simplified AC/DC hybrid coupled power network



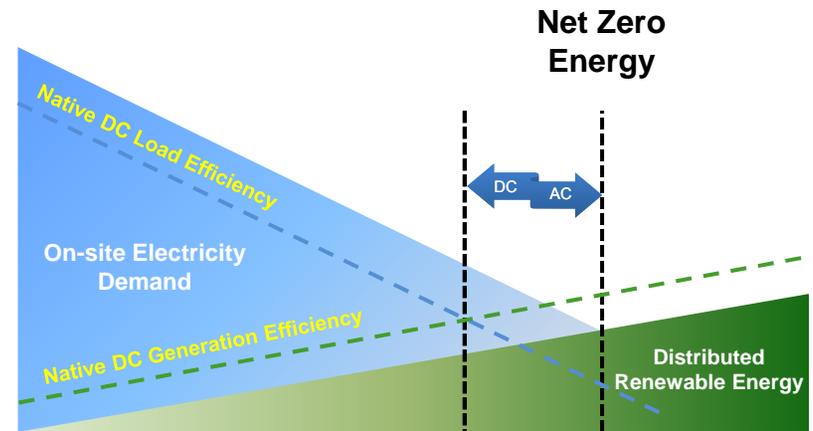
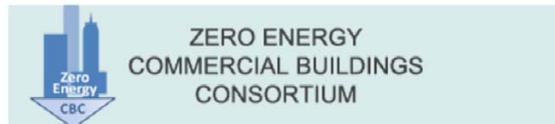
OPPORTUNITY:

More flexibility, less energy, less capital, more reliability?

Net Zero Energy Building Model

Buildings that produce as much energy as they consume

1. **Integrated design** and operations planning
2. **Site renewable** strategies get optimized using dc
3. **Energy Storage** in dc allow Grid independence
4. **System Intelligence** control, monitor, verify



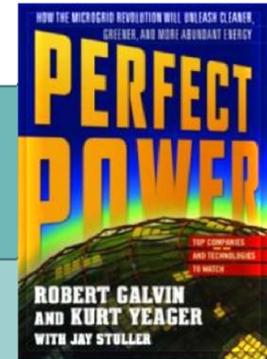
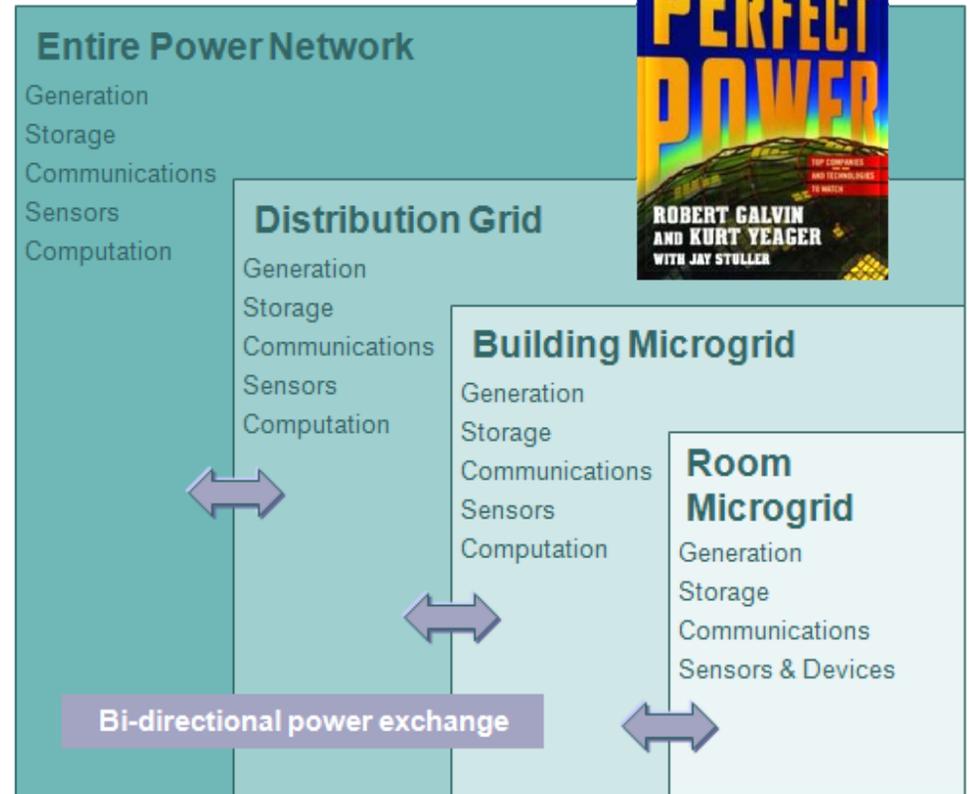
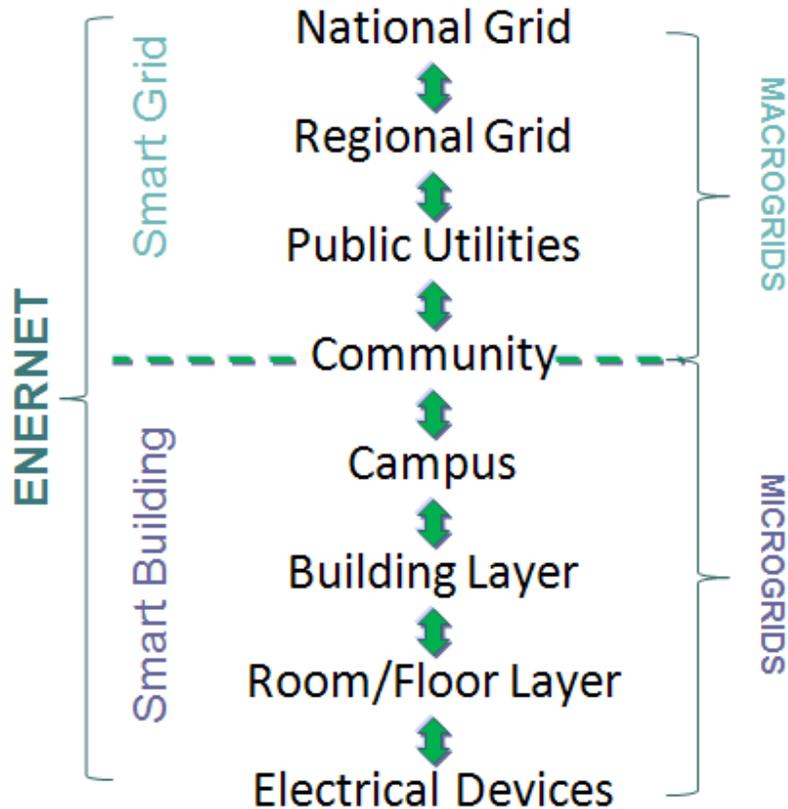
“DC power would fundamentally change the way power is distributed in commercial buildings...”



- 2012:** Begin DC Microgrid Demonstrations
- 2030:** All new commercial buildings
- 2040:** 50% of commercial building stock
- 2050:** All commercial buildings

Smart Grid to Smart Buildings:

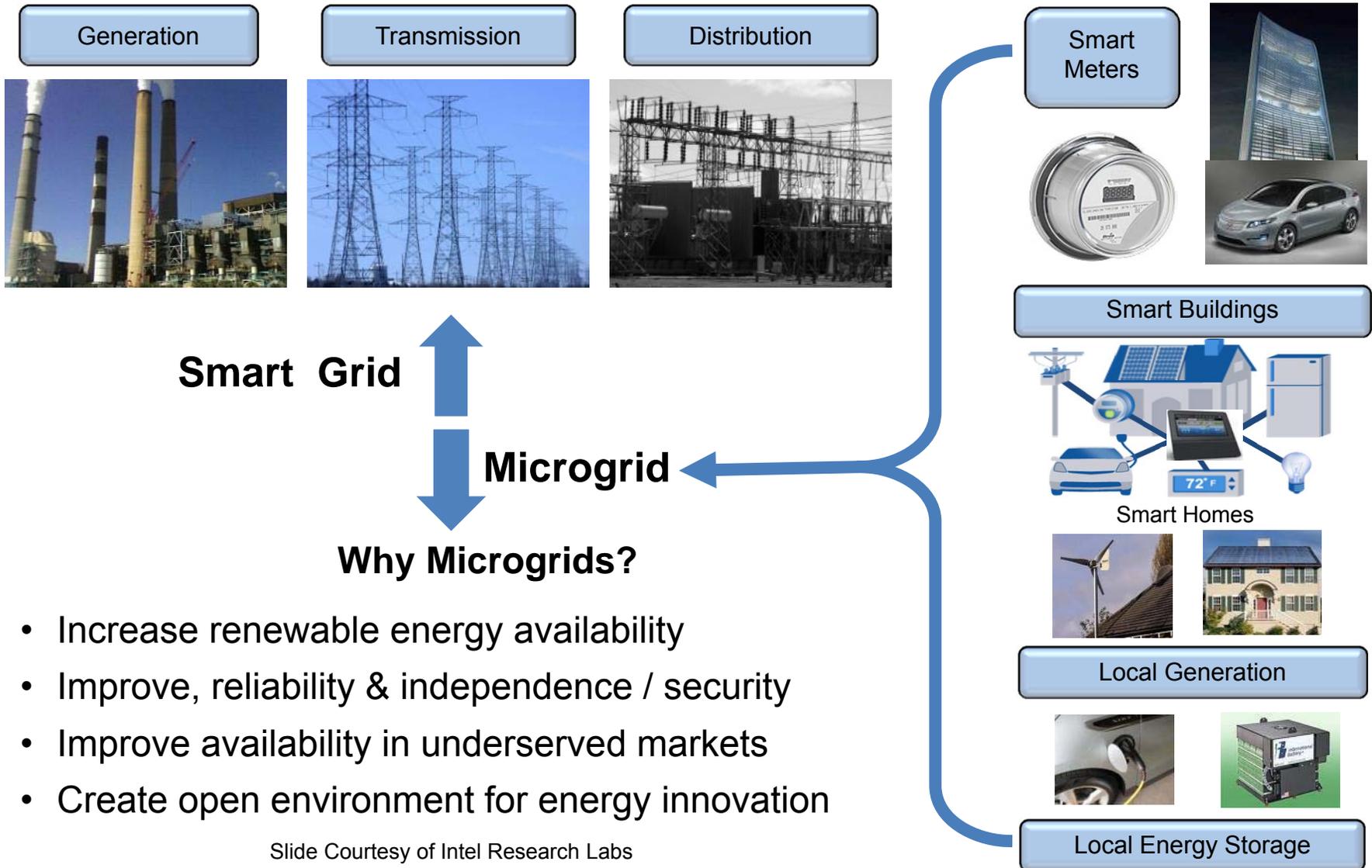
Layered DC Microgrids at the Core of the New Energy Network



En•er•net: noun \en-ər-net\ : the Internet of powered things Bob Metcalfe

From Smart Grid to Microgrids

The Need to Balance the Renewable Power Equation

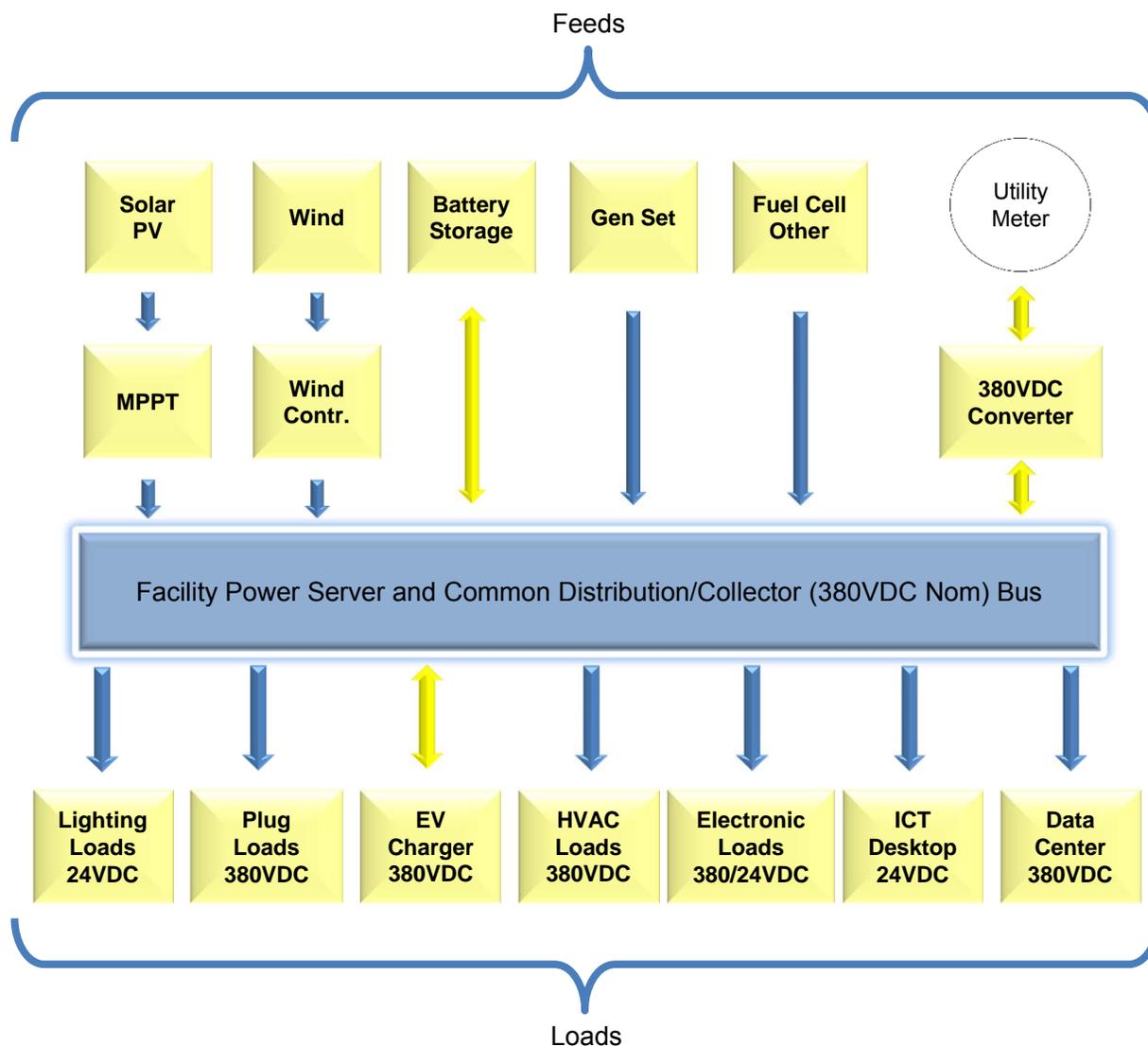


Slide Courtesy of Intel Research Labs

Zero Net Energy Buildings (ZEB)

DC Microgrid with Renewable & Alternate Distributed Generation

Slide Courtesy of 



DC Microgrid may include :

- Various AC and DC loads: fixed & plug and play loads
- Dispatchable generation: fuel cell or bio-fuel turbine.
- Non-dispatchable sources: solar PV and wind turbines.
- Energy storage, such as ultra-capacitors or batteries.
- Common Distribution – Collector Bus
- Management & Demand Response (DR) capability
- Ride-thru & Off-grid operation capability (islandable)

A Family of Open Power Standards for Hybrid DC Microgrids

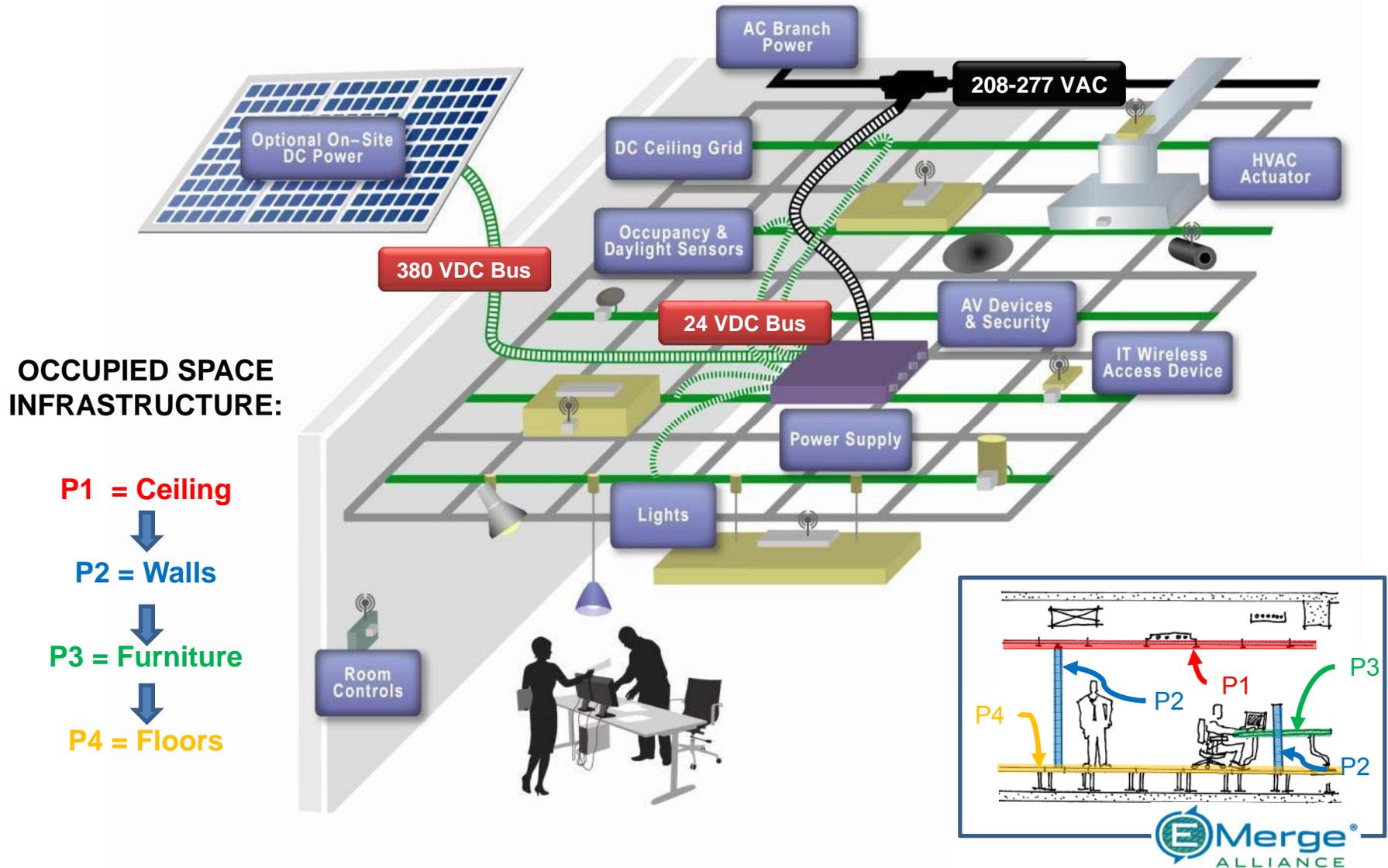
Vision: DC Microgrids in Buildings



1st Standard: Occupied Space

Developed for commercial interiors

Status: Version 1.0 Issued, Version 2.0 in Committee development



Benefits of LVDC Power Platform in Commercial Interiors

Flexibility

- Plug & play use of devices, upgradeable
- Faster, easier, cheaper for moves, adds & changes



Energy Savings

- Less conversions in DC sources & loads
- LED lighting: 5-15% more efficient, driven by DC

Sustainability

- Re-use of buildings and equipment
- More efficient use of clean energy & DC devices
- Smarter buildings (device level controls) for Smart Grid efforts



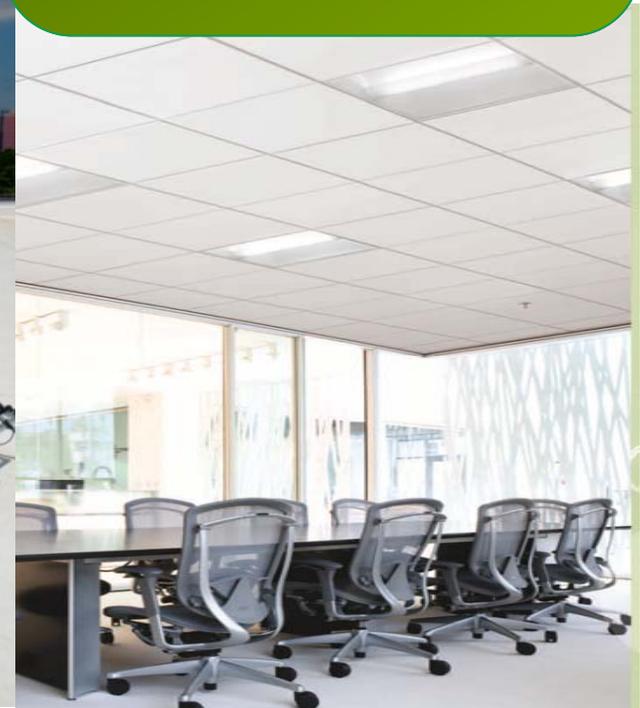
Typical Applications

- Office
- Higher Education
- Government
- Military
- Owner Occupied

- Conference Rooms
- Lobbies & Reception
- Data Centers



**LEED Projects
Net Zero Buildings
On-site Renewable Energy
Flexible Spaces**



Photos courtesy of 

Benefits

Flexibility:

- Faster moves, adds, changes
- No rewiring
- Future-proof for new technologies like LEDs

Sustainability

- **Reduce** -- Simpler devices, fewer AC-DC conversions
- **Re-use** -- Plug & play modularity
- **Recycle** -- High recycled content grid
- **Renew** -- Connect to alternative energy (like solar & wind)



Photos courtesy of  Armstrong

Finished product looks the same

- LVDC powered ceilings looks the same as a standard suspended ceiling.



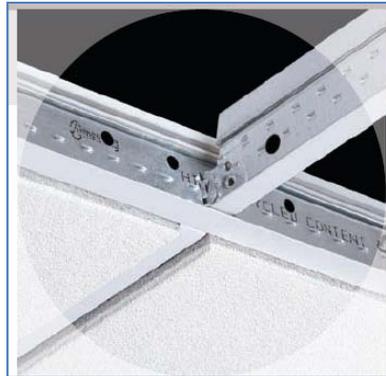
Photos courtesy of 

Ceiling Grid as a DC “Power Highway”

9/16” T-bar Grid

Exposed Tee System

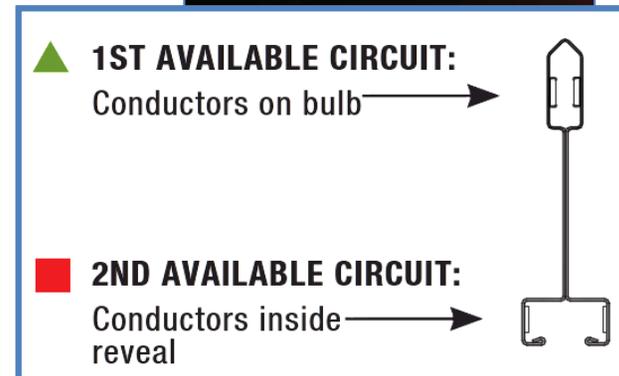
- DC Conductors on Bulb
 - Power capability from above
- Main Beams only
- Integrate with standard cross tees & moldings



- **9/16” Bolt-slot Grid**

1/4” Reveal Slot System

- DC Conductors on Bulb and inside 1/4” Reveal
 - Power capability from above and below
- Main Beams only
- Integrate with standard cross tees & moldings



Product Example: LED Fixtures

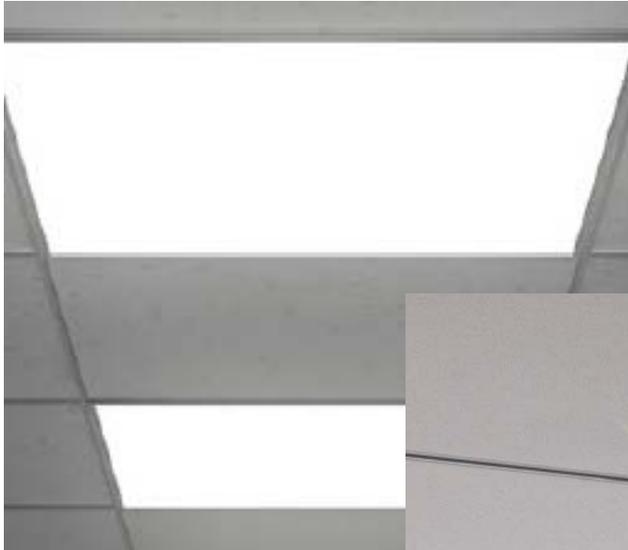
Current Designed & Listed Product



Change to Listed DC Driver



Add Listed Device Load Connector/Cable Assembly



Slide Courtesy of Armstrong World Industries

- Direct DC input eliminates AC-DC conversion
- Can improve driver efficiency by 5-15%
- Results in higher lighting system efficacy (light output per watt)
- Can improve driver reliability significantly by eliminating HV inductors

Product Example: Fluorescent Fixtures

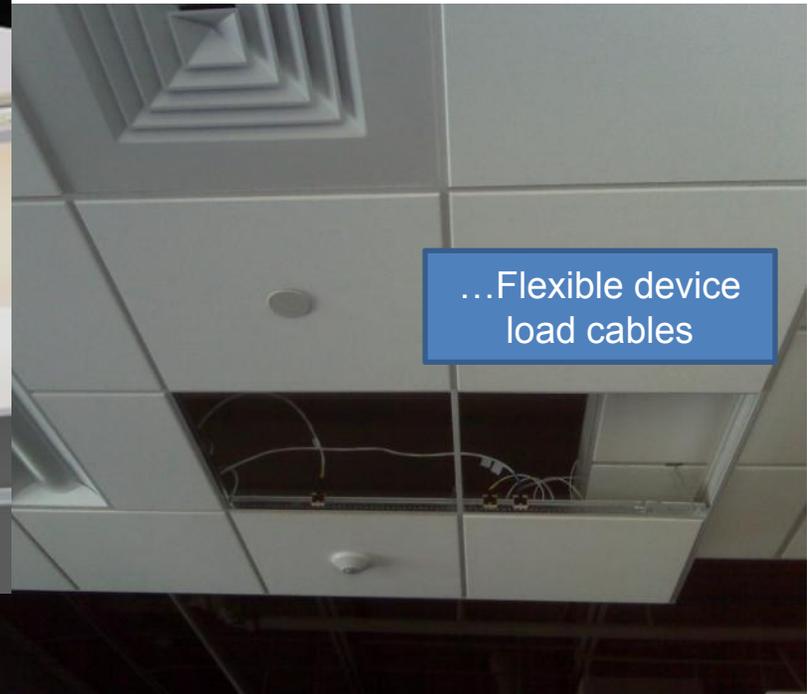
Current Designed & Listed Product



Change to DC Ballast



Add Device Load Connector/Cable Assembly

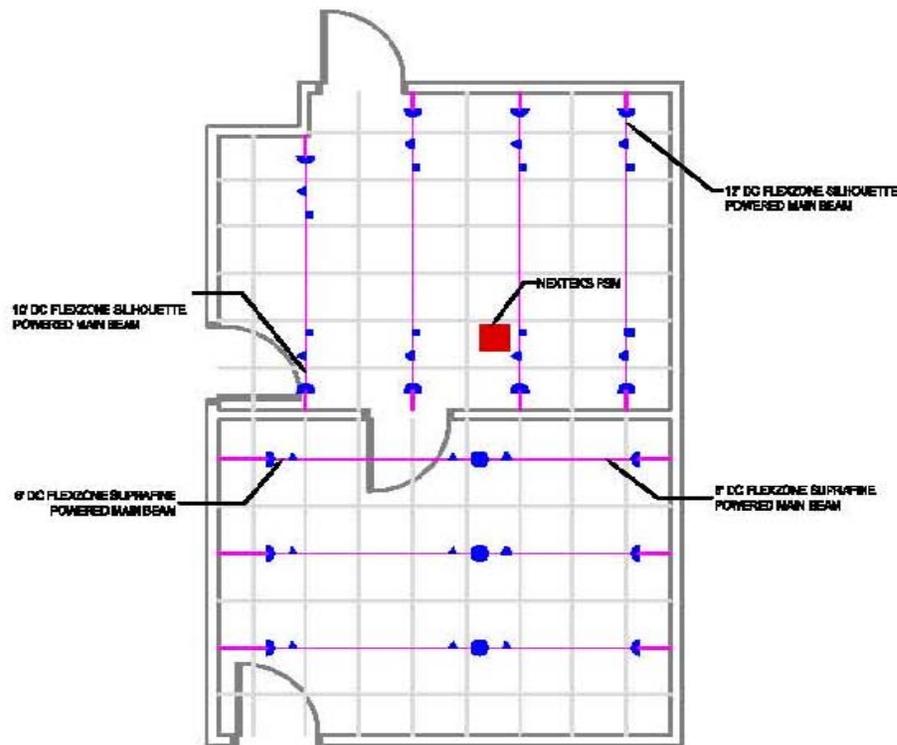


Slide Courtesy of Armstrong World Industries

- Direct DC input eliminates AC-DC conversion
- Can improve ballast efficiency by 10% or more
- Results in higher lighting system efficacy (light output per watt)
- Can improve ballast reliability significantly by eliminating HV inductors

Follow the Ceiling Layout

- Acoustical contractors install DC powered ceiling main beams exactly where they are shown on the RCP.



EMerge Alliance Occupied Space Standard

Example Site Applications in the Field

PNC Financial
Headquarters Office
Pittsburgh, PA



lauckgroup
Architectural Office
Dallas, TX



US Green Bldg Council
Conference Rooms
Washington, DC



Nextek Power
NextEnergy Center
Detroit, MI



UC San Diego
Sustainability Center
San Diego, CA



Southern Cal Edison
Utility Services Office
Irwindale, CA



Johnson Controls
Headquarters Office
Milwaukee, WI



Optima Engineering
MEP Firm
Charlotte, NC



LA Community College
Trade Tech Campus
Los Angeles, CA



CA Lighting Tech Center
UC Davis Campus
Davis, CA



EMerge Alliance Occupied Space Standard

Example of Net Zero Energy Building



 PNC Financial Services Group Inc. announced it will debut its new net-zero energy bank branch during first quarter 2013 in Fort Lauderdale, Fla.



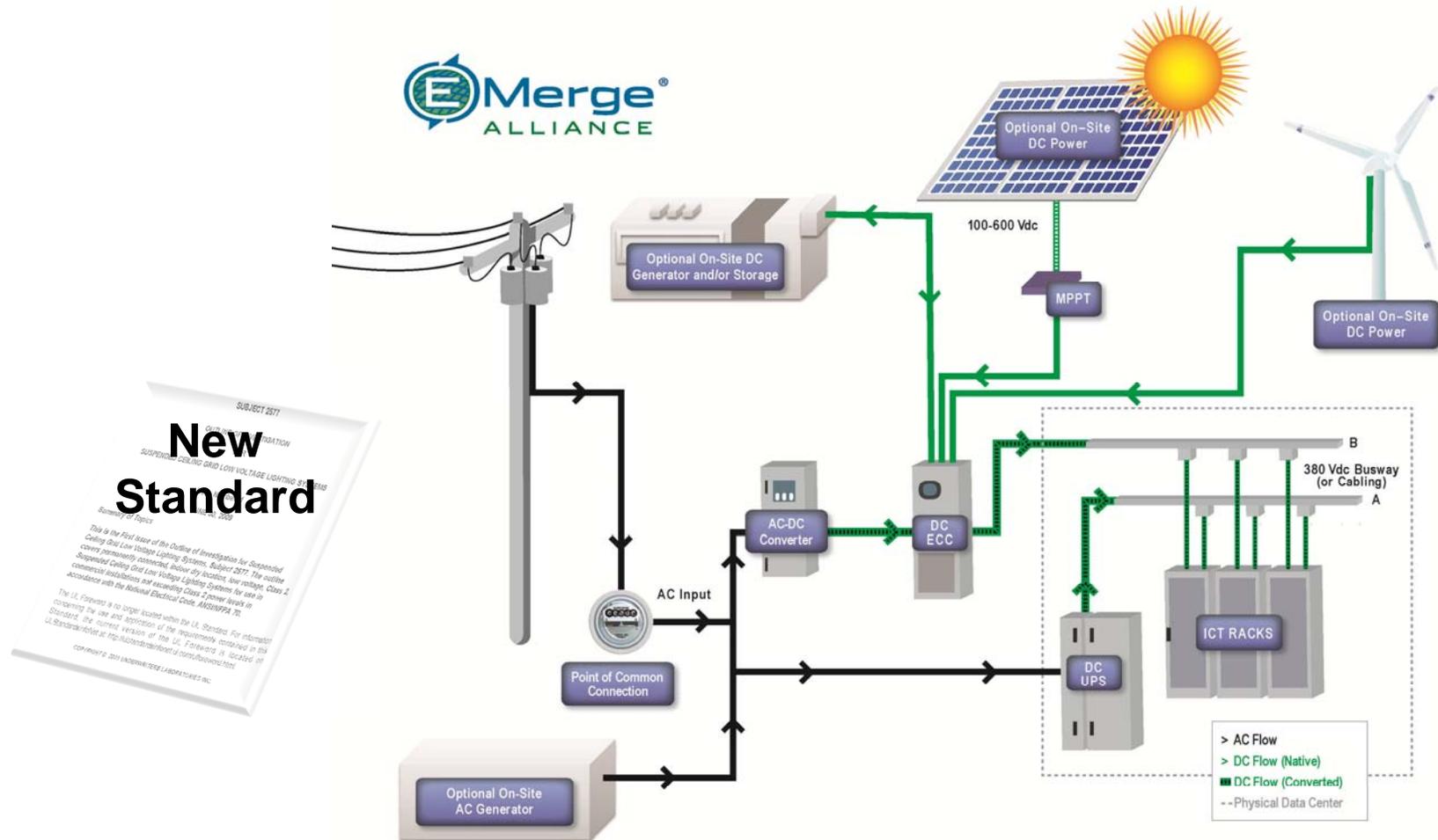
PNC expects the branch to exceed LEED Platinum certification and be its most energy efficient, using 50 percent less energy than a typical branch.

Picture Courtesy of PNC Financial Services Group

2nd Standard: Data and Teleco

Developed for 380VDC ICT System

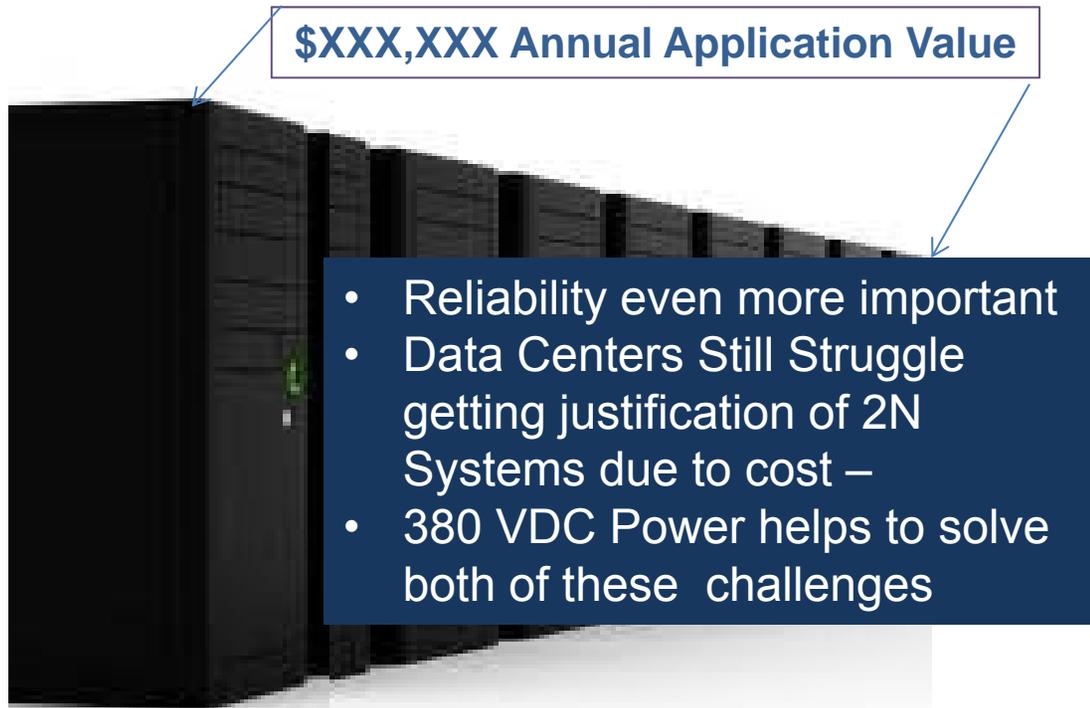
Status: Complete - Pending Final Approval (October 2012 Release)



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VISA: Virtualization...is driving power density



Reported by VISA 380VDC Energy Lab – Ashburn, VA

*Average consolidation is 8:1
Average Maintenance Agreement for 1U Server is \$500
Average Maintenance Agreement for 2U Server is \$750
8:1 Consolidation yields \$3250 of savings per year

*Power Consumption
Average current 1U power supply is 675W
Average current 2U power supply also 675W
8:1 Consolidation yields a savings of 4725 Watts
4 tons of CO2 are eliminated for every server virtualized, the equivalent to taking 1.5 cars off the highway.

*Application Value Density –
8 racks into 1 = 8 Racks of Value in 1

EMerge Alliance Data/Telecom Standard

Applications in the Field

EPRI/LBNL - Electric Power
Research Institute
Lawrence Berkeley National Lab,
California



Duke Energy data center in
Charlotte, North Carolina



Calit2 - California Institute for
Telecommunications and Information
Technology, UC San Diego



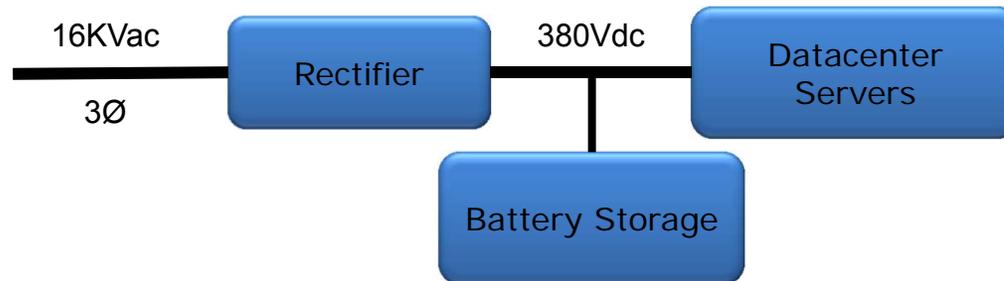
EMerge Alliance Data/Telecom Standard

Applications in the Field



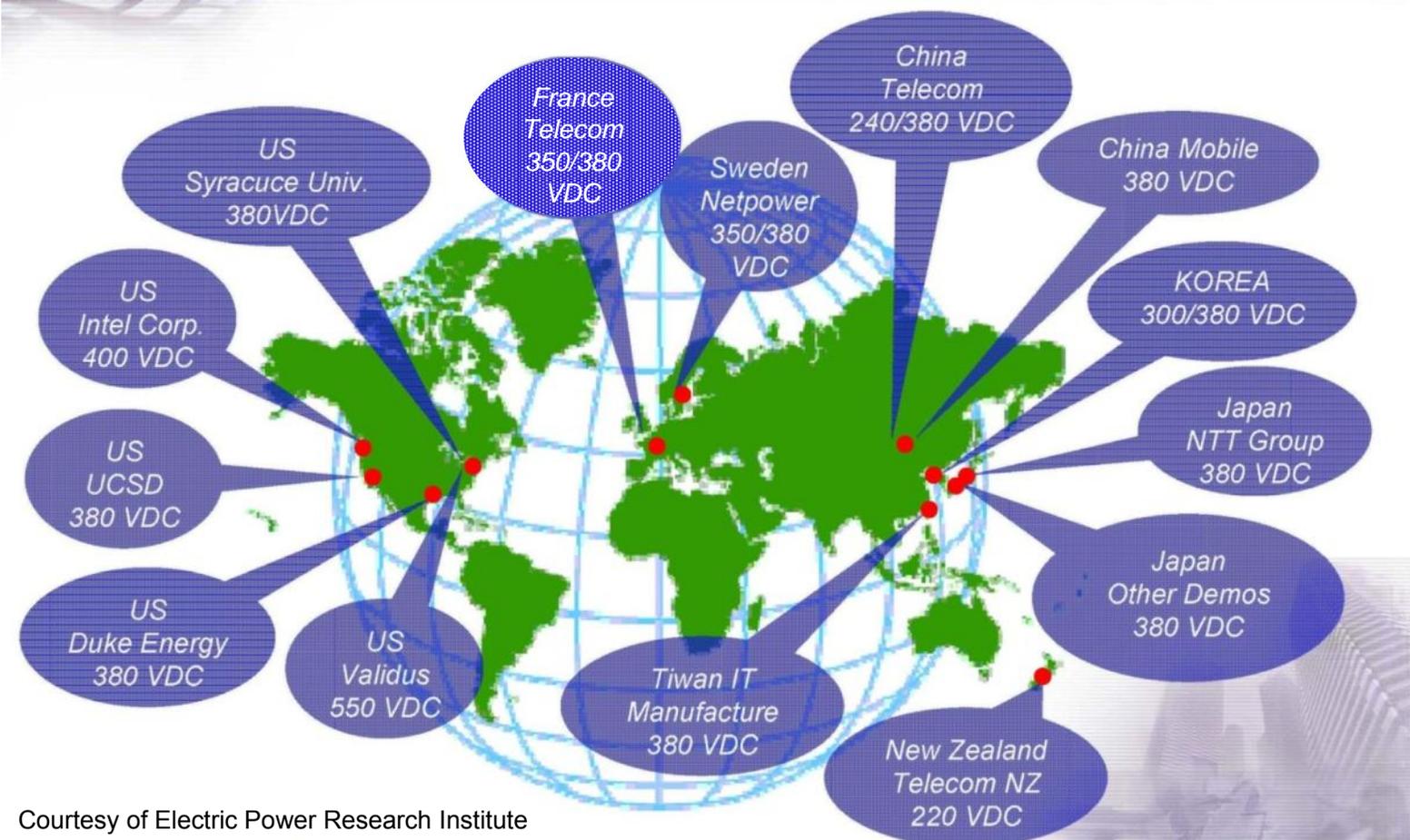
Zurich-West 380Vdc Data Center

- ABB/Validus Power Distribution
 - In: 16KV AC
 - Out: 1MW @ 380Vdc
 - Battery Backup: 10 mins
 - Backup Generation
- 1,100m² of 3,300m² Vdc
- HP 2U, Blades & Storage Servers
- Demonstrated Benefits
 - 10% Better Energy Efficiency
 - 15% Lower Capital Cost
 - 25% Smaller Footprint
 - 20% Lower Installation Costs



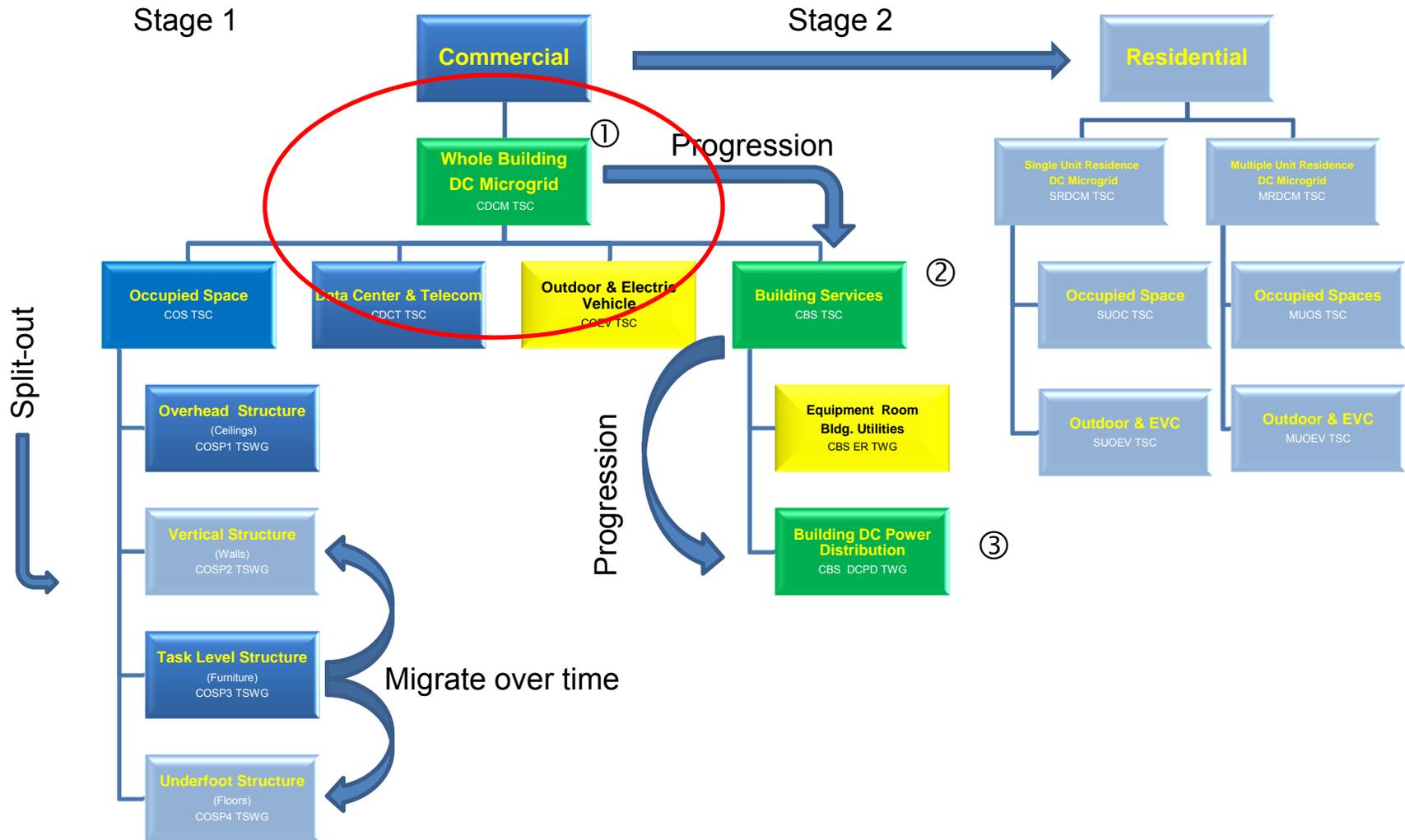
Photos courtesy of Green-ch, ABB* and HP*

380DC SITES AROUND THE WORLD



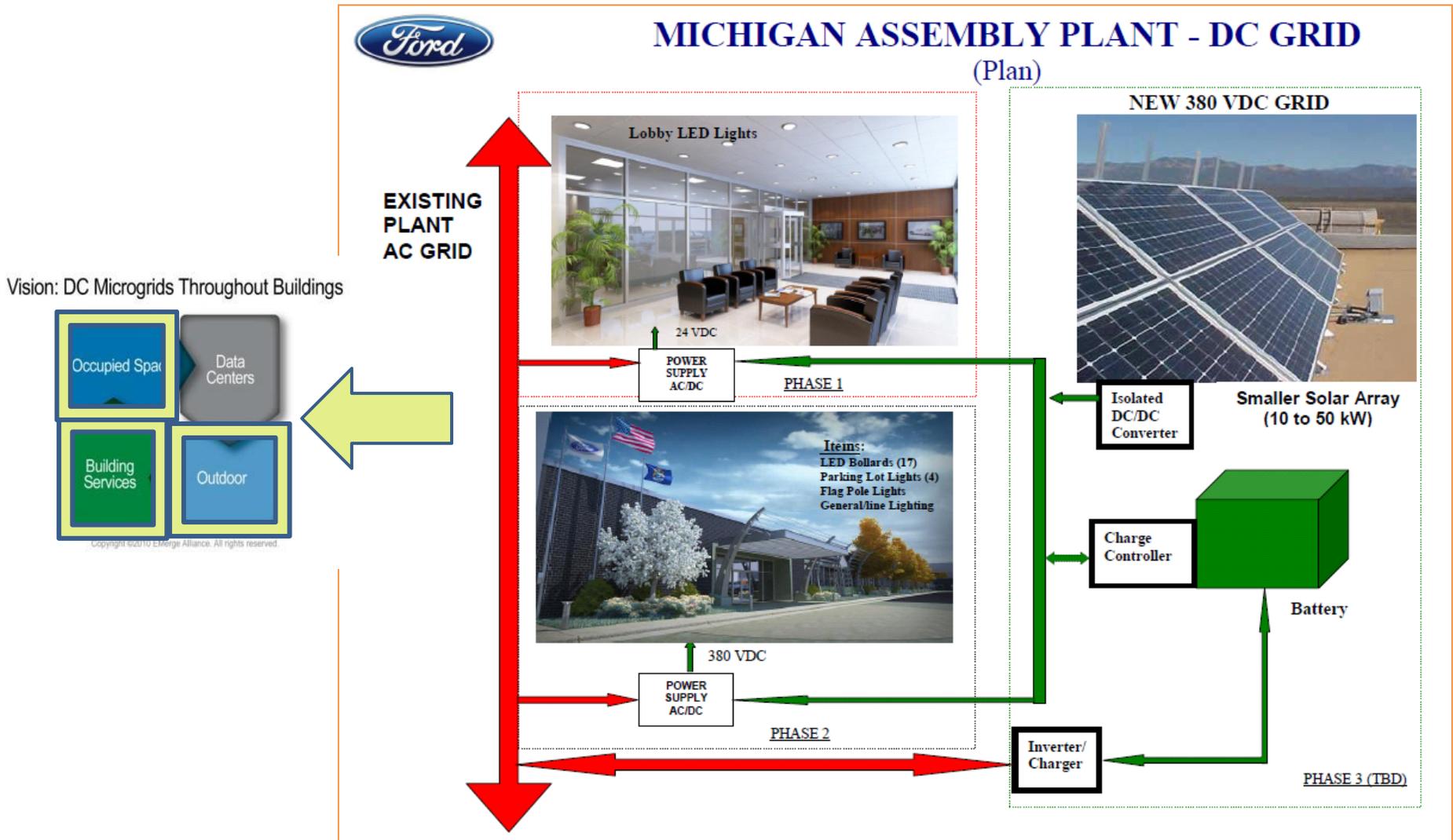
Courtesy of Electric Power Research Institute

Application Standards Committee Roadmap



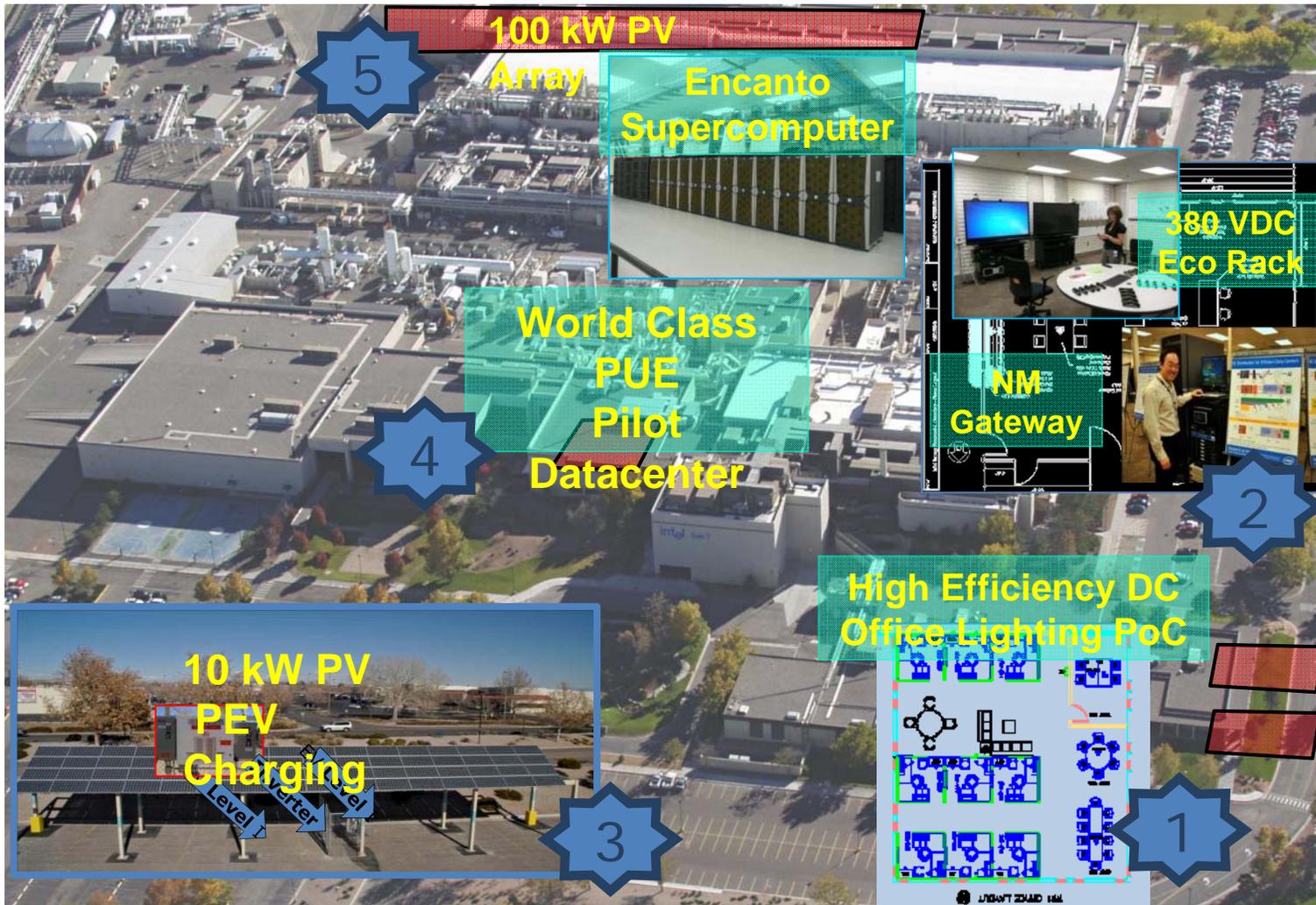
Whole Building Hybrid DC Microgrid

Ford's Deep Renovation Strategy Includes Multiple Stages



Standards Allow Incremental Plan/Execution

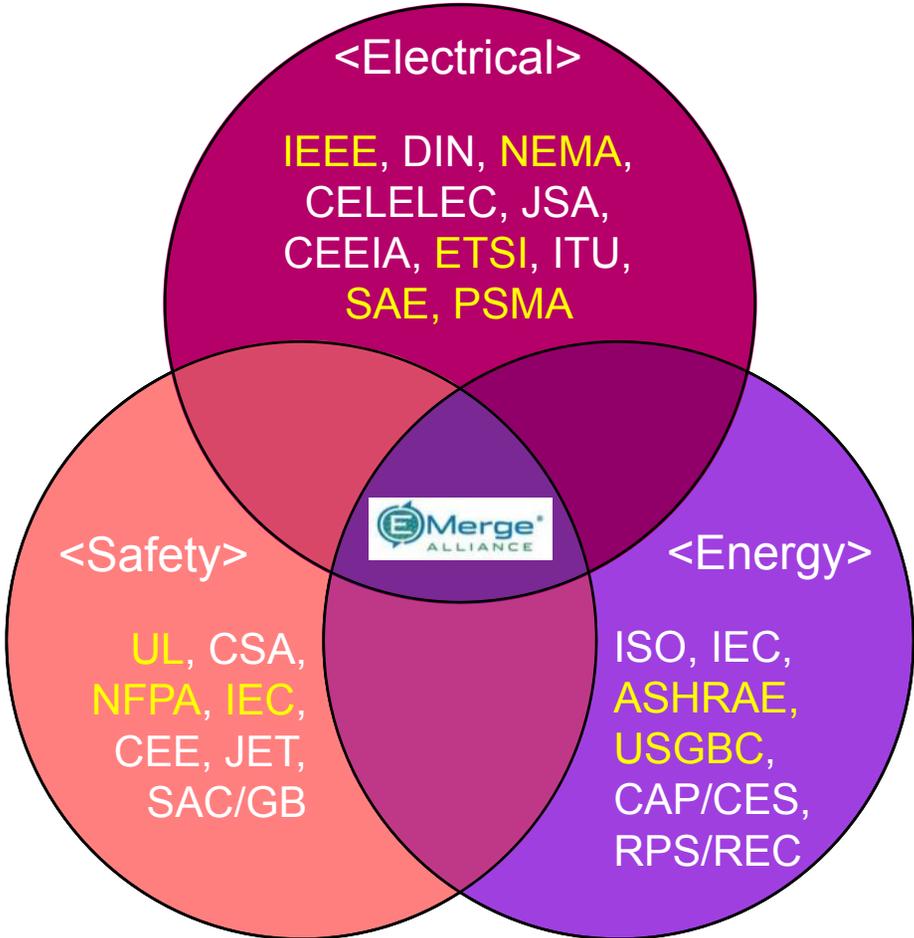
Five Discrete Projects Capture Key Elements



 Rio Rancho Campus

Courtesy of Intel Research Labs

Information/Collaboration/Harmonization





Standards Coming Up in...

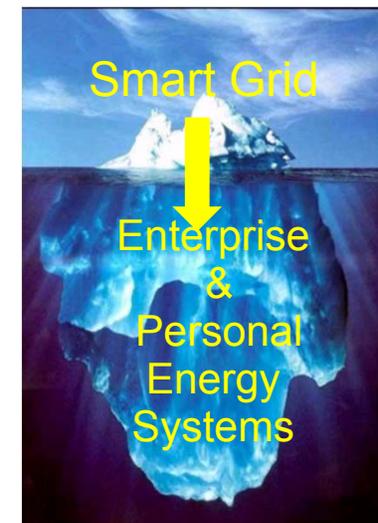
Task Level (desktop & plug loads)
Whole Building Microgrids
Outdoor DC / Electric Vehicle Charging
Building Services (HVAC)

Working with DOE/NIST/SGiP & SAE



DC – The Power to Change the World

- Biggest inflection point since the PC, Internet & Cell Phone
 - Electric grid is transforming
 - Government regulation, incentives
 - Imperative to “save the planet”
 - New devices and sources predominantly dc
- Opportunities - Goals
 - Focus on the Edge
 - 5M Commercial buildings & 1B homes with LV intelligent devices
 - Enterprise systems can be modular
 - 1.5B people without power world-wide
 - Personal energy systems are scalable
 - EMerge Alliance as a catalyst
 - Establish the vision, lead in awareness, collaborate on requirements, enable open standards & a horizontal global industry
 - Accelerate the transition – pull 2030 into this decade
 - Transformation is opportunistic
 - Standards should be pro-active
 - *Microgrids - DC and AC are both a big part of this solution set*



EnerNet: Doing for power what the Internet did for information networking



PHILIPS

Armstrong

THANK YOU!

