



Power Management in Zero-Net-Energy Buildings



2013
IS 2.3.5

DC – The Power to Change Buildings



Smart Power Standards

Net Zero Power Starting Points



PROBLEM: Mismatched AC and DC Power Distribution

ENERGY SOURCES – MIXED AC & DC



AC/DC Site Generation



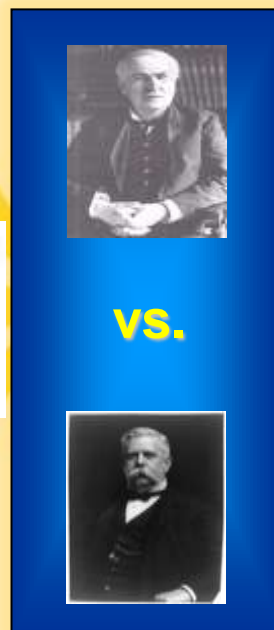
DC Photovoltaic



DC Wind Power



AC Line Power



ELECTRIC DEVICES – TYPICALLY DC



Electronic Lighting



HVAC Actuators
Sensors & Controls



Electric Vehicles



AV/IT Devices



Data & Telecom Centers

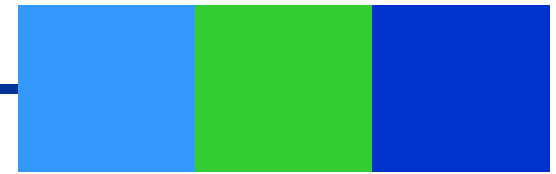


Security & Safety

DC Power Storage

RESULT: Lost Opportunity Reduce Consumption, Improve Quality, Reliability

Net Zero Power Desired State



SOLUTION: A simplified AC/DC hybrid coupled power network



RESULT: More flexibility, less energy, less capital, more reliability

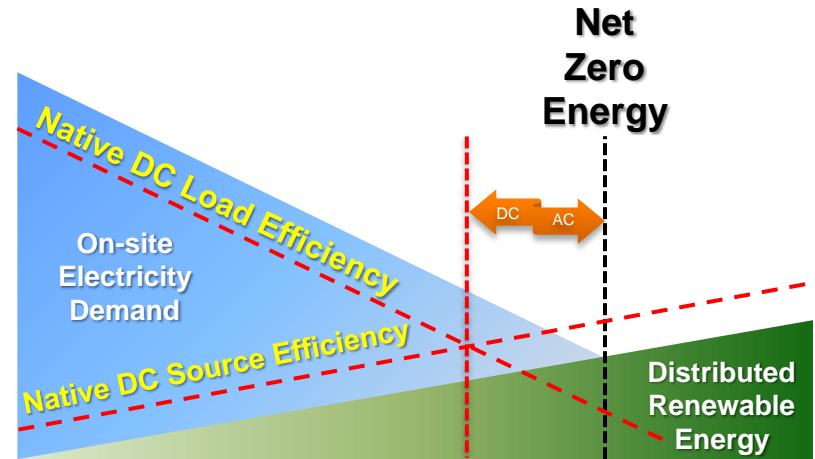
DC Facilitates Net Zero Attainment

The Right Approach can save Time and Money

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



- 2013:** Begin DC Microgrid Demonstrations
- 2030:** All new commercial buildings
- 2040:** 50% of commercial building stock
- 2050:** All commercial buildings



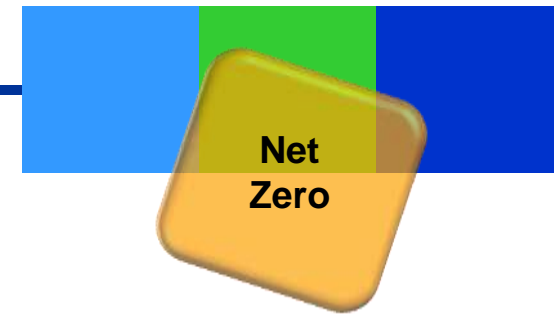
“DC power would fundamentally change the way power is distributed in commercial buildings...”



Challenge of Existing Buildings

Transform Opportunistically Over Time

- ⇒ **Retrofits**
 - ⇒ **Renovation**
 - ⇒ **Re-Use**
- ⇒ **85% of buildings that will exist in 2030 are here today!**



eebHUB Energy Efficient Buildings Hub
Re-energizing buildings for the future.™



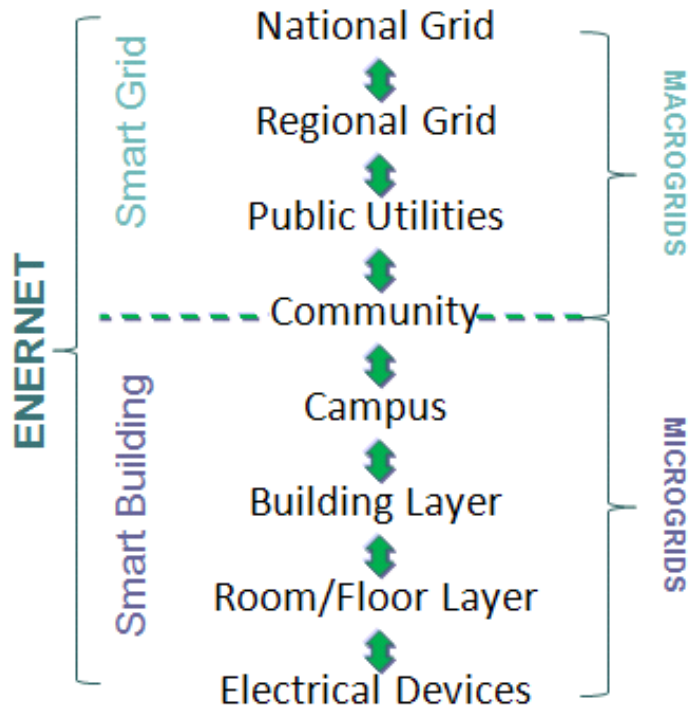
Microgrid Networks Can Help

Microgrids are like Scalable Networks



Benefits:

- ⇒ **Autonomy** – can be islanded for interruption protection
- ⇒ **Stability/Reliability** – Isolated/buffered from damaging grid disturbances
- ⇒ **Compatibility** – easily connected to ac distribution to form hybrid grids
- ⇒ **Flexibility** – can change & grow incrementally/opportunistically
- ⇒ **Scalability** – load and source components can be easily added for growth
- ⇒ **Efficiency** – less conversions, better supervisory management/control
- ⇒ **Economics** – better productive utilization on-site renewable assets
- ⇒ **Peer-to-peer connectivity** - can opportunistically connect with whole building microgrid conversion over time

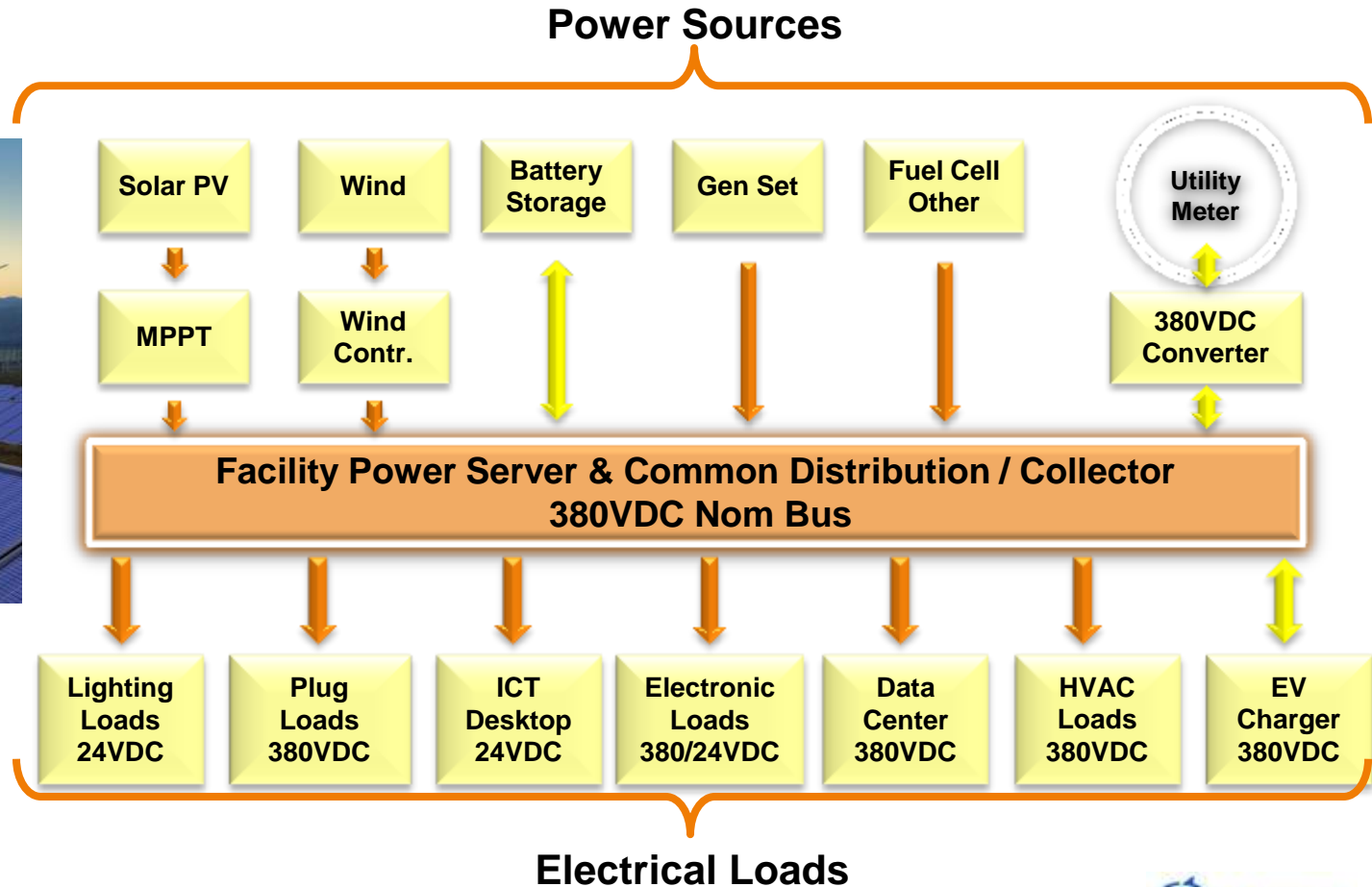


New DC Power Standards Are Helping

Industry Standards are Key



There are new standards for generating and distributing DC power in buildings.



Opportunistic Transformation Strategy

Area Microgrids are Interconnected Over Time

DC Power Standards



Hybrid AC/DC Buildings Are the 1st Step

A Net Zero Future starts Now

Design Strategies

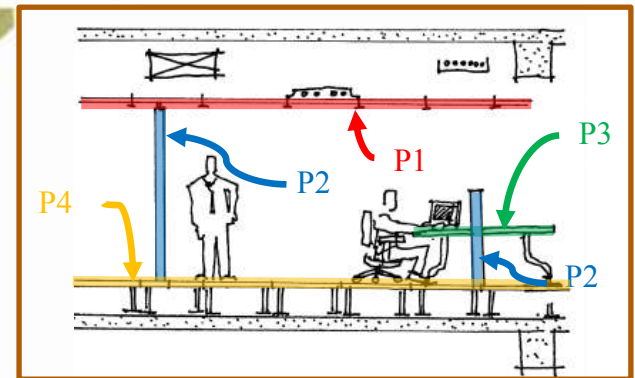
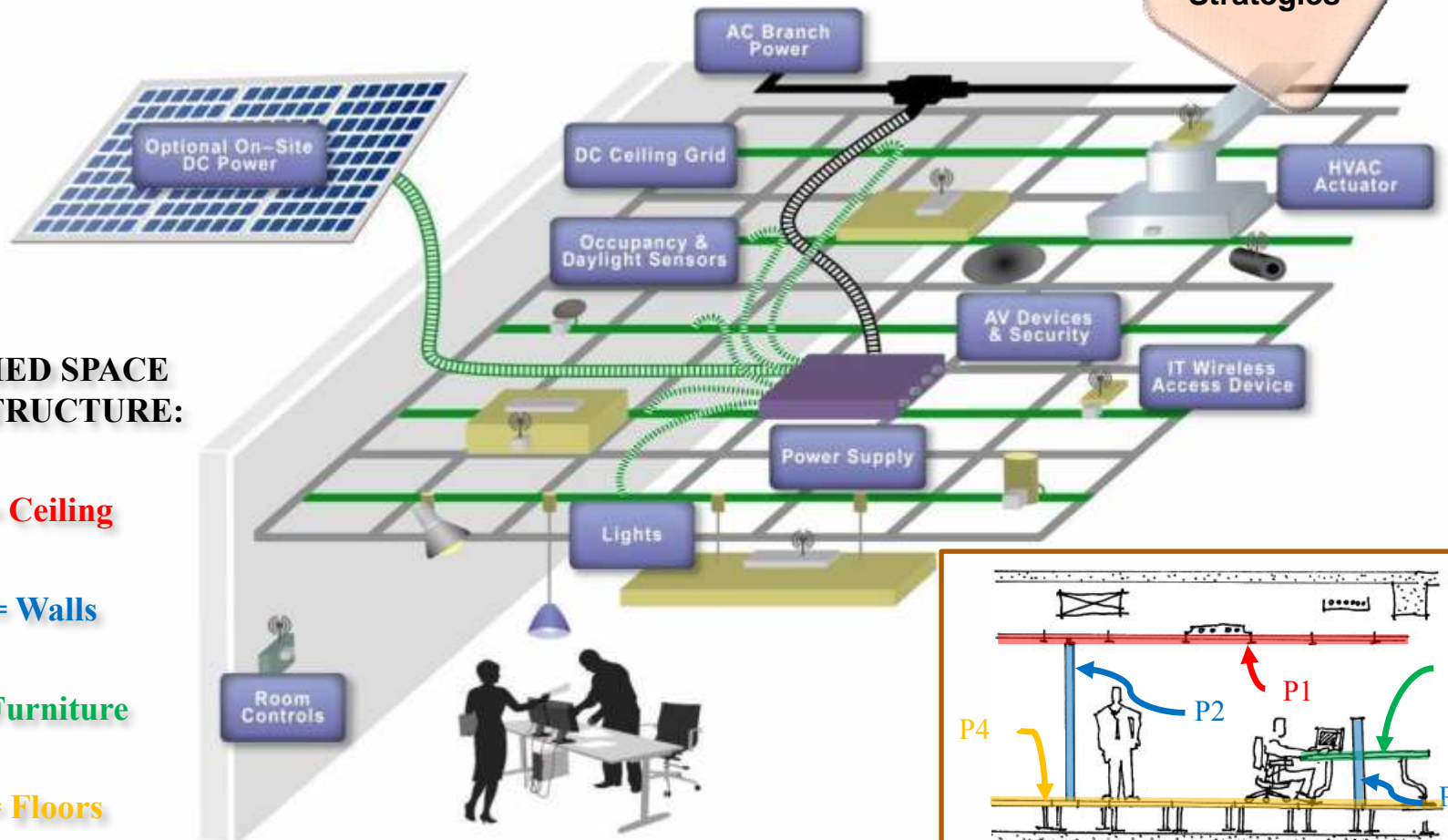
OCCUPIED SPACE INFRASTRUCTURE:

P1 = Ceiling

P2 = Walls

P3 = Furniture

P4 = Floors



We can begin to leverage Hybrid Power for Building Interiors Now!

Low Voltage DC at the Fringe

LVDC Technology can Help make it Happen

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/Reliability

- Re-use/Re-configurability of buildings & equipment
- Improved Reliability of clean energy & DC devices
- Smarter buildings for Smart Grid Integration



Getting Started Now with Interiors

Setting Up Initial DC Microgrids at the Room Level



Buildings
3.0

⇒ Start Small

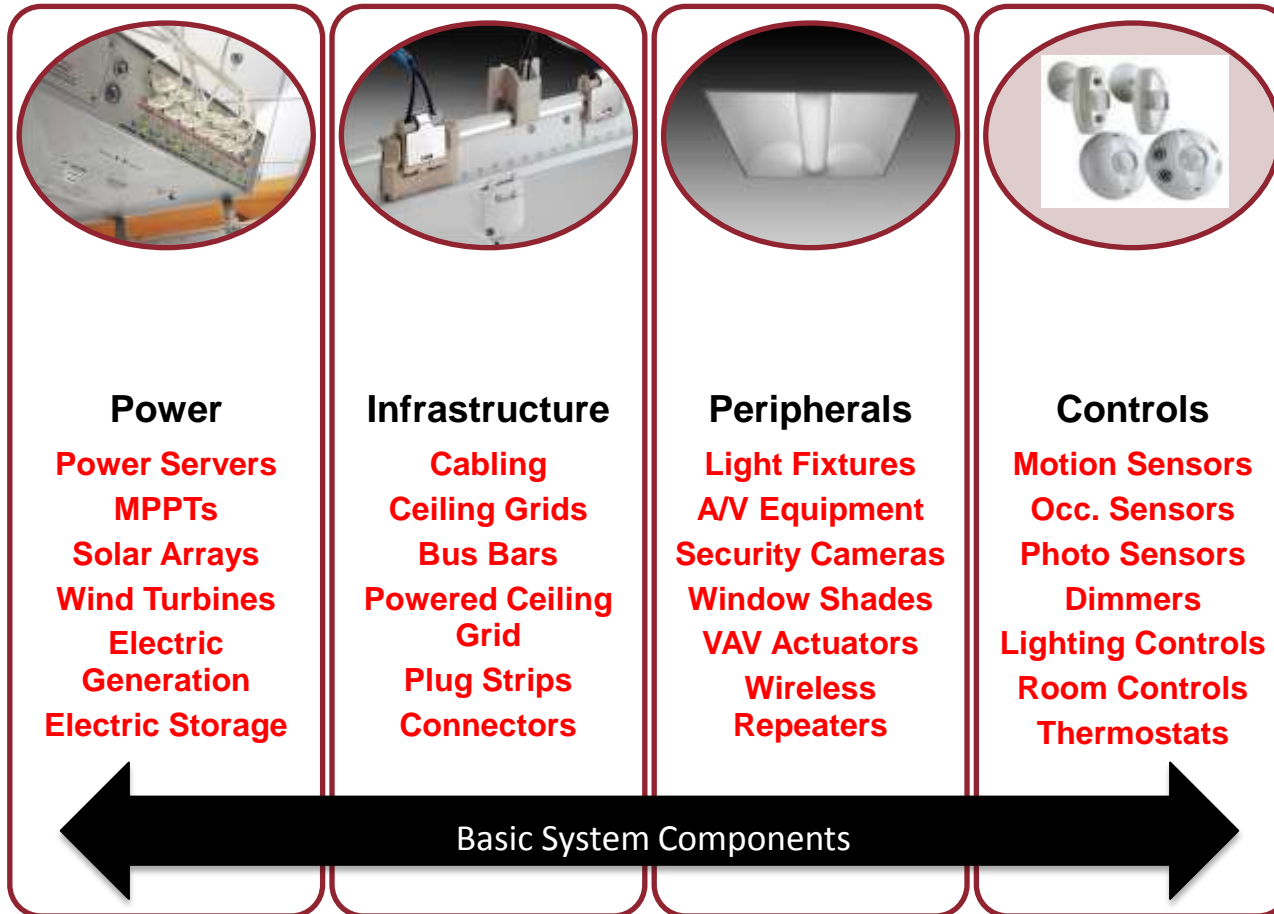
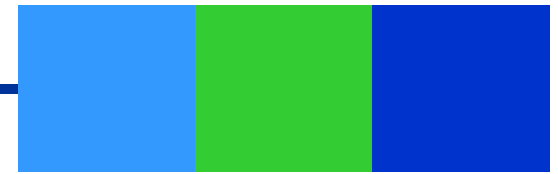
- No space is too small to begin your move to Net Zero
- Start with Suspended Ceilings: 70% of buildings use them
- UL recognized product is readily available

⇒ Finish Big

- Scaling flexibility allows you to be “opportunistic” with timing
- Focus on both new construction and Renovations/New Fit-outs
- Site-based generation and storage can be added at any time

The Solution Is Well Supported

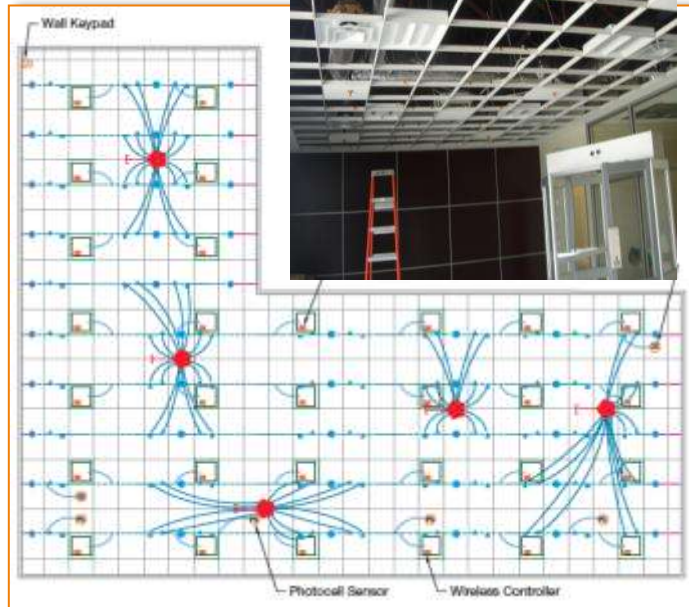
The Eco-System for DC is rapidly Building



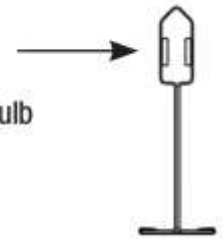
A
Systems
Portfolio

The New Role for Ceilings

The Suspended Ceiling

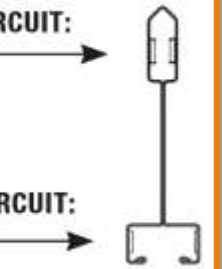


▲ **AVAILABLE CIRCUIT:**
Conductors on bulb



▲ **1ST AVAILABLE CIRCUIT:**
Conductors on bulb

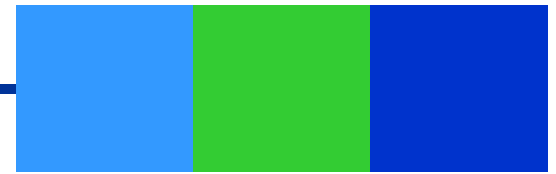
■ **2ND AVAILABLE CIRCUIT:**
Conductors inside reveal



Ceiling Grid Products

The Power Systems' Role

The Power Source

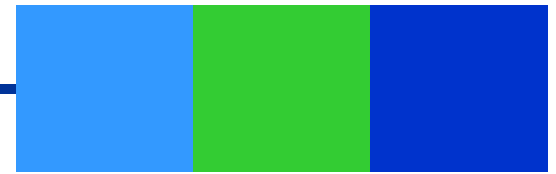


Power Supply Module



Cabling's Role

The Interconnection Cabling

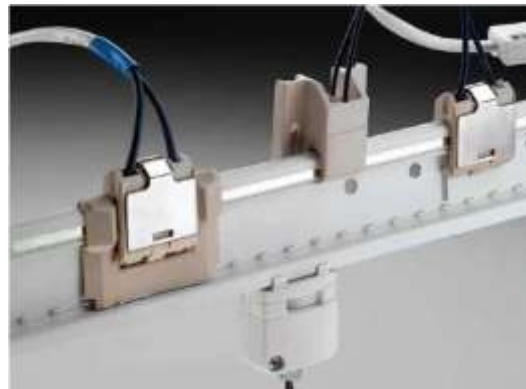


Integral Bus Bar
Connectors



Load Device
Cable Assemblies

Bus Bar Connections



Standardized Connectors



Power Feed
Cable Assemblies

Lighting's Role

The Lighting & Controls



Occupied Interior Spaces

The Applications are not Restricted



DC Powered Interior Spaces:

PNC Financial Services
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



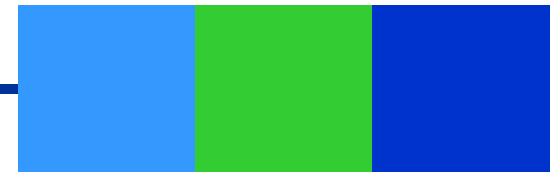
LA Community College
Trade Tech Campus
Los Angeles, CA



CA Lighting Tech Center
UC Davis Campus
Davis, CA

Using the EMerge Standard at PNC

Producing more than it Consumes



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.

The bank features solar connected **DC FlexZone™** ceilings that distribute native dc electricity to power efficient solid-state LED lighting and controls.

Case Study: UC San Diego SRC

Secondary Education Application

Design
Strategies

- ⇒ Sustainability Resource Center (SRC)
- ⇒ Office space, reception, and library
- ⇒ Student, campus and community use
- ⇒ Sustainable materials, energy efficient lighting and controls
- ⇒ On-site solar array



Focus: Direct DC Power

Alternative Energy doubles Relative Efficiency Gain

Design
Strategies

Uses Solar Generated DC Directly Without Inversion to AC

DC Source: Dedicated Solar Array

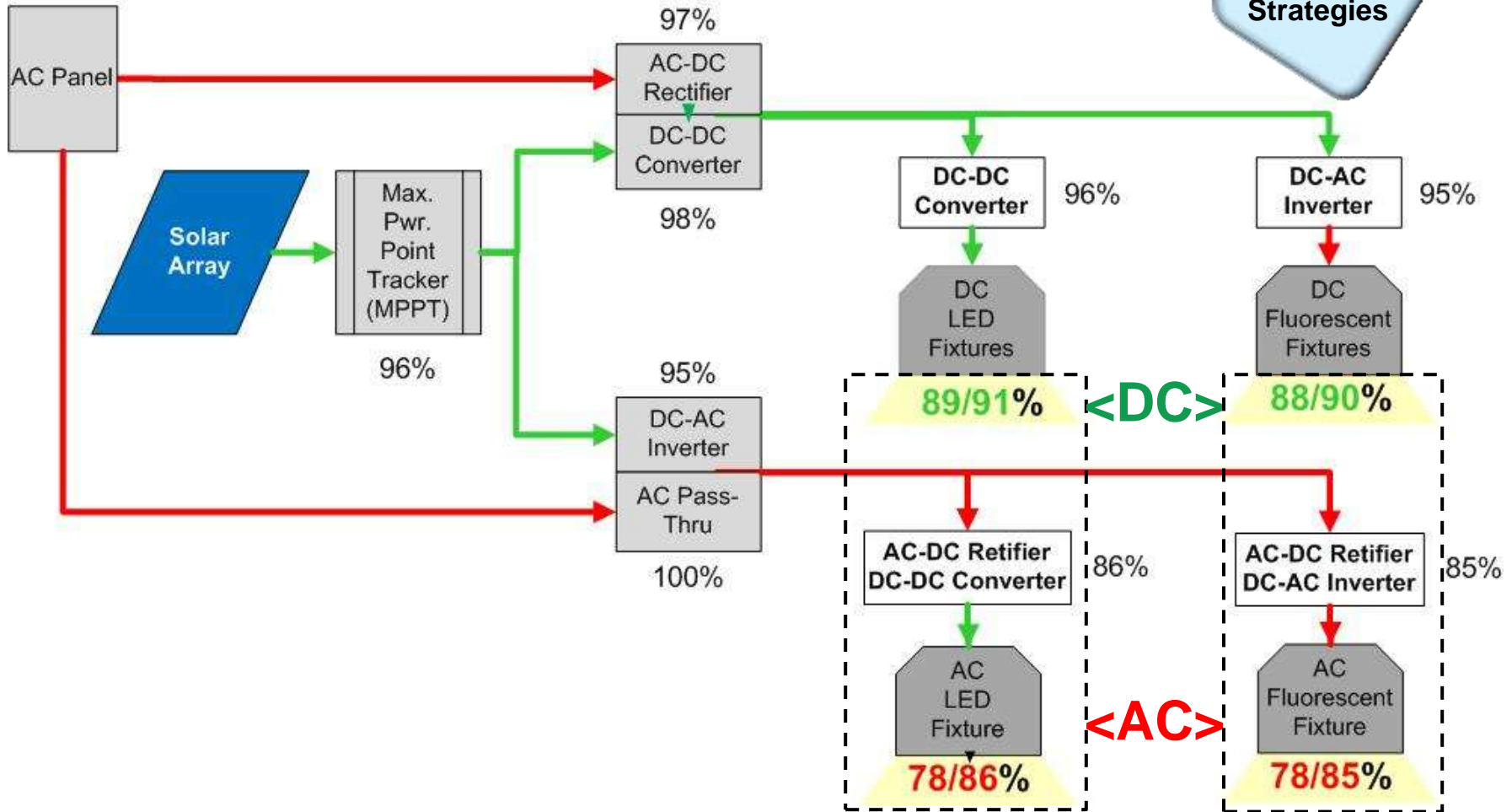


DC Loads: Lighting & Controls



Energy Efficient Design

Ohm's Law makes a Difference



Efficiency is >10-15% higher with solar, wind & on-site storage.

Energy Use Analysis

Enhanced Certification Opportunities

Design
Strategies

Improved power and lighting efficiency

- ⇒ *Because of fewer power conversions at solar & fixture level*
- ⇒ Won 2010 Best Practice Award for Lighting Design & Retrofit, California Higher Education Sustainability Conference
- ⇒ Achieved LEED-CI Gold
- ⇒ Innovation Credit:
 - ☑ “High Efficiency DC Microgrid”



Data Centers Are Next

Focused on Energy Efficiency & Surety



- ⇒ Huge energy user in buildings
- ⇒ Not just Google or Facebook
- ⇒ 99% are “small” (server rooms, closets, etc...2.5 million total)
 - ⇒ Contain majority of all servers (57%)
 - ⇒ From 2-32 servers per location
 - ⇒ Less internal expertise in power/space/heat management
- ⇒ 6 billion KW hours could be saved each year with a 10% improvement in data center energy efficiency

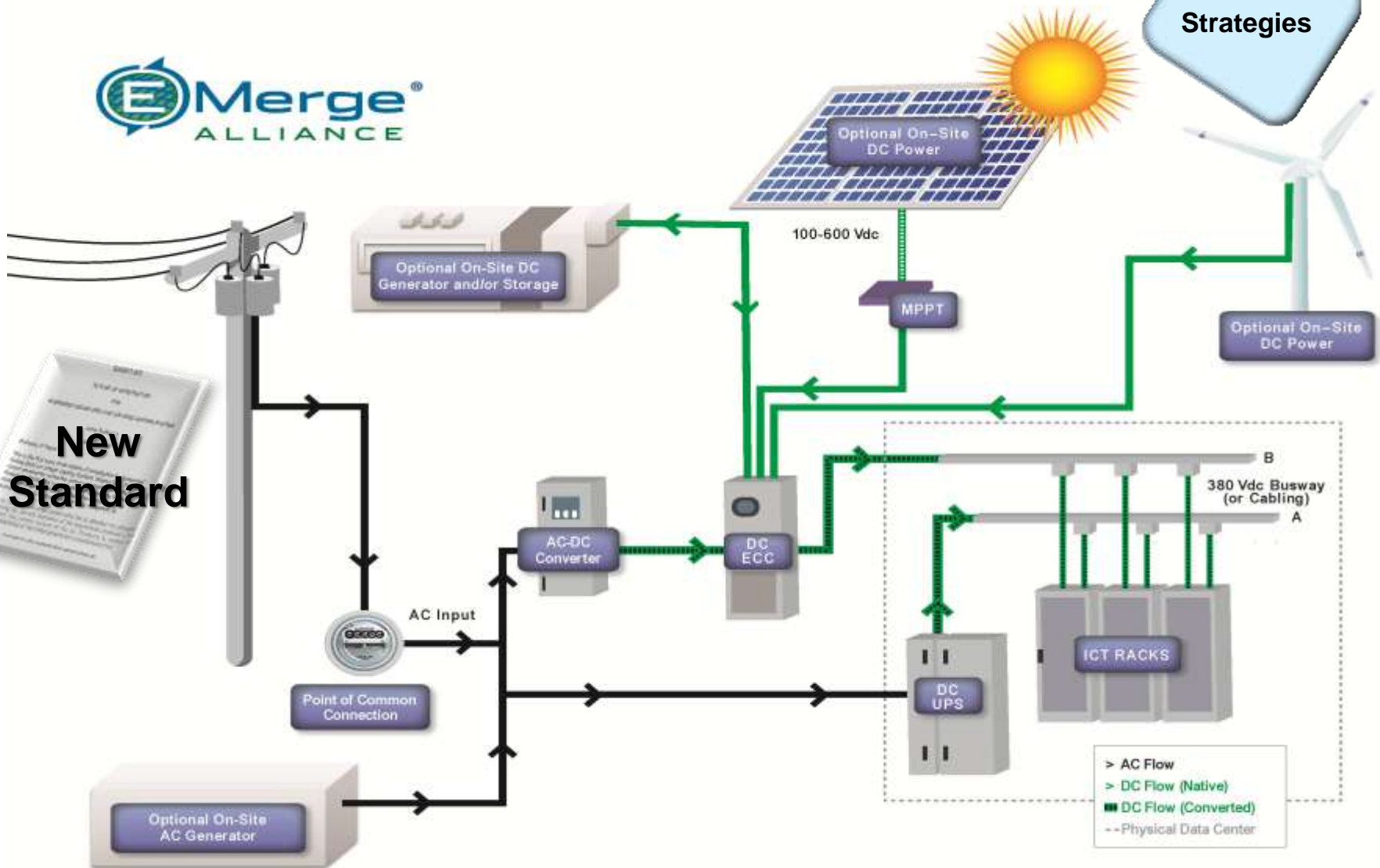


The Standards Are Being Implemented

EMerge Standard has been Issued



Technical Strategies

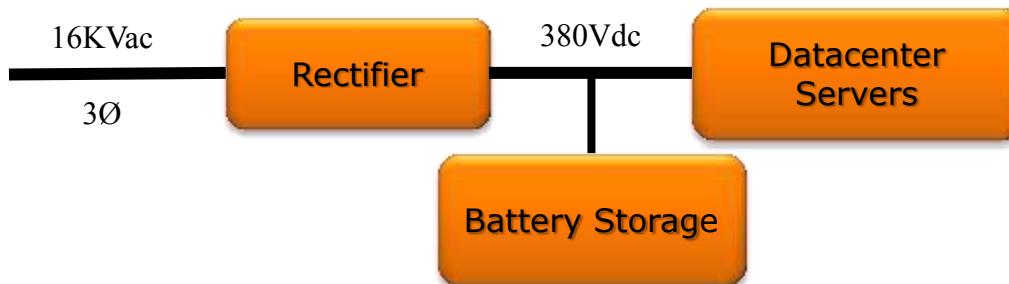


New Standard

Full Scale Applications in the Field

Green.ch-ABB 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 ABB* and HP*

Building Campus DC Microgrids

Full Scale Applications Under Development



PURE MICHIGAN
Michigan Economic Development Corporation

DC MICROGRID IMPLEMENTATION AT THE NEXT ENERGY CENTER

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24v DC OFFICE AREA LIGHTING (RETROFIT OF EXISTING TS LAMP FIXTURES)



16 CHANNELS @ 24vDC / 95 watts ea.

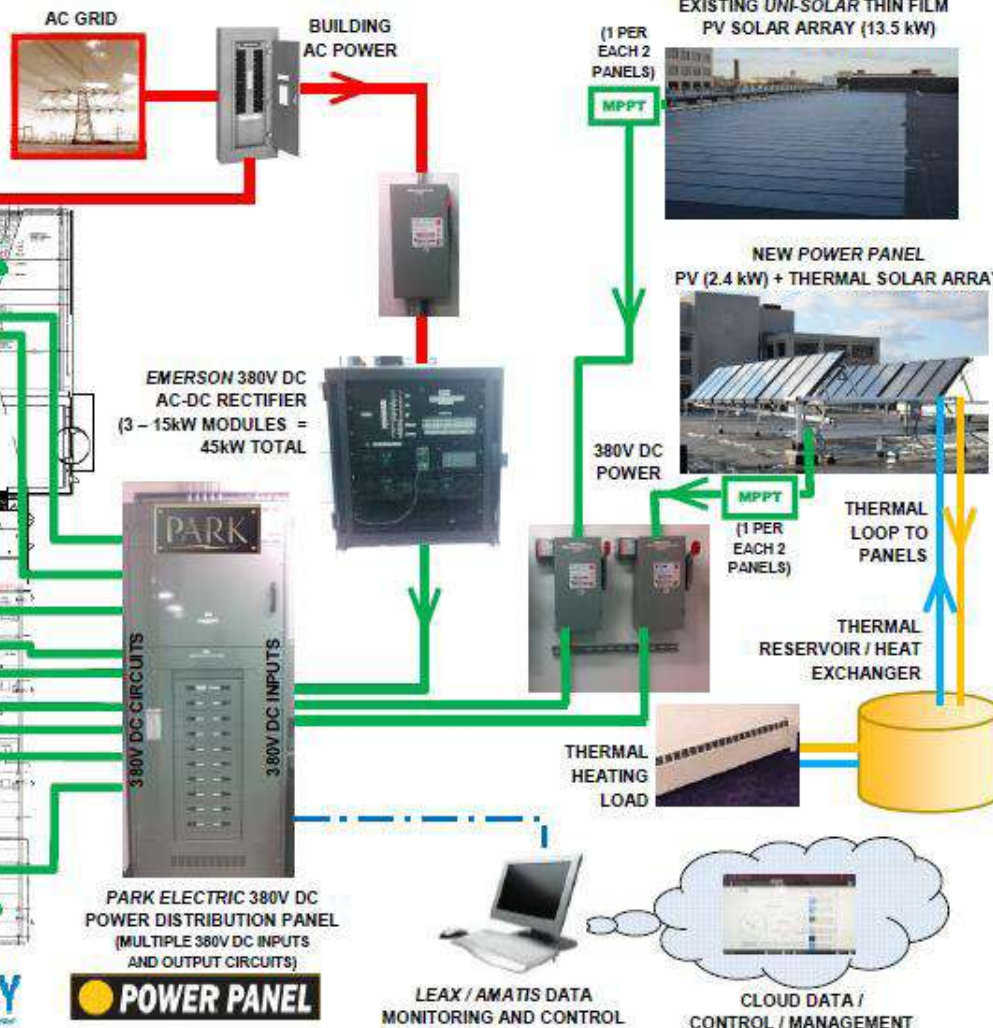
24v DC HIGH BAY ALUMALIGHT 6 LAMP T8 FLUORESCENT LAB LIGHTING (NEW FIXTURES TO REPLACE EXISTING HID)



24v DC NEXTEK FANS



NEXTECH ENERGY CENTER BUILDING PLAN





Q & A