BERKELEY LAB

LAWRENCE BERKELEY NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY

DC Power as an Integrating Platform in Zero Net Energy Buildings

Rich Brown

EPIC Symposium

3 December 2015

Why the interest now in DC power?

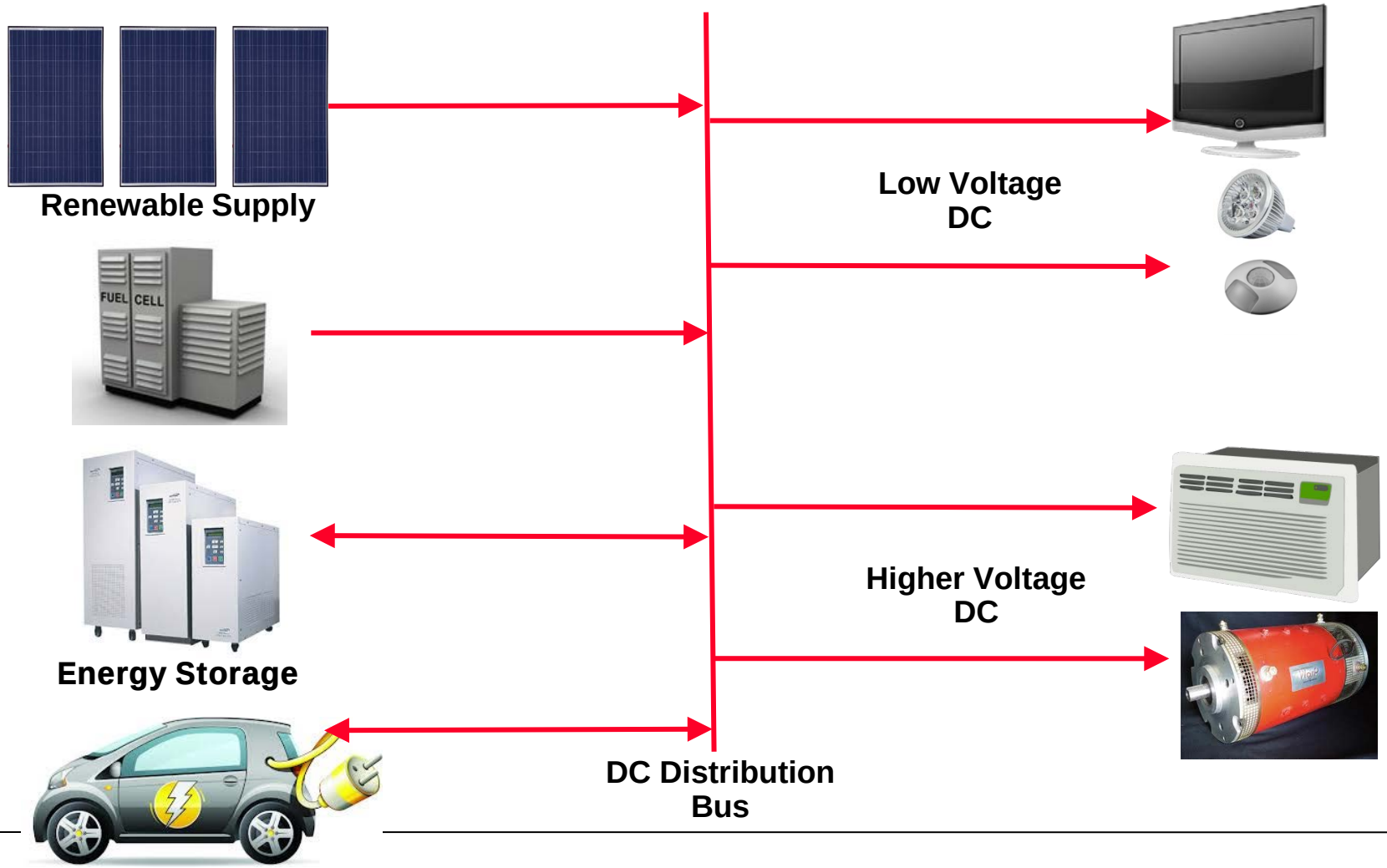
Technology Developments

- More native-DC building equipment
- More DC-based distributed generation
- On-site storage
- Advances in power electronics
- Evolving DC power standards
- DC power & communications (e.g., USB)
- More power-quality sensitive loads

Policy Goals & Market Needs

- Climate change goals
- Renewable generation
- Electricity storage
- Zero-net energy (ZNE) buildings
- Electric vehicles
- Disaster resiliency

DC Power Systems Allow Direct Integration of DC Supply & Loads



EPIC Study: DC Power in ZNE Buildings

Investigate the following topics:

- Energy use comparisons of AC and DC systems
- Availability of DC power distribution and end-use equipment
- Status of codes and standards
- Options for hybrid AC and DC systems
- Occupant and human behavior for acceptance of DC
- Non-energy: reliability, controllability, convenience
- Training and educational needs
- Cost-benefit analyses

Project Partners

BERKELEY LAB
Lawrence Berkeley National Laboratory

EPRI ELECTRIC POWER RESEARCH INSTITUTE

ciee California Institute for Energy and Environment

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

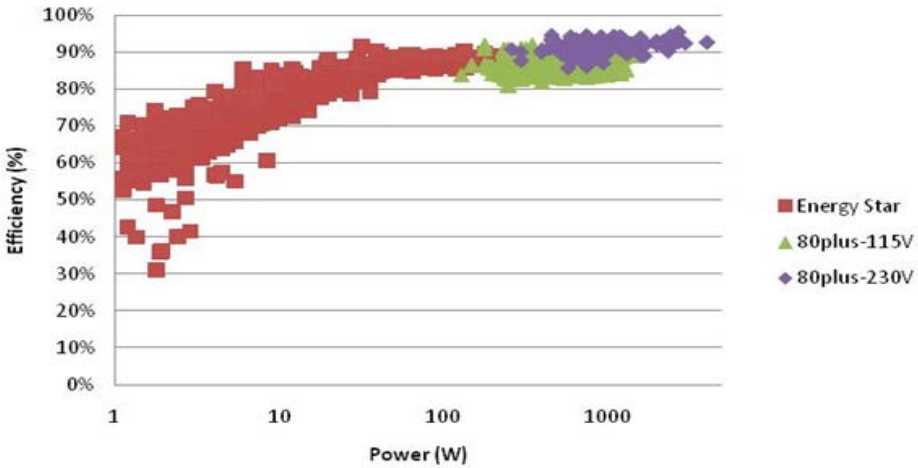
ARUP

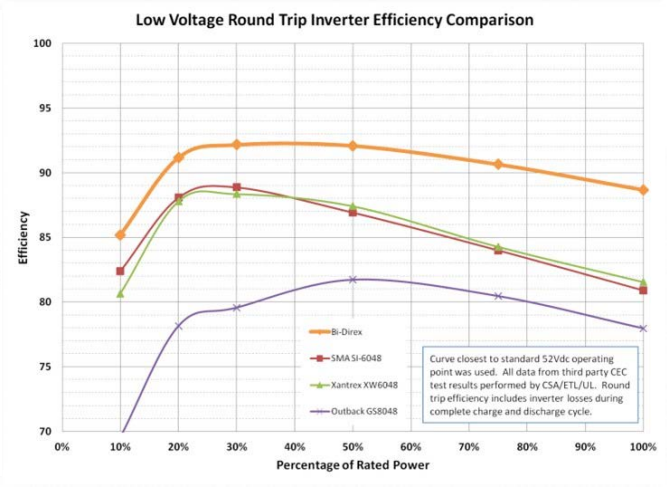
EMerge® ALLIANCE

BERKELEY LAB

Review Existing Knowledge about DC and AC-DC Hybrid Systems

- Summarize current literature on DC and hybrid AC/DC distribution in buildings
  - Energy Savings (converter efficiencies, line losses, etc.)
  - Non-Energy Benefits (reliability, controllability, etc.)
  - Analyses of System Costs
  - Market & Technical Barriers
  - Current Market Adoption
  - Existing Codes and Standards
- Interview key stakeholders and hold public workshop





BERKELEY LAB

Develop End-Use Design Templates

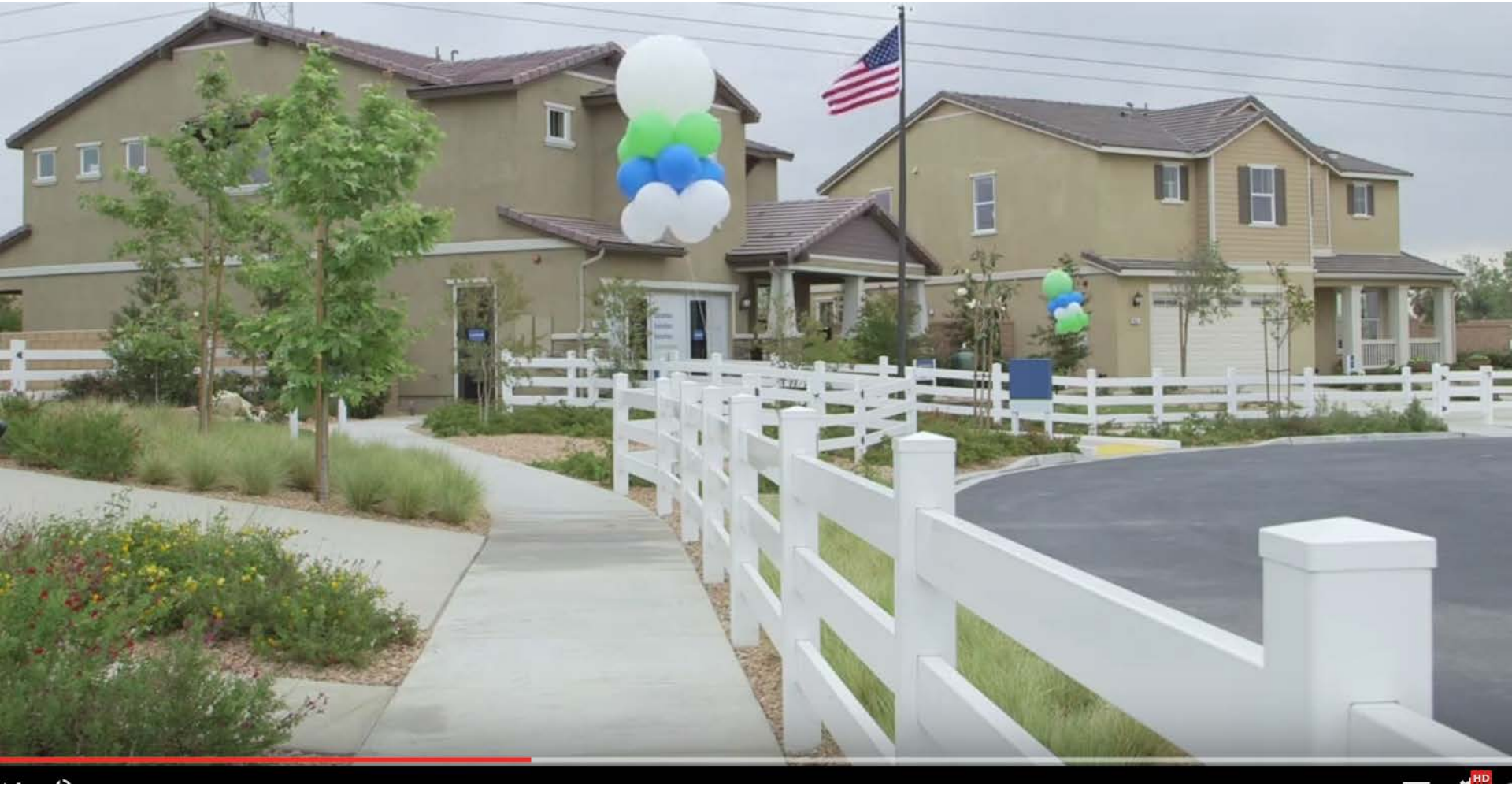
Evaluate standard AC vs. DC designs for two actual buildings

- Evaluate key end-use applications:
  - Lighting, HVAC, plug loads
  - PV systems
  - Battery storage and EV charging

- Develop design templates for alternative DC designs
  - Use actual drawings, specs, and cost data for model buildings
  - Apply data from literature review
  - Hold design charette and incorporate feedback

- Analyze final templates for energy savings, cost, reliability, controllability, demand response, Smart Grid integration, non-energy benefits, market barriers, existing codes, and standards

ZNE New Home – Meritage Homes, Fontana, CA



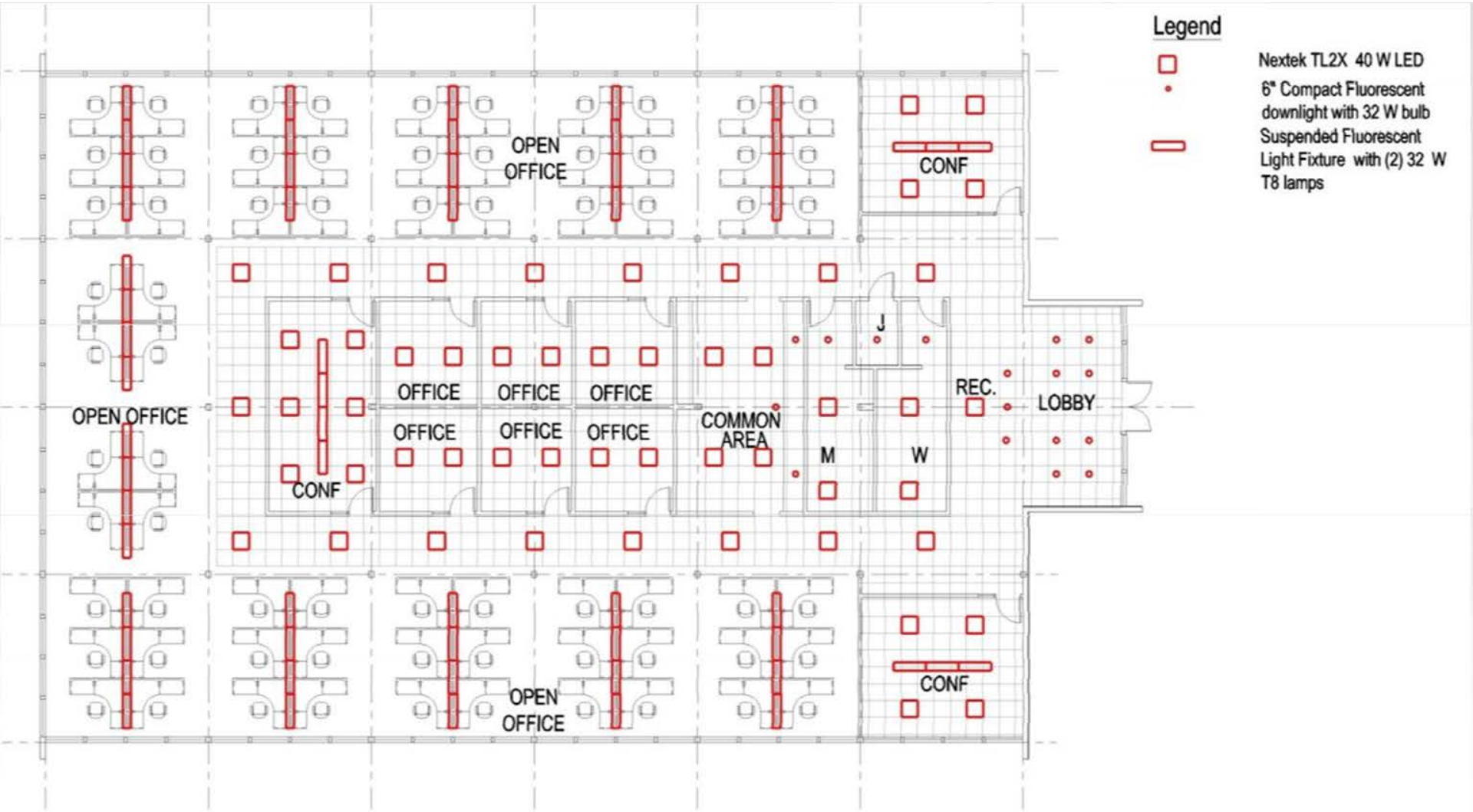
Source: Southern California Edison

ZNE Commercial Building – IBEW Training Center, San Leandro, CA

Source: High Performance Buildings Magazine

9

Typical Baseline Lighting Design – AC



Source: Emerge Alliance

Develop DC Design Guidelines

- Distill findings from literature review and design templates into “best practices” for design of DC systems in buildings
- Evaluate the best practices employed, cost differential, and barriers to adoption for DC and AC-DC hybrid systems that integrate photovoltaic generation, electric vehicles, and battery storage
- Consider whole-building integration of PV systems, EV charging, battery storage, and DC end-use devices

Case Study – PNC Bank Branch, Ft Lauderdale, FL

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.

Summary

- DC power in buildings may help meet CA policy goals for ZNE buildings, renewables, and electric vehicles
- CEC wants to understand:
  - the benefits and barriers to this technology
  - where it makes sense
  - how to further develop and deploy
- Looking for help from industry and other stakeholders for information about current state of the art, barriers, costs, benefits

Thank You

Rich Brown
REBrown@lbl.gov
(510) 486-5896