The IEEE First International Conference on DC Microgrids

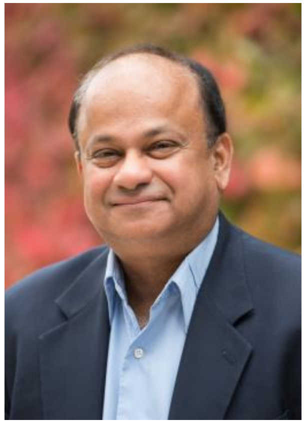
http://www.icdcm.co/

June 7-10, 2015

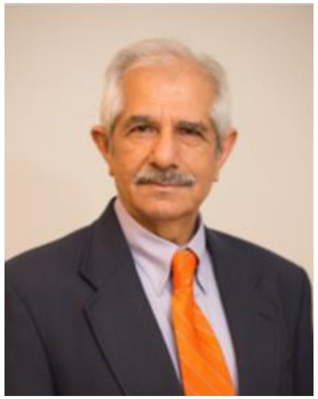
Sheraton Atlanta Hotel

Atlanta, Georgia, USA

Organizers



- Krishna Shenai, Ph.D., General Chair, LoPel Corporation
- Rajendra Singh, Ph.D., Technical Chair, Clemson University



- Bernd Wunder, Fraunhofer Institute
- Keith Corzine, Clemson University
- David E. Geary, Universal Electric Corp.
- Herbert L. Ginn, Univ. of South Carolina
- Roger Dougal, Univ. of South Carolina
- Sol Haroon, IP UtiliNET
- Maryam Saeedifard, Georgia Inst. of Tech.

Subject Areas

- DC Microgrids
  - Developing Areas,
  - Data Centers,
  - Telecom Sites,
  - Smart Homes
  - Buildings
- AC/DC Hybrid Systems Implementations
- DC Microgrid Performance Studies / Analysis / Simulations and Business Models
- Cyber Security
- DC Devices, Protection and Switching
- Batteries / Storages


ICDCM 2015


International Conference on DC Microgrids
Plenary Session
Chair: Rajendra Singh
Speakers:
Keiichi Hirose | NTT Facilities, Inc., Japan
Sonny Wu | LatticePower and Boston-Power, China
Mario Tokoro | Sony Computer Science Laboratories, Inc., Japan
Monday, June 8
8:00 AM - 10:15 AM

Plenary Speakers

- **Dr. Keiichi Hirose, NTT Facilities, Inc. Japan**

  Evolution of DC Microgrid from Telecom/Data-Center Infrastructure- 10-Year Experience and Next Challenge

- **Dr. Mario Tokoro, Sony Computer Science Laboratories, Inc., Japan**

  DC-Based Open Energy System – A Sustainable, Dependable, and Affordable Solution for Next-Generation Electrical Power Infrastructures

Keynote Speakers





- **Dr. Mohammad Shahidehpour, Illinois Institute of Technology,**

  DC Microgrids in Smart Cities: Economic Operation and Enhancement of Resilience by Hierarchical Control
- **Dr. Kumar Venayagamoorthy, Clemson University,**

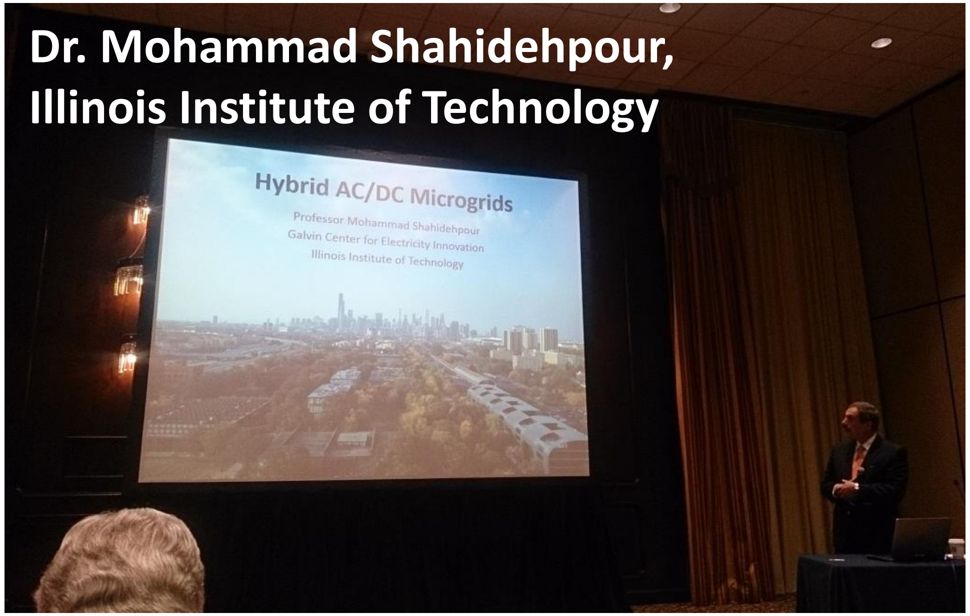
  Situational Intelligence and Intelligent Control of DC Power Systems
- **Dr. Josep M. Guerrero, Aalborg University, Denmark**

  Advanced Control Architectures of DC Microgrids
- **Dr. Scott Backhaus, Los Alamos National Laboratory,**

  Summary of DOE DC Microgrid Scoping Study Draft – Opportunities and Challenges
- **Mr. Robert F. Lachenmayer Jr., Schneider Electric, USA**

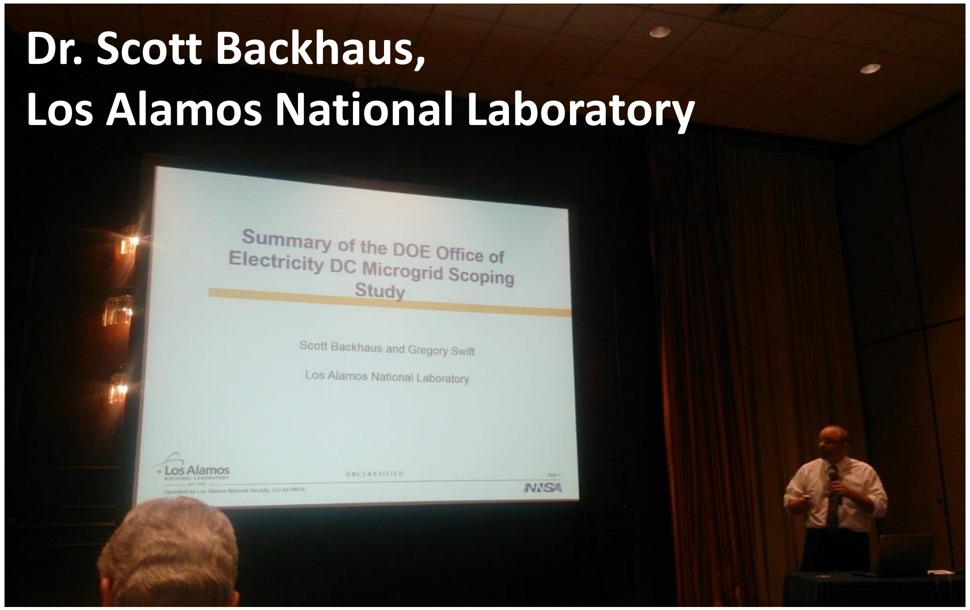
  Implementing and Enabling Business Model for DC Microgrids

Keynote Speakers

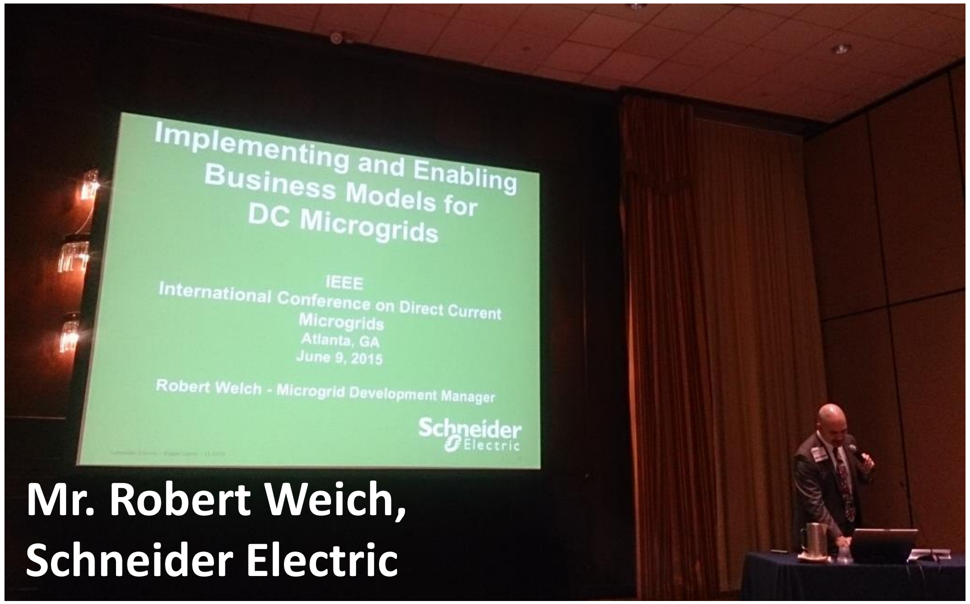


Dr. Mohammad Shahidehpour,
Illinois Institute of Technology

Dr. Kumar Venayagamoorthy,
Clemson University



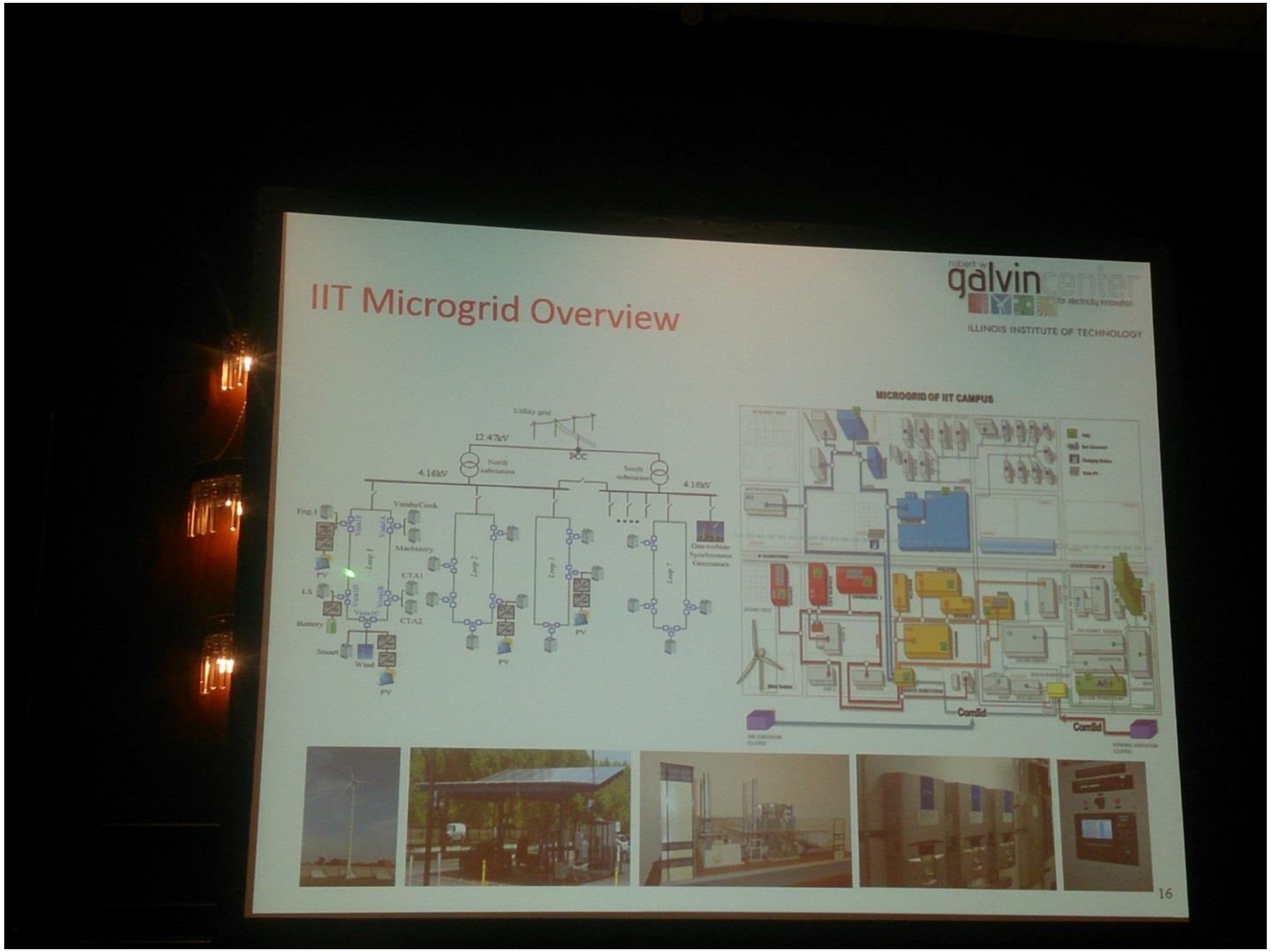
Dr. Scott Backhaus,
Los Alamos National Laboratory



Mr. Robert Weich,
Schneider Electric

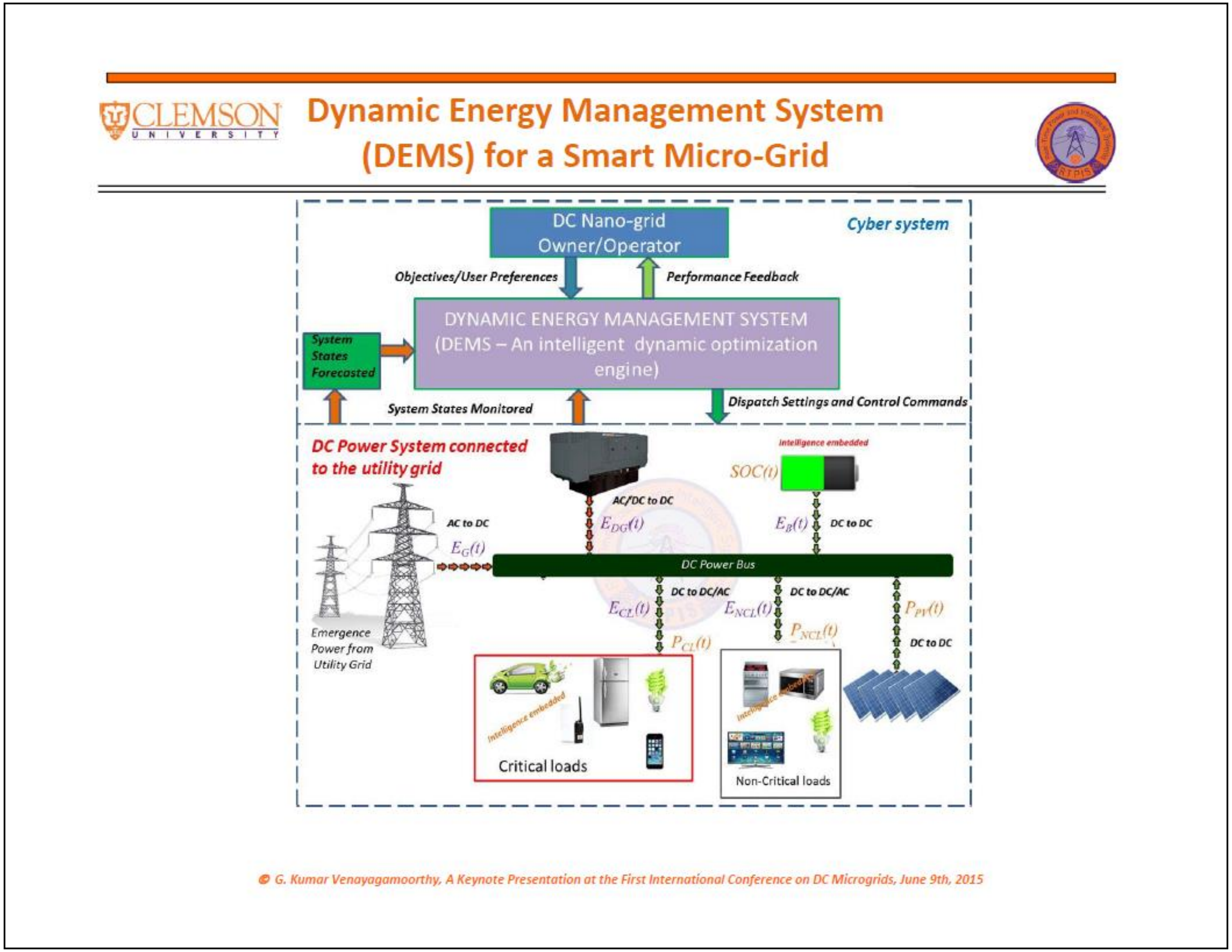
DC Microgrids in Smart Cities: Economic Operation and Enhancement of Resilience by Hierarchical Control,

Mohammad Shahidehpour, *Illinois Institute of Technology*



Situational Intelligence and Intelligent Control of DC Power Systems,

Kumar Venayagamoorthy, *Clemson University*



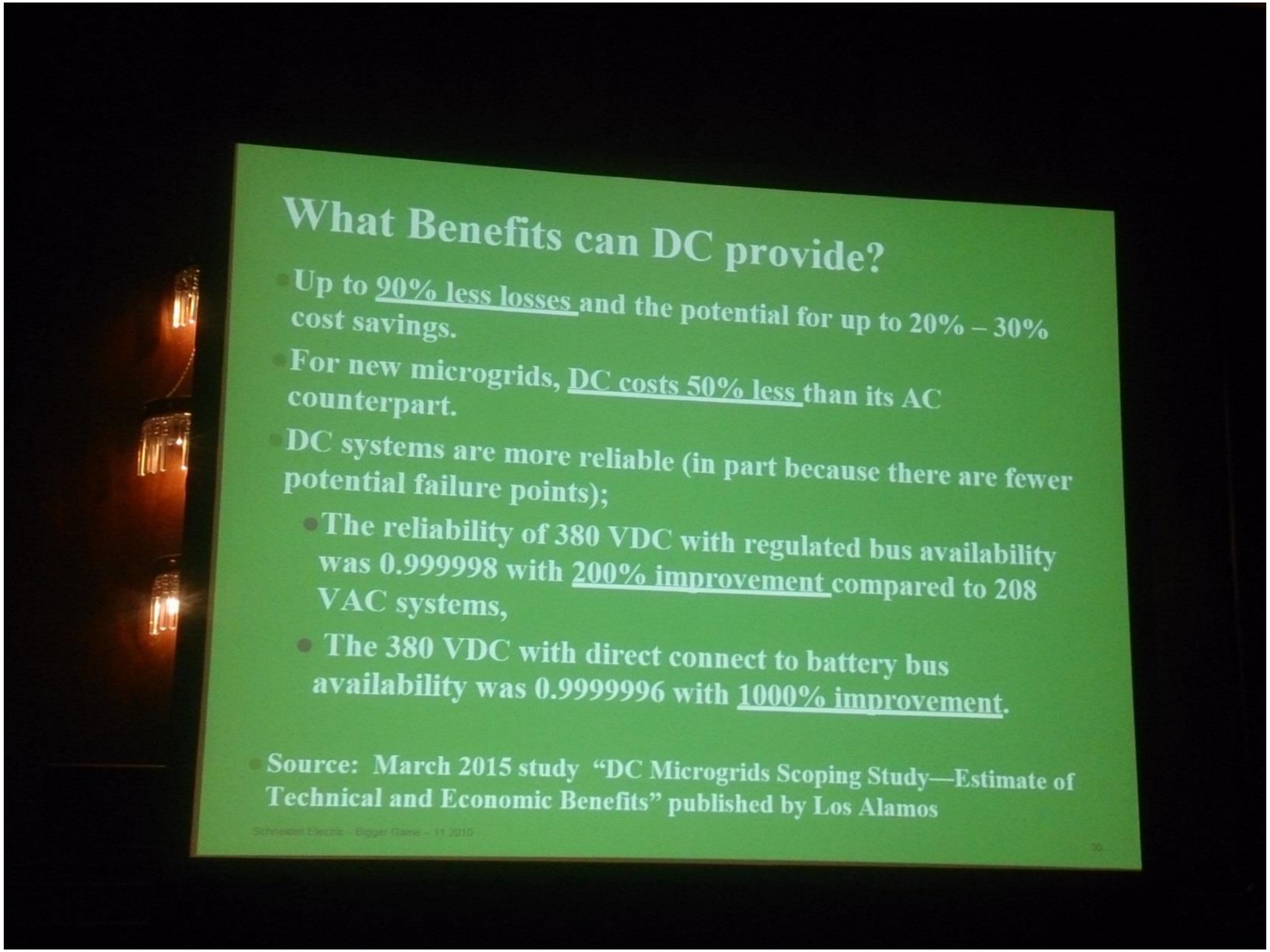
DOE DC Microgrid Scoping Study – Opportunities and Challenges,

Scott Backhaus, Los Alamos National Laboratory

Metrics For Comparing DC and AC Microgrids

Metric	Assessment
Operating Cost	No export (advantage to DC), Export/Import (~same)
Capital Cost	No export (advantage to DC), Export/Import (~same)
Engineering Cost	Not assess in detail—potential advantage to DC
Reliability	No significant difference—spares at AC-DC interface
Resilience	No significant difference
Power Quality	Advantage to DC
Safety and Protection	No significant difference
Energy Efficiency	No export (3% advantage DC), Export/Import (~same)
Environmental	Same as Energy Efficiency

Implementing and Enabling Business Model for DC Microgrids, Robert F. Lachenmayer Jr.(Robert Weich), *Schneider Electric*



Technical Sessions (1)

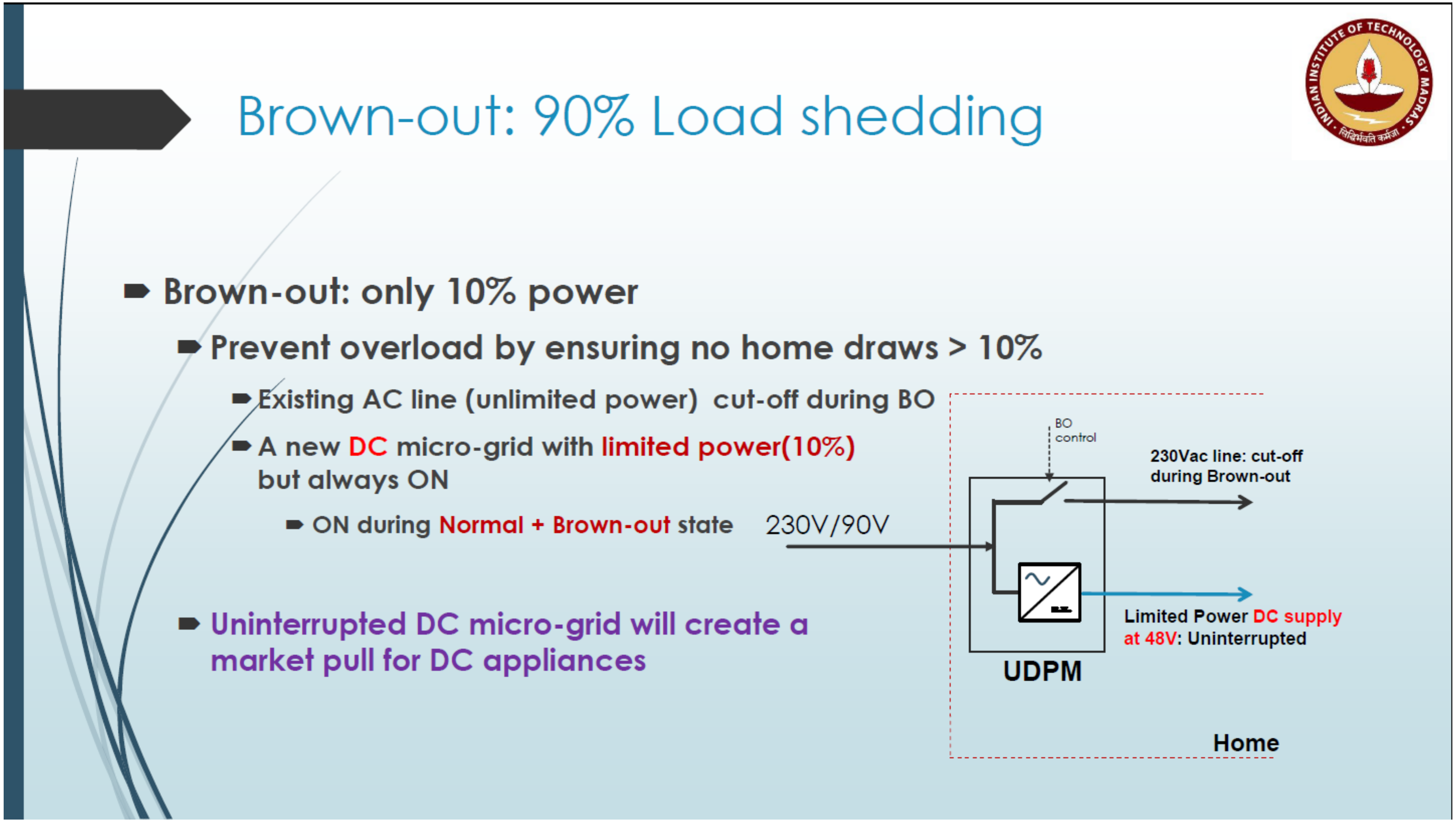
- Rural and Off Grid DC Microgrid and Nanogrid
  - 3 presentations, All from India
- Performance Analysis and Optimization
  - 7 presentations, US/Germany/Denmark/China/US/US/Canada
- DC Microgrids in Residential and Commercial Buildings (1)
  - 4 presentations, Germany-Netherlands/US/US/US
- DC Microgrids in Residential and Commercial Buildings (2)
  - 4 presentations, US/Thailand-US/Netherlands/Netherlands
- Distribution Energy Generation & Integration (1)
  - 3 presentations, US/India/Denmark
- Distribution Energy Generation & Integration (2)
  - 4 presentations, US/China/Netherlands-China/Denmark-Spain
- DC Microgrids in Residential and Commercial Buildings (3)
  - 6 presentations, Germany/China/Brazil/Denmark-China/US/US
- Panel: DC Power for Data Centers
  - 5 panelists, Japan/US/US/US/US

Technical Sessions (2)

- Real-Time Monitoring and Control
  - 4 presentations, Italy-Denmark/Finland/US/Egypt
- Communication and Security Analysis
  - 5 presentations, US/UK-China/US/Italy-Switzerland/US
- Protection and Switching Techniques (1)
  - 4 presentations, France/Germany/China/US
- Protection and Switching Techniques (2)
  - 5 presentations, US/China/US/Netherlands/Netherlands
- Advanced Power Electronics (1)
  - 3 presentations, US/US/India
- Advanced Power Electronics (2)
  - 5 presentations, US/US/Brazil/Canada/US
- Local DC Power in Transport Sector
  - 3 presentations, US/US/Denmark
- Storage Technology
  - 3 presentations, New Zealand/New Zealand/Italy

Technological and Deployment Challenges and User-Response to Uninterrupted DC (UDC) deployment in Indian homes,

Ashok Jhunjhunwala, *Indian Institute of Technology Madras, India*



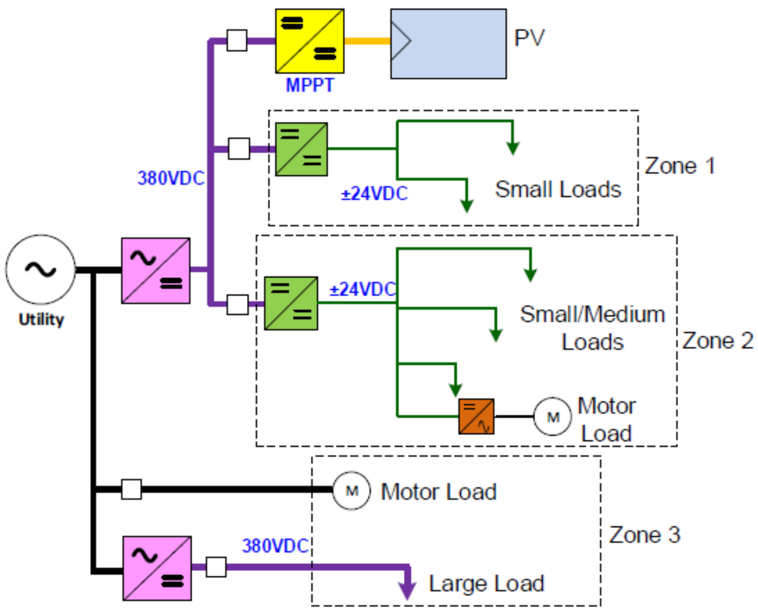
Analysis of Emerging Technology for DC-Enabled Smart Homes,

Alexander Brissette, ABB Inc.

Hybrid AC/DC Topologies

Example 2

- AC to 380Vdc backbone
- 380Vdc backbone to 48Vdc/±24Vdc subnetworks
- Large/motor loads served separately
- DC bus for PV MPPT into 380Vdc backbone
- Pros:
  - Advances use of DC
  - 380Vdc proven in datacenters
- Con: Safety concerns



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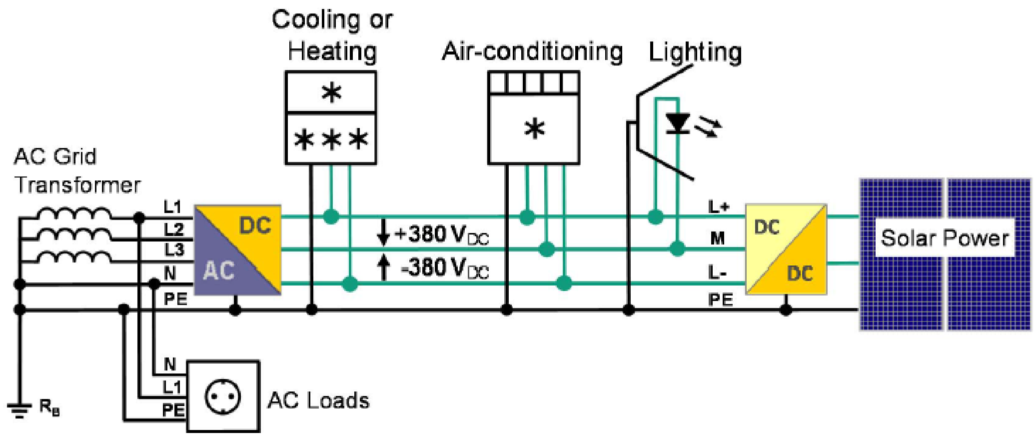
DC Power Grids for Buildings,
U. Boeke, Philips Research

Summary

DC power systems can support higher building energy efficiency

- 2 % utility power savings have been demonstrated at 2 kW
- 5 % utility power savings are seen as potential for P > 8 kW
- Consider 2-phase DC grids to compete with 3-phase AC



PHILIPS

DC Local Power Distribution with Microgrids and Nanogrids,
Bruce Nordman, Lawrence Berkeley National Laboratory

Grid terminology

- **Microgrid** Capability

  "… a group of interconnected loads and distributed energy resources … . A microgrid can connect and disconnect from the grid to enable it to operate in both **grid-connected or island-mode**" *(US Dept. of Energy)*

  CIGRE defn. includes microgrids never connected to utility grid

- **Nanogrid** Simplicity

  "A **single domain of power**; single voltage, frequency (if AC), reliability, quality, capacity (power), price, and administration. Storage is internal to a nanogrid." Generation forms its own nanogrid. *(Nordman, 2010)*

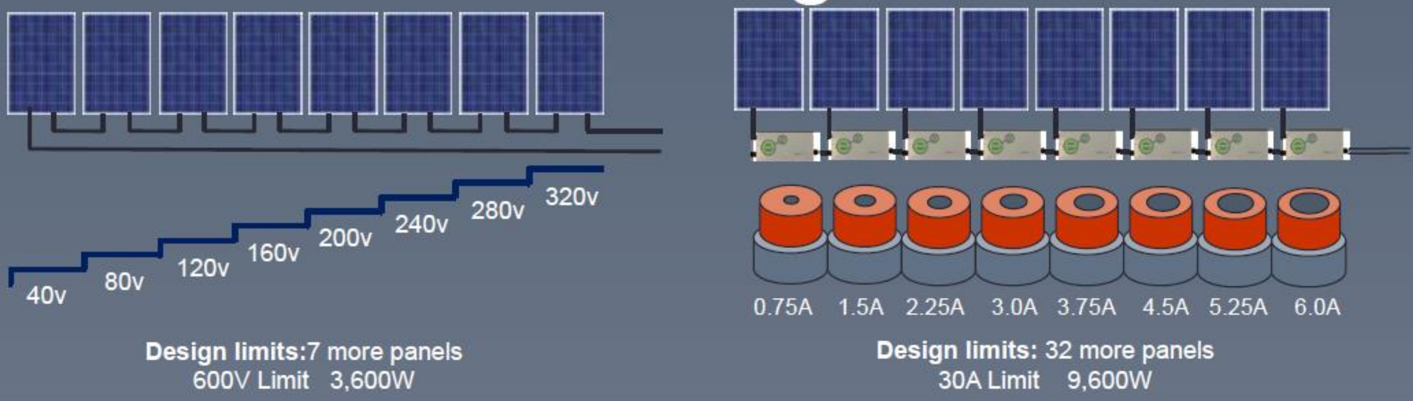
- **Picogrid** Singularity

  An **individual device with its own internal battery** for operation when external sources are not available or not preferred, and managed use of the battery. *(S. Ghai et al. in* e-energy 2013; *paraphrased)*

Integrating Storage and Renewable Energy Sources Into a DC Microgrid Using High Gain DC DC Boost Converters,

Gene Krzywinski, eIQ Energy, Inc.

The Parallel Advantage



Conventional Series Strings	Parallel DC
Panels and strings must match	No matching or balancing required
Weakest panel sets performance	Each panel is independent
Panel voltage drives system design	Site conditions drive system design
Centrally set operating point	Each panel is optimized

Speakers Affiliations (1)

- JP: NTT Facilities, Sony CSL
- It: Tamil Nadu Energy Development Agency, Cygni Energy Private Limited
- Ch: CGN Solar Energy Dev.(3), State Grid Co.(2),
- Ca: ARDA Power(2),
- NL: Philips Res.(2),
- Ge: Fraunhofer Inst.(3), Siemens, ETA,
- US: NREL, Schneider Elec., Bosch LLC, GE Elec. Power, ABB, Vicor Corp., eIQ Energy, LoPel Corp., Efficient Power Conversion Corp., dcFusion, Emerson, EMerge Alliance, ECE, Underwriters Lab.(3), Galvin Electricity Initiative
- Fr: Ampere Lab., Mersen,
- Br: CEFET-MG,

Speakers Affiliations (2)

- De: Aalborg U. (7),
- It: U di Palermo, Politecnico di Milano, U. degli Studi di Salerno, U. di Pisa,
- Fi: Lappeenranta U of T,
- US: U of North Dakota(3), Los Alamos Nat'l Lab, Illinois Inst. T.(2)., Verginia Polytech, U Tex(2), Clemson U.(4), LBL, U. South Florida(2), LBNL, U. of Arkansas, UC Merced, North Carolina State U.,
- Arab: Arab Academy of Science
- In: Indian Inst of Tech(5)
- NL: Eindhoven U. , Delft U.(4),
- Ch: Xiamen U.(3), Ziejiang U., Donghua U., North China Electric Power U.,
- UK: Aston U.
- Sw: Swizerland Center for Elec. and Microtech.,
- Th: Chiang Mai Rajabhat U., U. Phayao,
- Br: U Federal de Santa Catarina, U. Federal de Minas Gerais,
- Sp: Univ. Politecnica de Catalnya,
- NZ: U. of Waikato(2),

Thank you for Inspiration