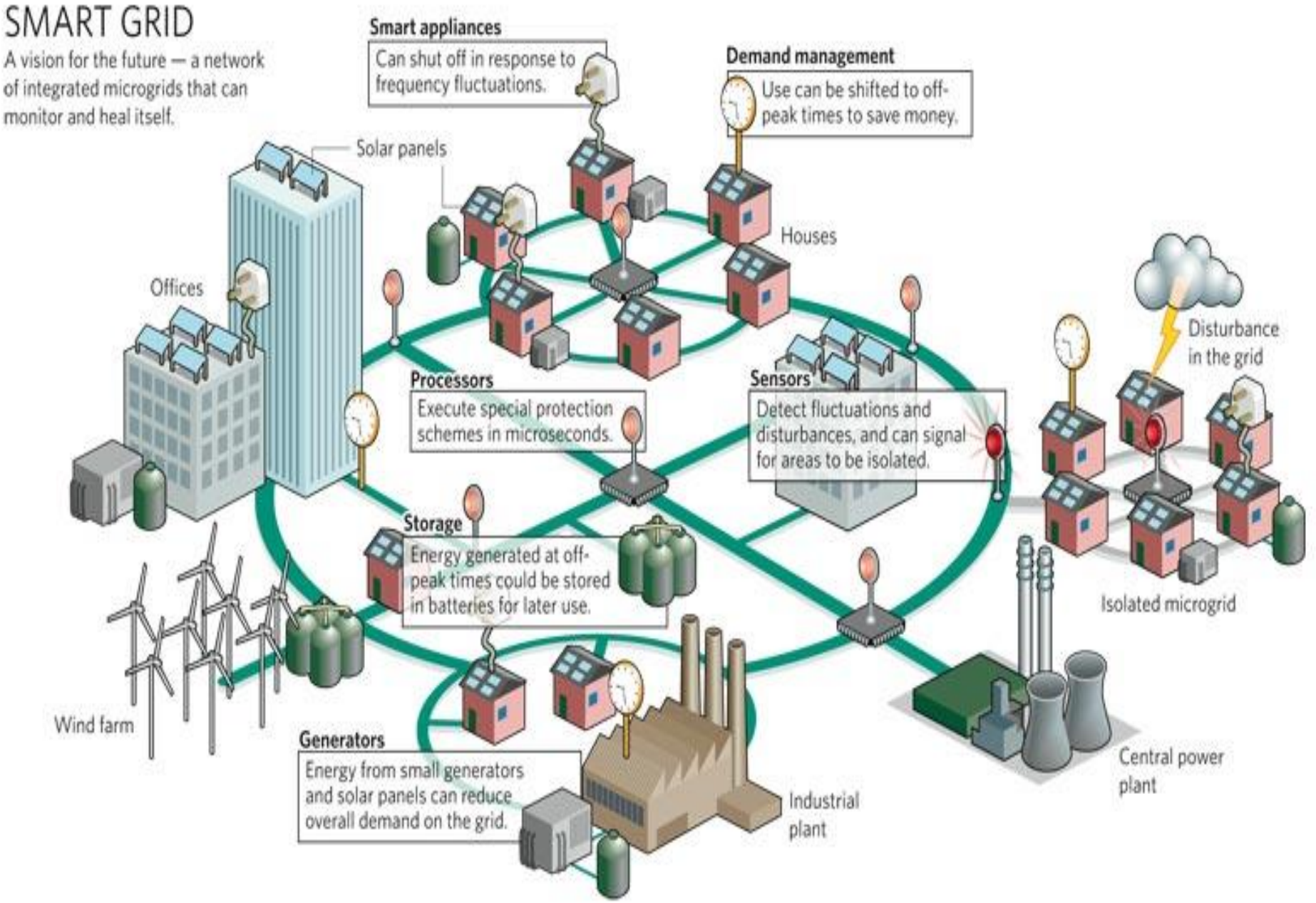
Microgrid of smart buildings

Stephen Hsu
Professor of Engineering and Applied Science
GW Energy Institute
George Washington University

stevehsu@gwu.edu

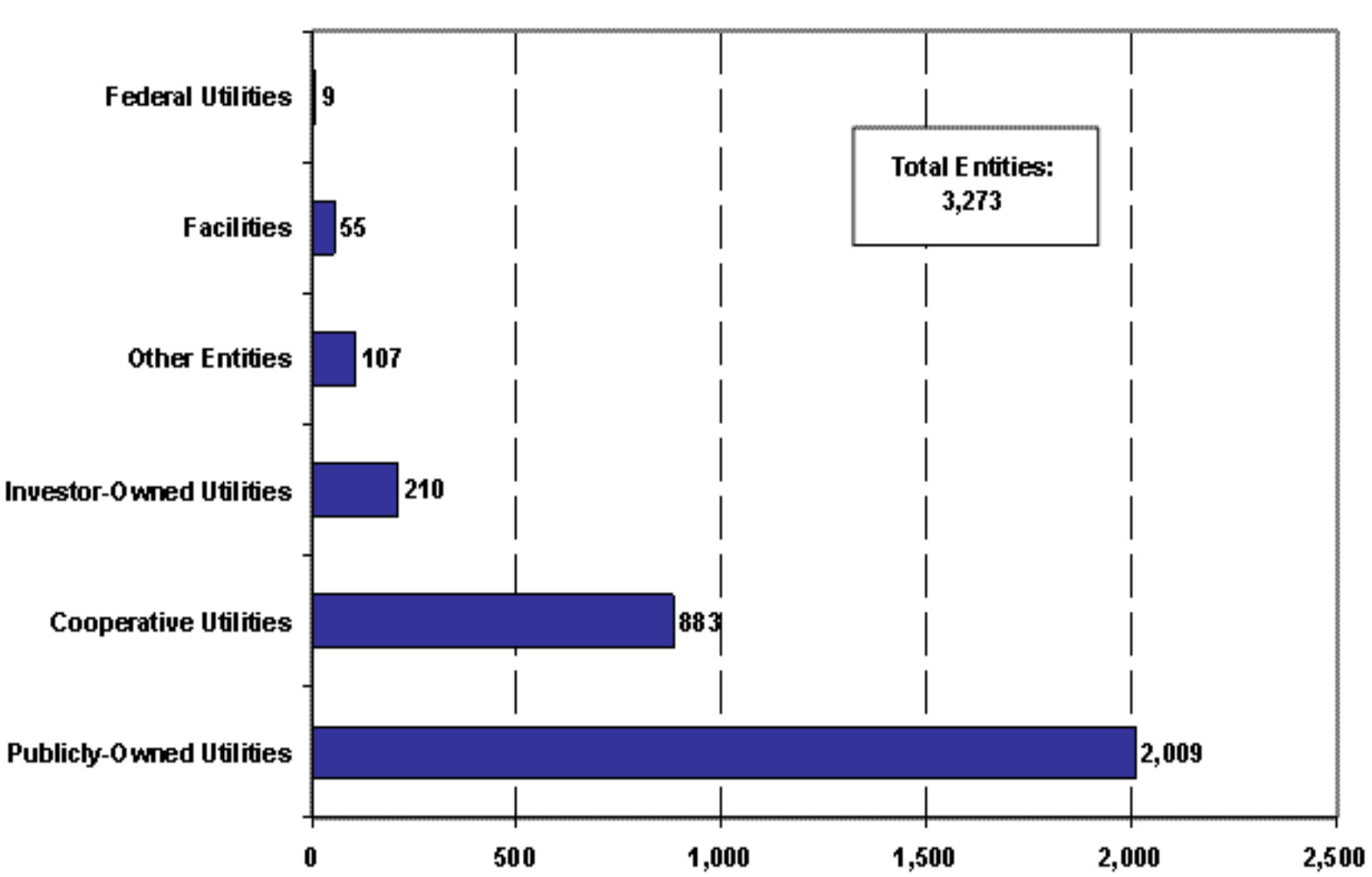


www.consumerenergyreport.com/.../smartgrid.jpg

Smart Grid

- Smart meters & two way communication
- Digital information made available to consumers, enable them to choose/decide
- What they use, when they use it, how much it cost per item at what time
- Grid operators can manage peak load demand, distribute energy to where is critical
- Encourage investment in energy conservation, efficiency improvements, green energy investment
- Enable optimized routing and quality of power
- Provide cost savings through efficient energy utilization
- Shared vision of energy management

Composition of Electric Entities in the United States, 2007



EIA

Microgrid Definition

General Definition

A microgrid is an integrated energy system consisting of interconnected loads and distributed energy resources which as an integrated system can operate in parallel with the grid or in an intentional island mode.

Key Defining Characteristics

The integrated distributed energy resources are capable of providing sufficient and continuous energy to a significant portion of the internal demand. The microgrid possesses independent controls and can island and reconnect with minimal service disruption.

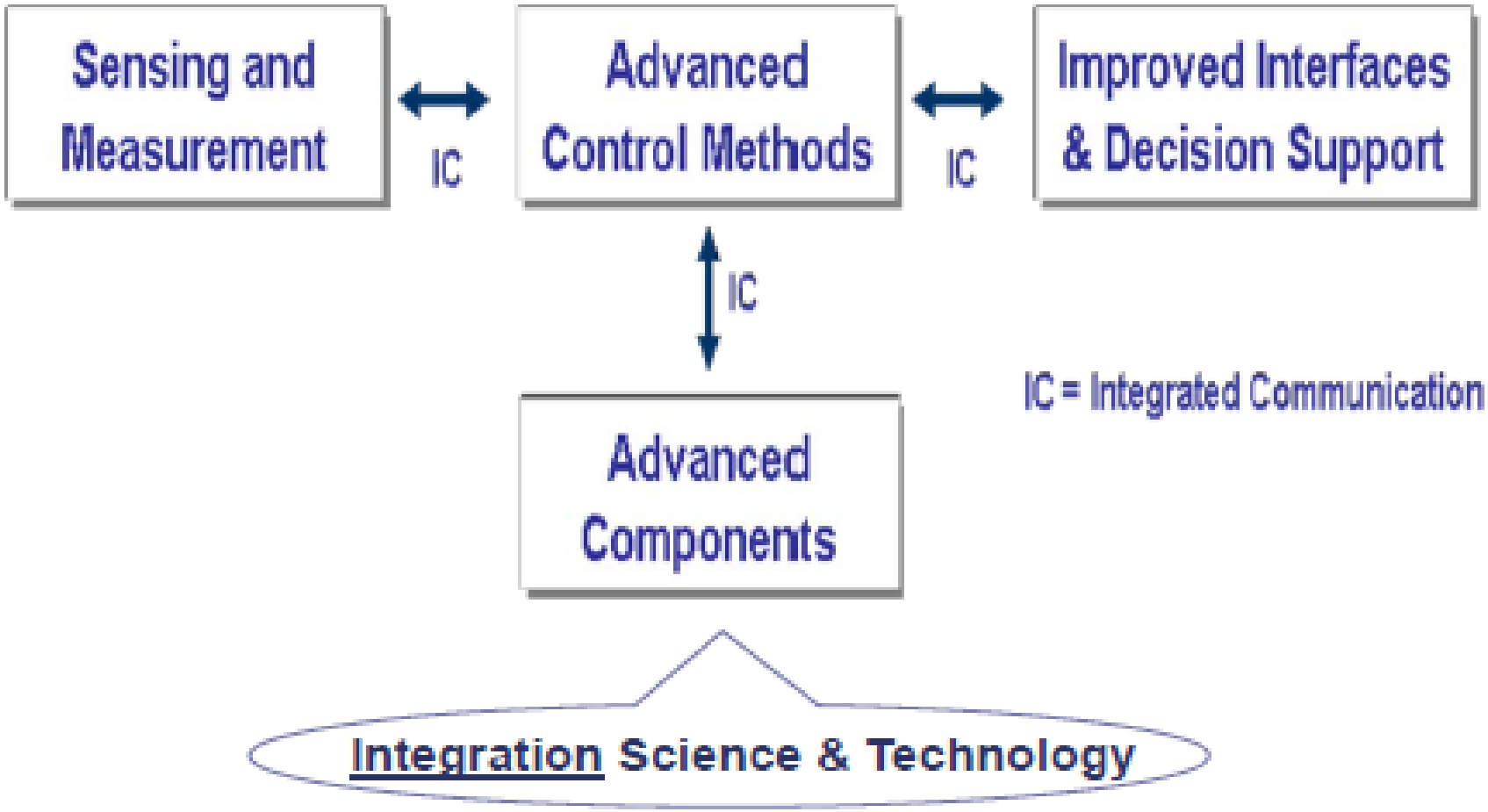
- Flexibility in how the power delivery system is configured and operated
- Optimization of a large network of load, local Distributed Energy Resources and the broader power system

DOE report 2005 Navigant consulting

Microgrid

- Power management within the boundary
- Single interface with utility company (cogeneration and/or islanding)
- Energy generation (energy on demand, district heating and cooling, renewable energy, etc.)
- Energy distribution and management (power quality)
- Cost savings through efficiency improvement in power management

Smart microgrid Research



After NETL

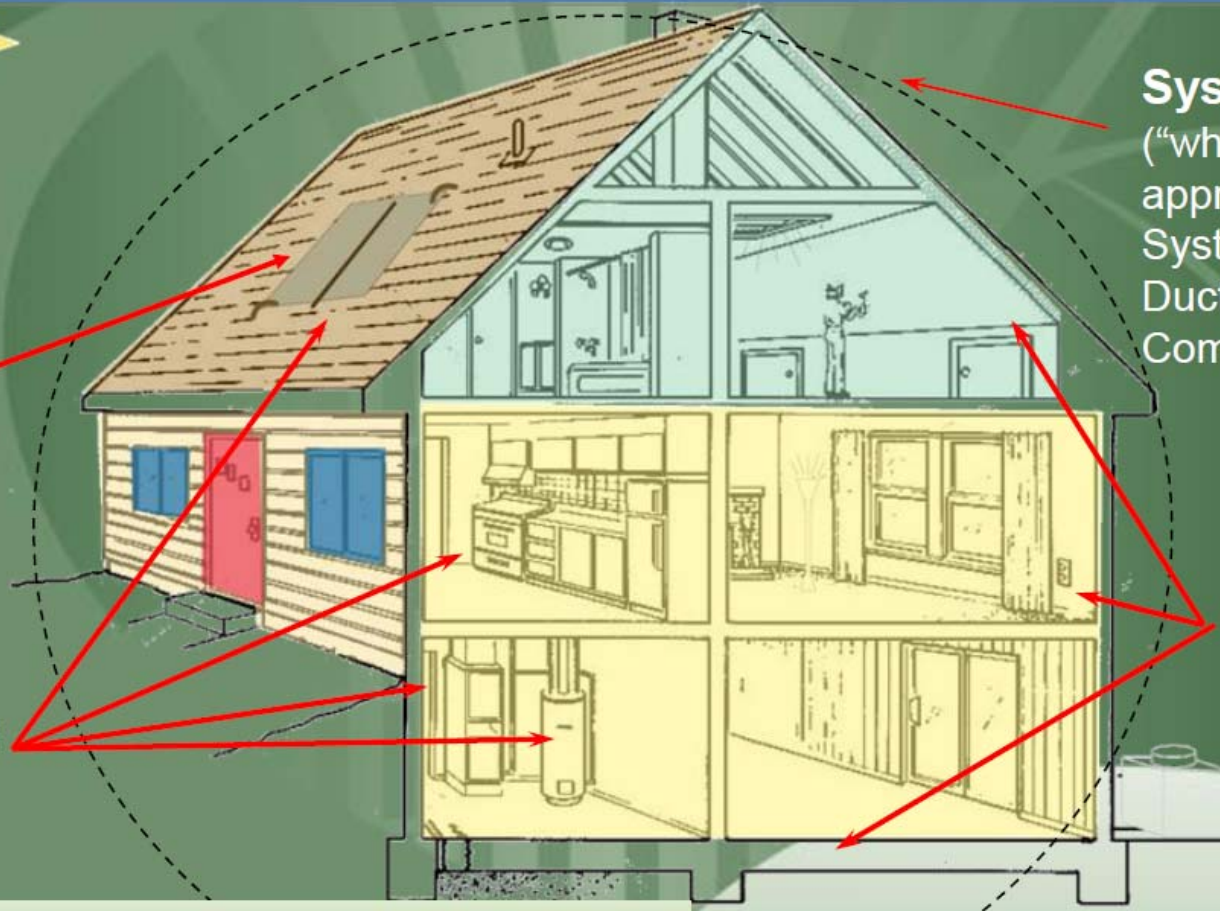
CERTS (Consortium for Electric Reliability Technology Solutions) microgrid demonstration projects

- Peer to peer, plug and play
- Direct energy generation
- Energy storage
- Renewable energy generation
- Inverter short circuit tests
- Power quality
- Efficiency improvement
- Operability and stability
- Sponsored by DOE, CA energy commission

CERTS Microgrid results

- Cost reduction: efficiency improvement through power management 2- 5% (highest case 10%)
- Reliability & power quality
- Security: parallel and island mode of operation
- Improved grid stability: when sufficient microgrids are linked, over all grid stability will increase
- Technology test platform for reliability and robustness
- Economic model verification
- Some systems with minimum renewal energy sources have little impact on carbon reduction

Energy Efficient Strategies for Homes



Systems
("whole-house" approach)
System Integration
Duct sealing
Combustion testing

Renewable Energy
Photovoltaics
Fuel Cells, Solar Hot Water, Geothermal

Building Envelope
Insulation, Windows, Walls, Floors
Air sealing

Equipment
HVAC equipment
Lights
Appliances

Reduce total building energy use by 60–70 percent

Highly efficient, cost-effective lighting technologies, air sealing advanced windows, appliances and space heating and cooling technologies.

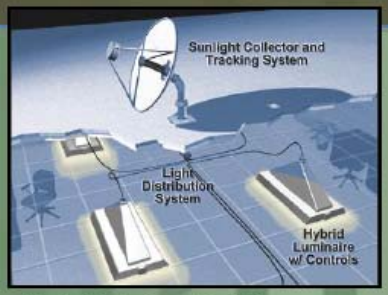
Net-ZERO
COUNTDOWN...NET-ZERO AND BEYOND

Dr. S. Shyam Sunder, NIST

SMH GWU

Future High-Performance Technologies

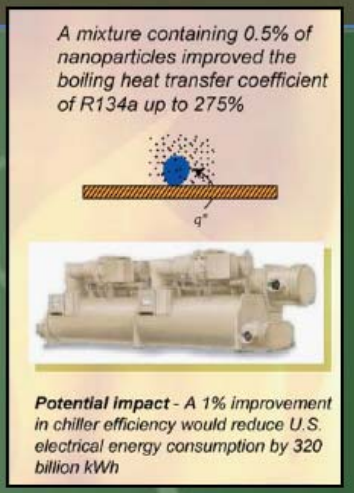
Lighting Systems
- **Solid State Lighting**
- Intelligent natural daylighting distribution systems



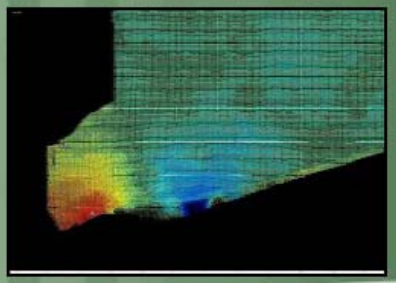
Hybrid Solar Lighting

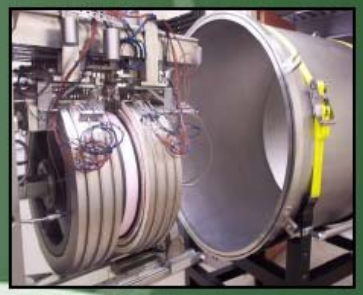
Building Envelope Systems
- Dynamic response (shades and electrochromic windows)
- Highly insulating façade systems
- Natural lighting technologies/designs (Green)


Solar Tracking Facility to Characterize Performance of Photovoltaic Cell Technologies



Intelligent Systems and Controls
- Diagnostic and real-time monitoring tools
- Sensors for improved building monitoring
- Grid/consumer supply/demand integration


Particle Image Velocimetry Image of Air Flow Distribution through Heat Exchanger


NIST's 0.5 meter Guarded Hot Plate Capable of Providing Measurements of Thermal Insulation from 90 to 900 K

Heating, Cooling, and Refrigeration


Boric Acid Nano Lubricant

- Nano-fluids and lubricants
- Thermally-activated heat pumps
- Distributed refrigeration/water-source heat pump
- Thermoelectric cooling
- Frostless heat pump
- Improved residential HVAC air distribution systems

Net-ZERO
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SMH GWU

Smart buildings (new or retrofit)

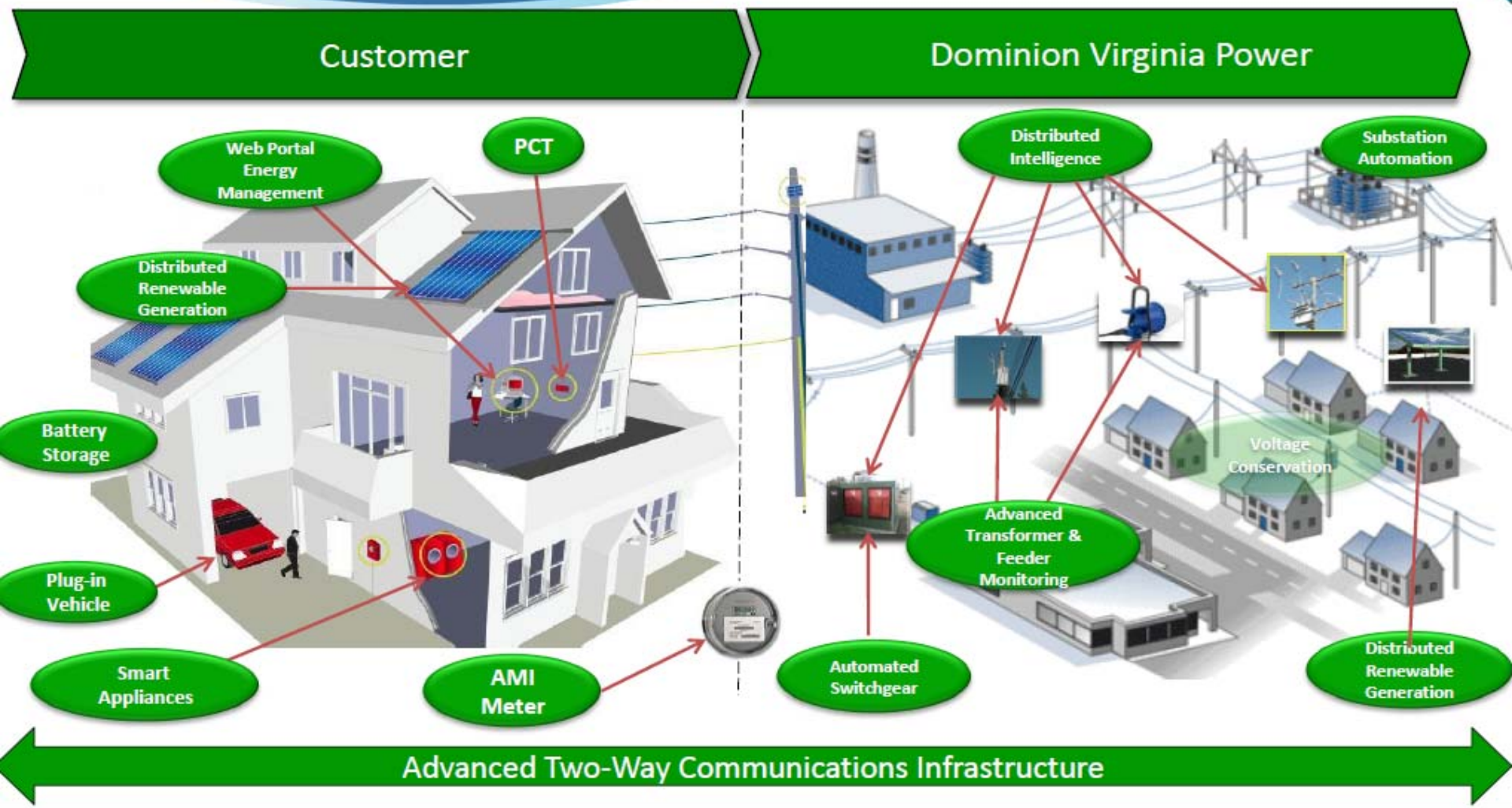
- Smart windows
- Increased insulation through high performance materials
- Envelope modifications
- Advanced HVAC; sensor signal activated flow
- Solar panels, solar glazing
- Geothermal assisted heat pumps
- Geothermal heat sources where feasible
- Combined CHPs
- Smart energy control programs
- Green roofs, new materials, smart control programs

Controllable shades

Demonstration projects being planned

- GWU Ashburn Virginia campus
- Multi-technology test-bed
- Open architecture control program
- Power management efficiency improvement
- Energy conservation device insertion
- Energy efficiency improvements
- Compatibility of devices, interactions between power control and smart building technologies

Tomorrow's Integrated Smart Grid



Alternative Energy Solutions: Technology Priorities

- "Smart Grid"
- Distributed Generation
- Electric/Hybrid Vehicles
- Solar
- Wind
- Storage
- Integrated Microgrids

Dominion Power