Smartgrid/smart Microgrid + NZB technologies

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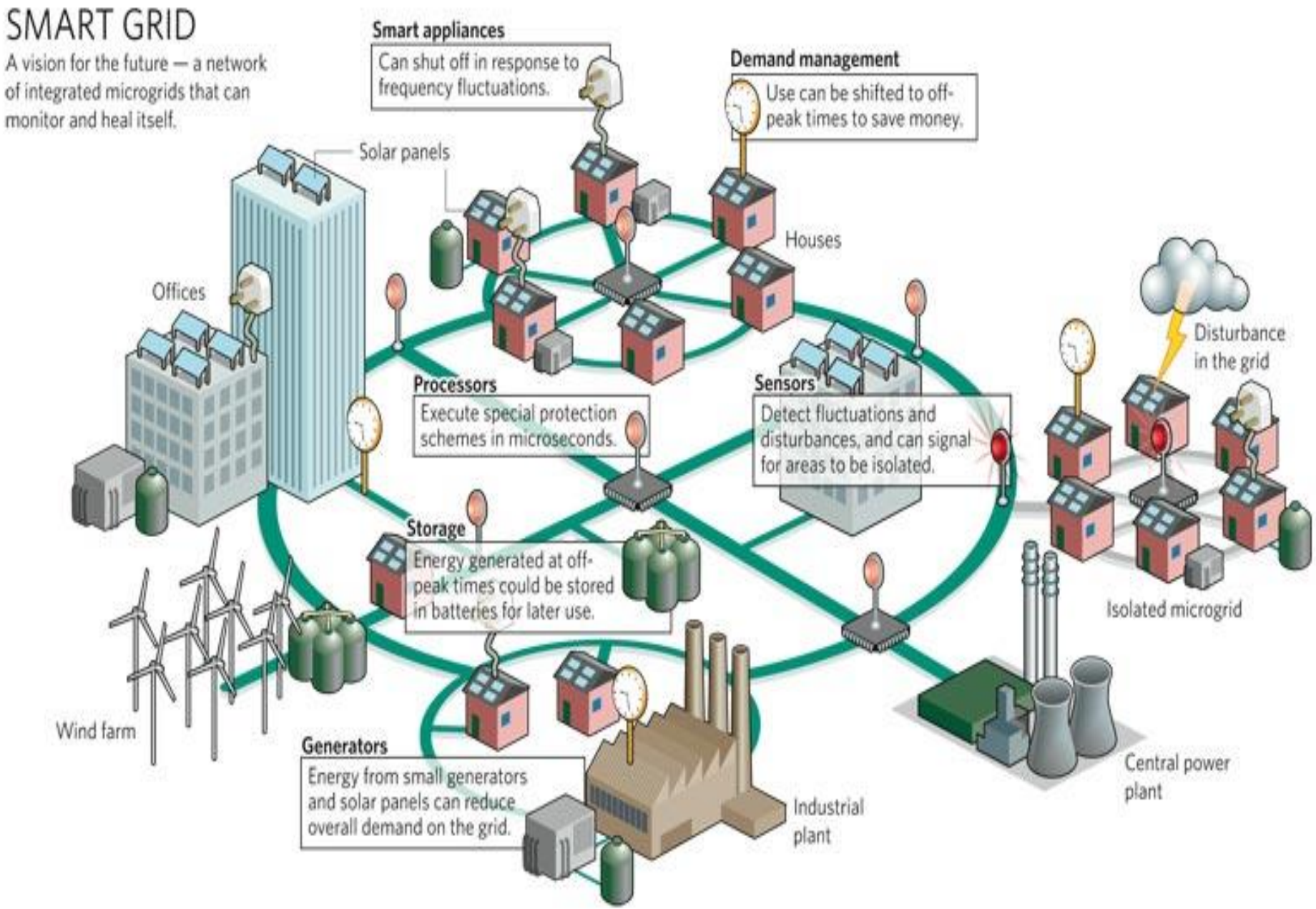
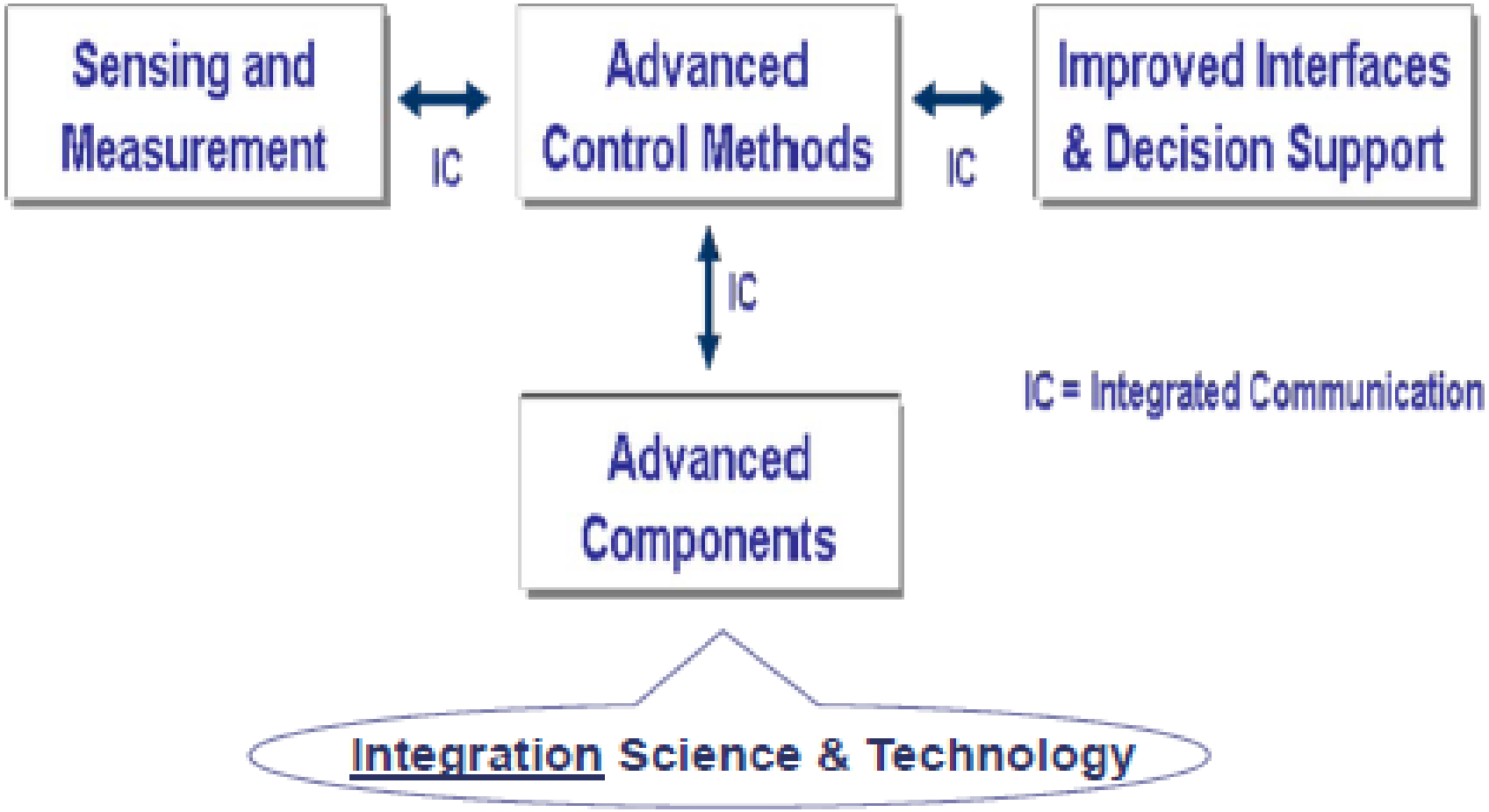
Smart Grid

- 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
- Enable investment in energy conservation, renewable energy investment (grid, consumers)
- Enable optimized routing and control of power quality
- Encourage the formation of microgrids
- Shared vision of energy management



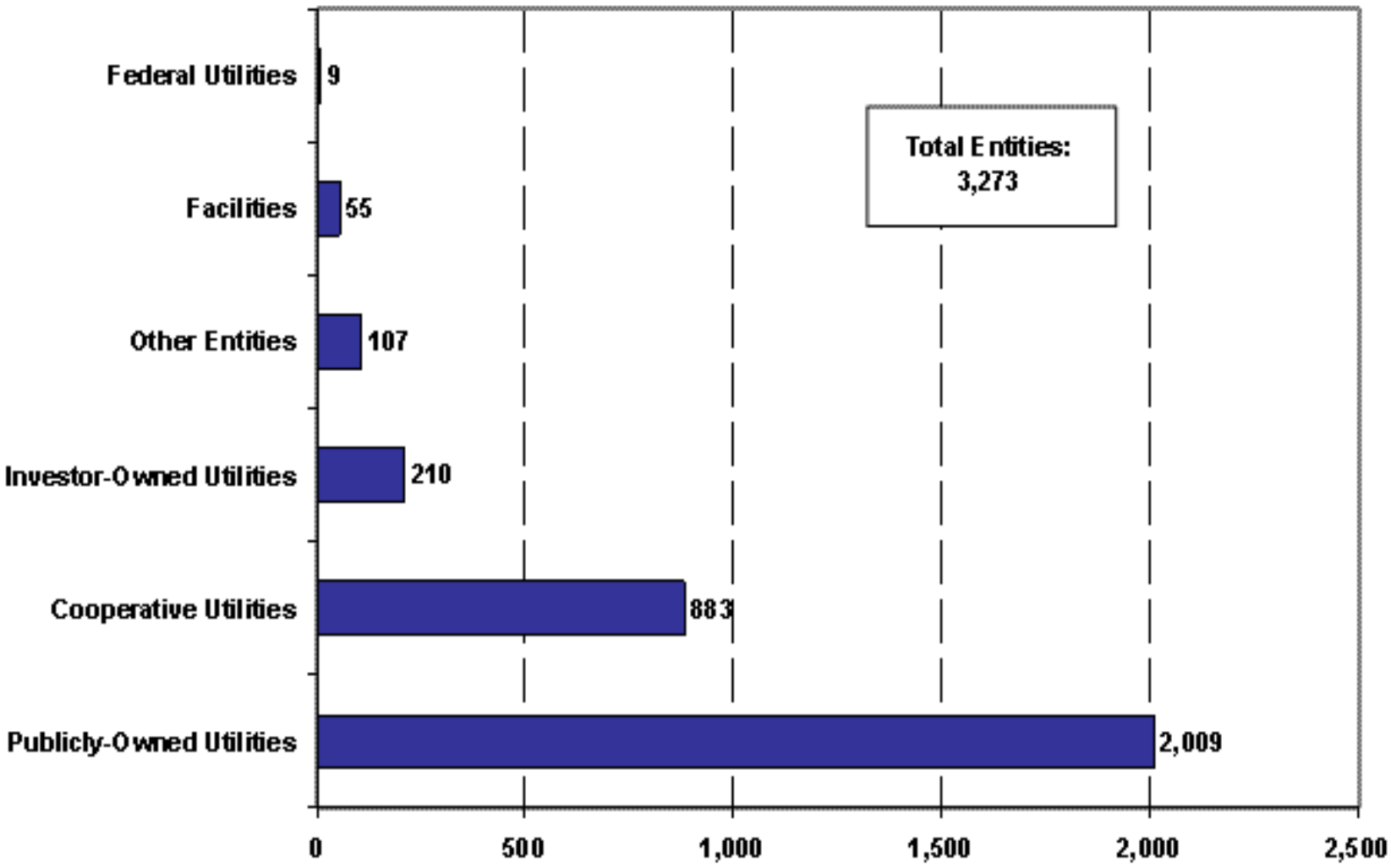
www.consumerenergyreport.com/.../smartgrid.jpg

Smart grid Research



After NETL

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

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Microgrid

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

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

- 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

The pilots would test different value propositions, scope and ownership options, and regulatory issues.

Phase 1 Pilots

Value Propositions Tested:
- Reduced Cost – Reducing the cost of energy and managing price volatility
- Reliability - improved reliability

Scope: Single facility and Multi-facility

Ownership: Landlord, Utility, Muni

Regulatory Focus
- Allow competition, while maintaining obligation to serve.
- Fairly compensate utilities for services provided and investments made

Phase 2 Pilots

Value Proposition Tested:
- Security - Increasing the resiliency and security of the power delivery system by promoting the dispersal of power resources

Scope: Multi-facilities, Feeder and Substation

Ownership: Utility, Muni

Regulatory Focus:
- Cost recovery of security investments

DRAFT

Phase 3 Pilots

Value Proposition Tested:
- Power System - Optimizing the power delivery system, including the provision of services
- Green Power - Managing the intermittency of renewables and promoting the integration of energy-efficient technologies

Scope: Feeder and Substation

Ownership: Utility, Muni

Regulatory Focus:
- Provide transparent compensation for environmental, system reliability, and homeland security benefits.
- Permit customers to see the real cost of electricity, which include real-time, location, and environmental attributes

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The pilots would also test the technology required to support the microgrid value propositions.

Phase 1 Pilots

Value Propositions Tested:
- Reduced Cost
- Reliability

Control System Focus:
- Primary – Internal
- Secondary – External

Technical Functional Reqs Tested:
- Design
  - Critical loads
- Performance requirements
- Monitoring and Control
- Protection

Technology Platform Focus:
- Fast Switch
- Power Electronics

Phase 2 Pilots

Value Proposition Tested:
- Security

Control System Focus:
- Primary – External

Technical Functional Reqs:
- Protection
  - Black Start Capability

Technology Platform Focus:
- Fast Switch
- Power Electronics
- Energy Storage

Phase 3 Pilots

Value Proposition Tested:
- Power System
- Green Power

Control System Focus:
- Primary – External
- Primary – Asset

Technical Functional Reqs:
- Design
  - Switching (generator/ load isolation)
  - Load transfer
- Monitoring and Control:
  - Support ancillary services
  - Control system algorithm
  - Communications infrastructure
- Protection
  - Auto synchronization with the grid

Technology Platform Focus:
- Energy Storage
- Demand Response
- Processing/Sensing

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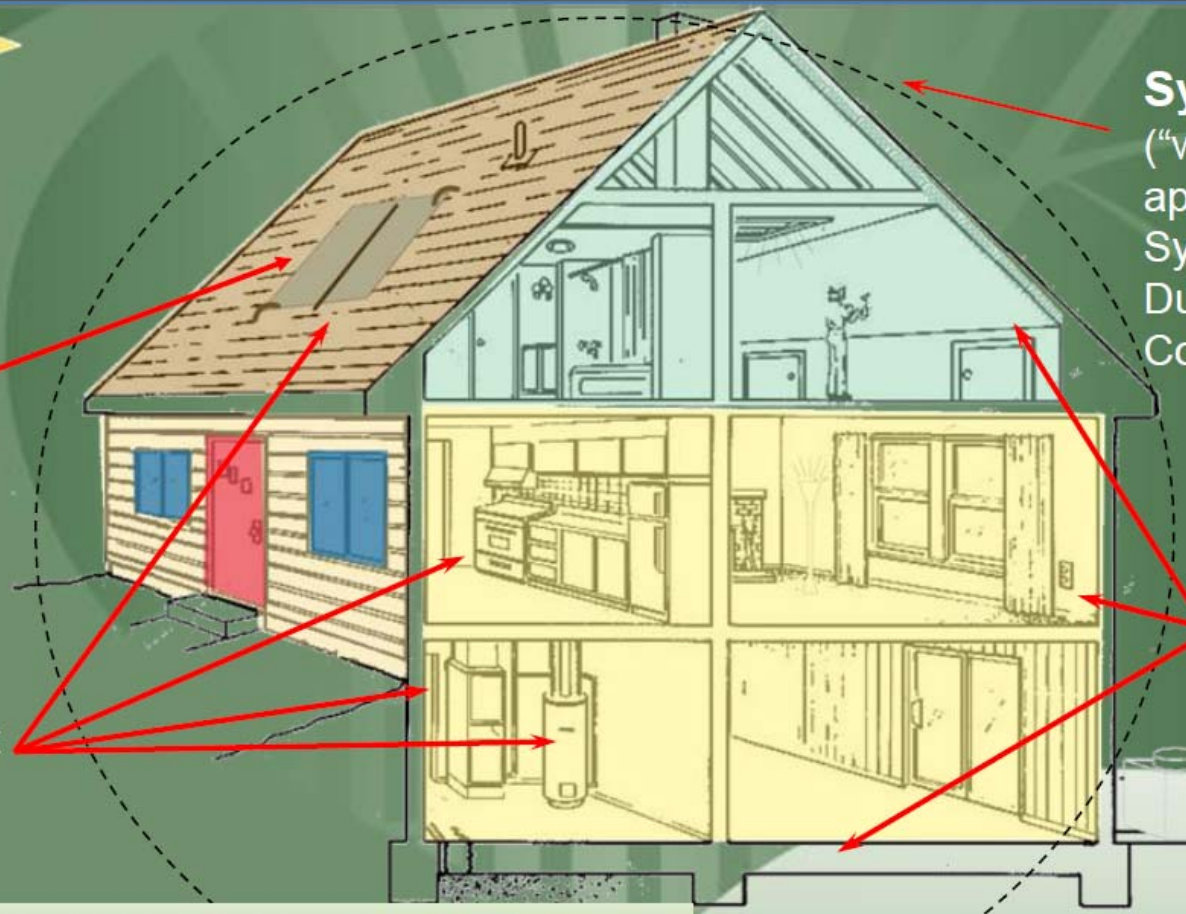
Microgrid provides

- Cost reduction: power management 2- 5% (10%)
- Reliability & power quality
- Security: parallel and island mode of operation
- Renewable energy: carbon reduction up to 40%
- Energy storage option
- Improved grid stability: when sufficient microgrids are linked, over all grid stability will increase
- Technology test platform for reliability and robustness
- Economic model verification

Energy Efficient Strategies for Homes



Renewable Energy
Photovoltaics
Fuel Cells, Solar Hot Water,
Geothermal

Equipment
HVAC equipment
Lights
Appliances

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

Building Envelope
Insulation,
Windows,
Walls, Floors
Air sealing

Reduce total building energy use by 60–70 percent

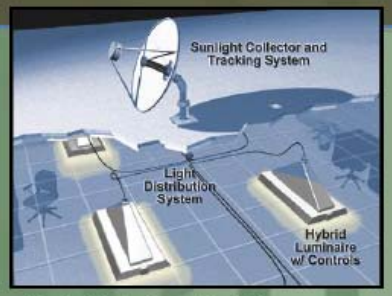
Highly efficient, cost-effective lighting technologies, air sealing advanced windows, appliances and space heating and cooling technologies.

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

Dr. S. Shyam Sunder, NIST

Future High-Performance Technologies

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

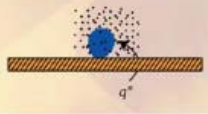


Hybrid Solar Lighting

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

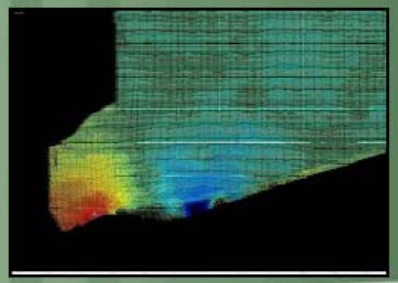
Solar Tracking Facility to Characterize Performance of Photovoltaic Cell Technologies

A mixture containing 0.5% of nanoparticles improved the boiling heat transfer coefficient of R134a up to 275%

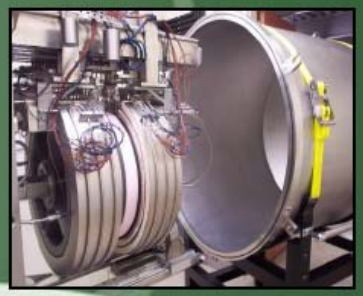


Potential impact *- A 1% improvement in chiller efficiency would reduce U.S. electrical energy consumption by 320 billion kWh*

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
- 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

Boric Acid Nano Lubricant

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

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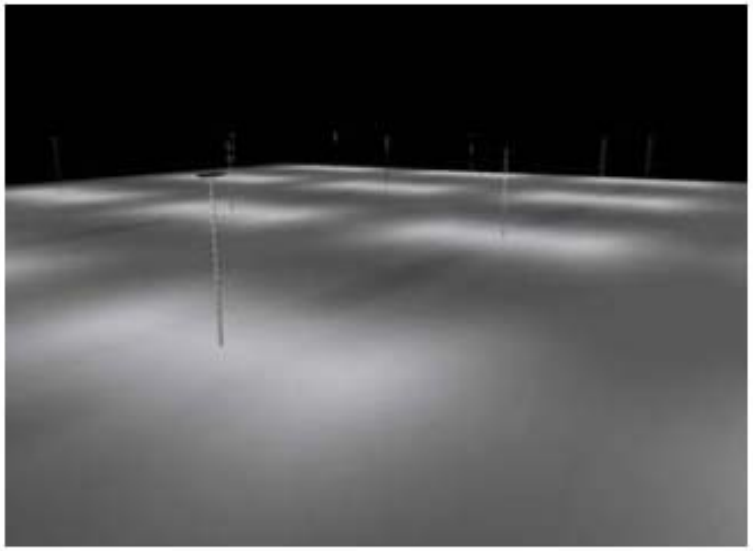
CBEA Technology Procurement: LED Outdoor Area (Parking Lot) Lighting

- Why LEDs make sense for commercial parking lots
  - Save energy
    - Enhanced luminaire optical efficiency
    - Better total system efficacy (lumens per watt)
    - Control capability, e.g., dimming
  - Reduced maintenance costs
  - Improved uniformity
  - Environmentally friendly
- Timing
  - REA working group established April 2008
  - Specifications completed by early 2009

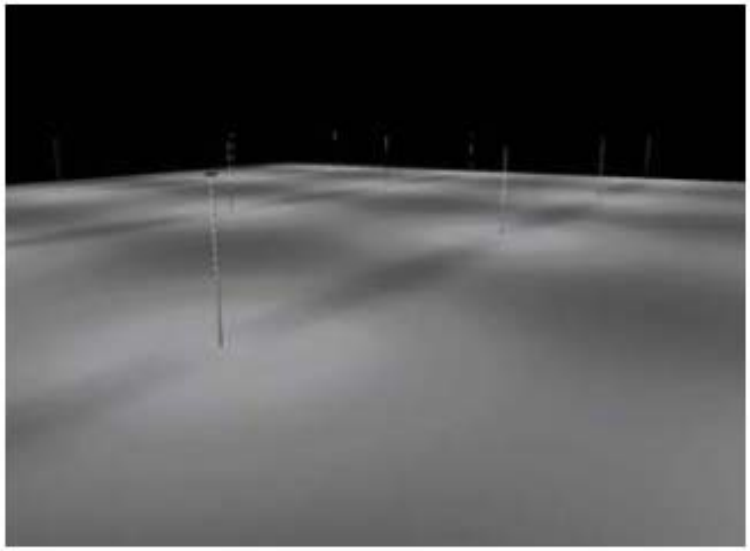
Design Criteria: Illuminance

MH Parking Lot



Average: 3.5 455W PMH
Maximum: 9.0
Minimum: 0.9
Max : Min: 10.0

LED Parking Lot



Average: 2.8 218W LED
Maximum: 5.2
Minimum: 1.2
Max : Min: 4.3

Linda Sandahl, Michael Myer, Eric Richman
Pacific Northwest National Laboratory,

Energy efficient building retrofit

- Smart windows; natural light; light pipes
- Increased insulation
- Local HVAC; motion sensor activated air flow; remote controlled dampers
- Solar panels, glazing, films
- Geothermal assisted heat pumps
- Geothermal heat sources where feasible
- Chillers
- Smart energy control programs
- Green roofs, new materials, smart controllers

How to establish a microgrid

- Define geographic boundary (multi-energy usage desirable)
- Multi-owner of properties may pose challenges
- Conduct an energy audit of existing buildings
- Negotiate with utility company for inter-connection and microgrid control
- Develop district heating and cooling options
- Develop energy efficient retrofits feasibility (green roof, natural lighting, micro-HCAC options, smart dampers, sensors, smart meters, partnership with building owners)
- Locality specific technology options (solar, geothermal, insulation, windows, etc)
- Instant-on emergency power
- Control program and energy management programs
- Security/efficiency/carbon reduction balance

Thank you for your attention

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