U.S. DEPARTMENT OF
ENERGY
Office of
Electricity Delivery
& Energy Reliability

The Role of Electricity in Smart Cities

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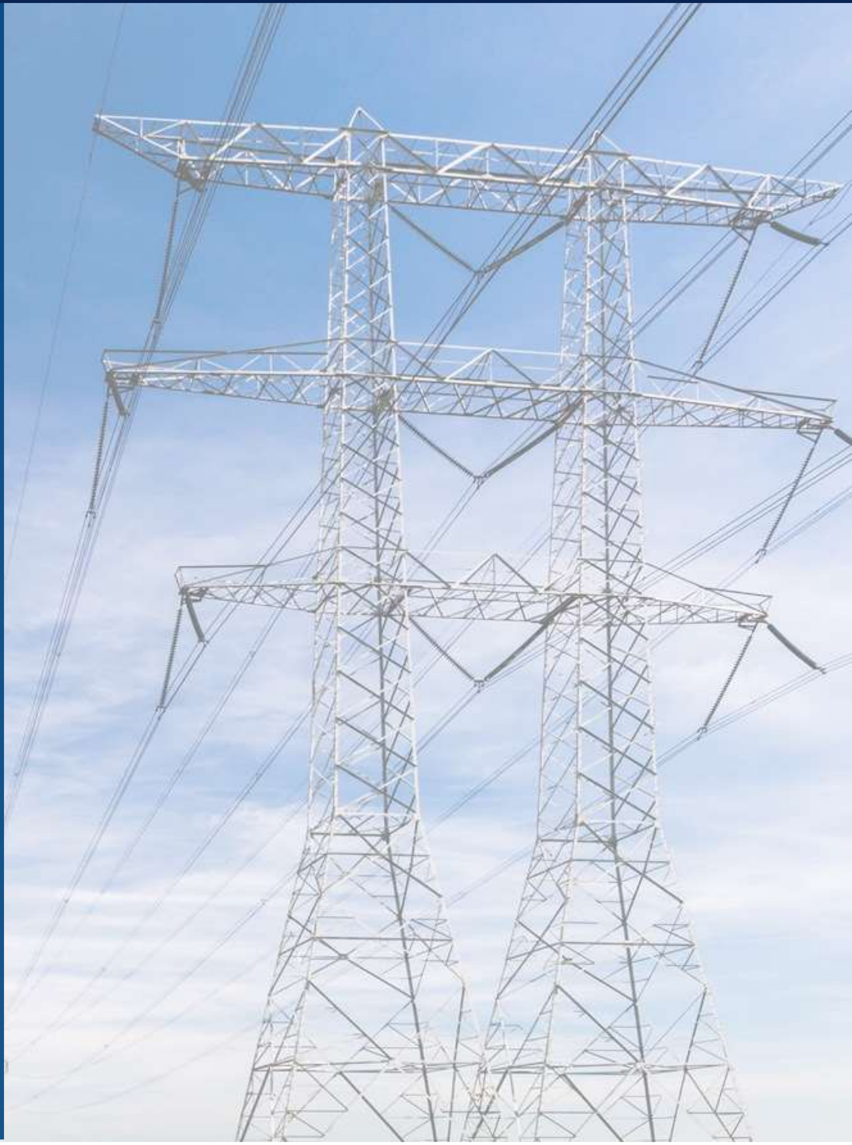
Date

Office of Electricity Delivery and Energy Reliability

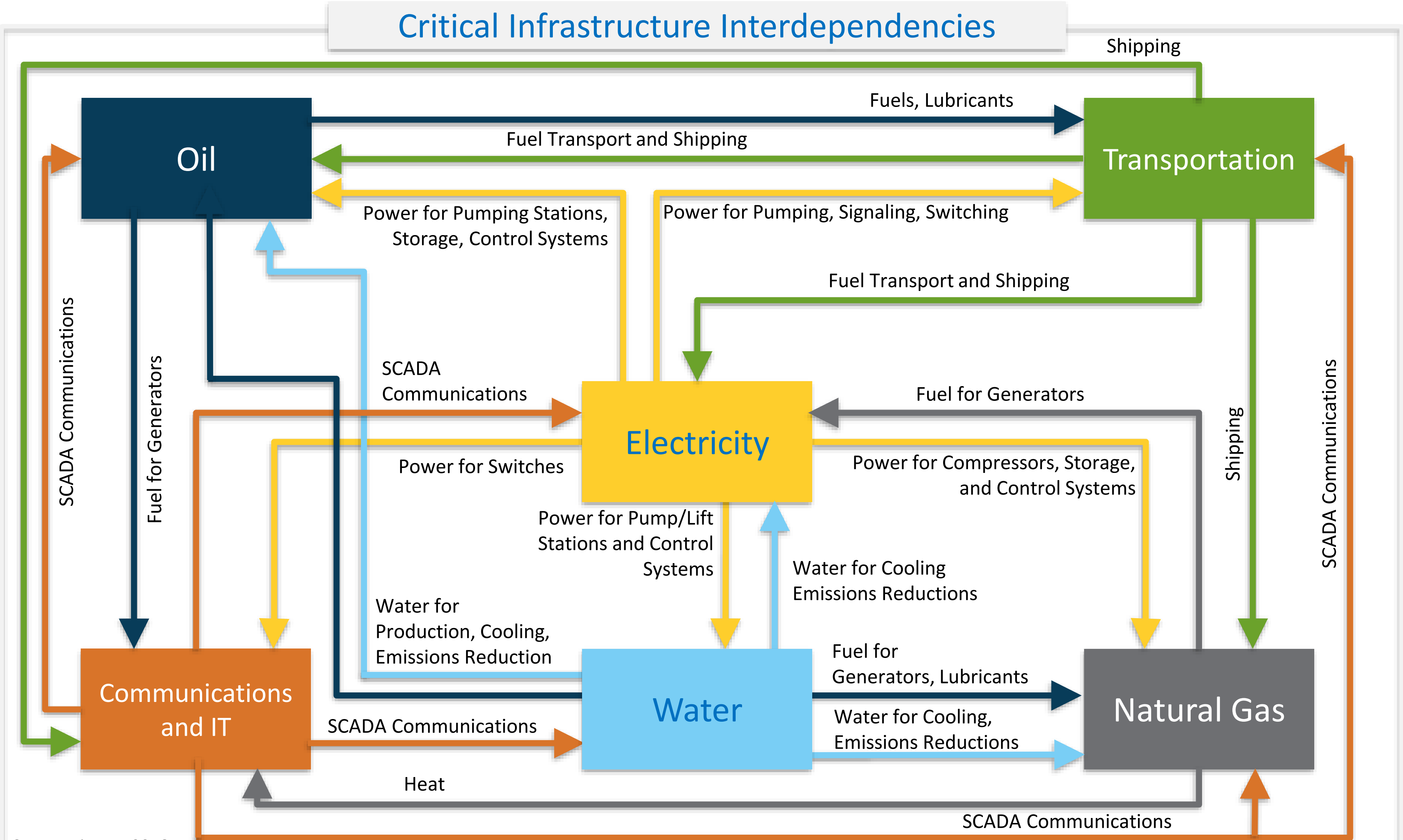
Strengthen, transform, and improve energy infrastructure so that consumers have access to reliable, secure, and clean sources of energy.

Advance electricity technology to provides a pathway towards American energy independence and domestic job growth.

Protect our nation by hardening and evolving the critical grid infrastructure that the American people and the economy rely upon.



U.S. Critical Infrastructures Depend on Electricity



Source: Finster, 2016

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Key Trends Driving Electricity System Changes

A changing mix of types and characteristics of electric generation

Growing demands for a more resilient and reliable grid

Aging Infrastructure

The emergence of interconnected electricity, information and control systems

Growing supply- and demand-side opportunities for customers to participate in electricity systems

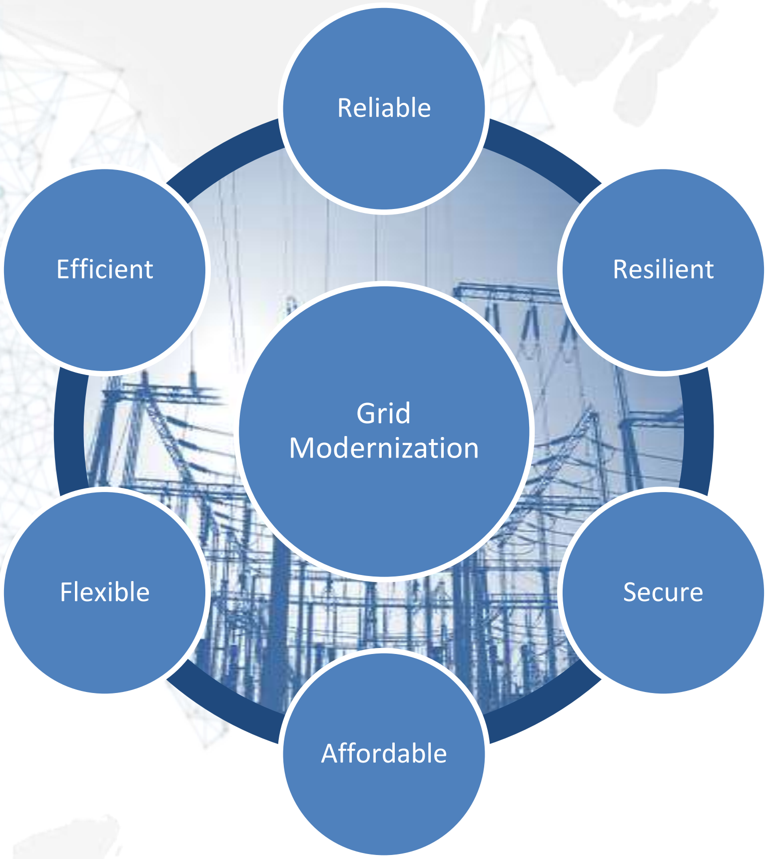
Smart Cities Definition and Common Challenges

Embedding new digital technologies into infrastructure and systems to enhance existing, and develop new, city/community resources and services.

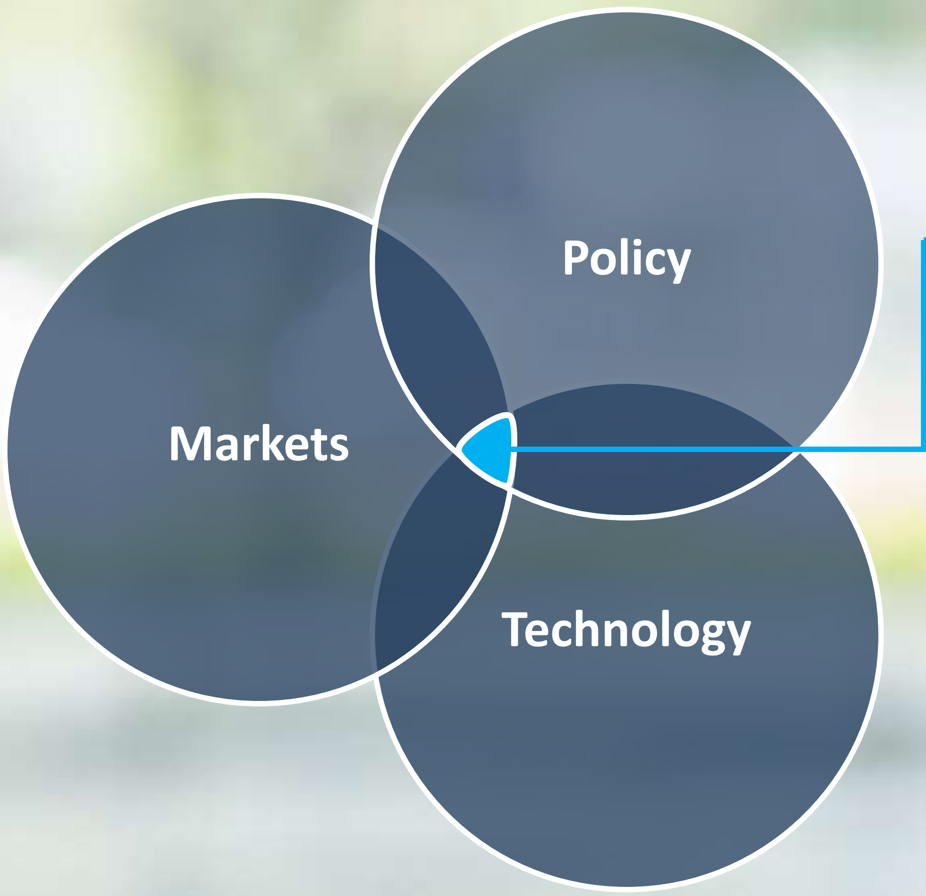
- Changing Populations
- Aging Infrastructure
- Growing Demands on Systems and Services
- Limited Space
- Ease of Low-Cost Transportation
- Support Across all Socioeconomic Statuses
- Resilience
- Security

Key Characteristics of a Modernized Grid

- **Reliable**
  Not prone to outage or disruption
- **Resilient**
  Smaller scale and shorter duration of disruptions if/when they occur
- **Secure**
  Able to mitigate and prevent damage from physical or cyber attack
- **Affordable**
  Deliver electricity at an economically-competitive price
- **Flexible**
  Actively respond to the variability and uncertainty of conditions at various timescales
- **Efficient**
  Enable the cost-effective utilization of all generation resources.

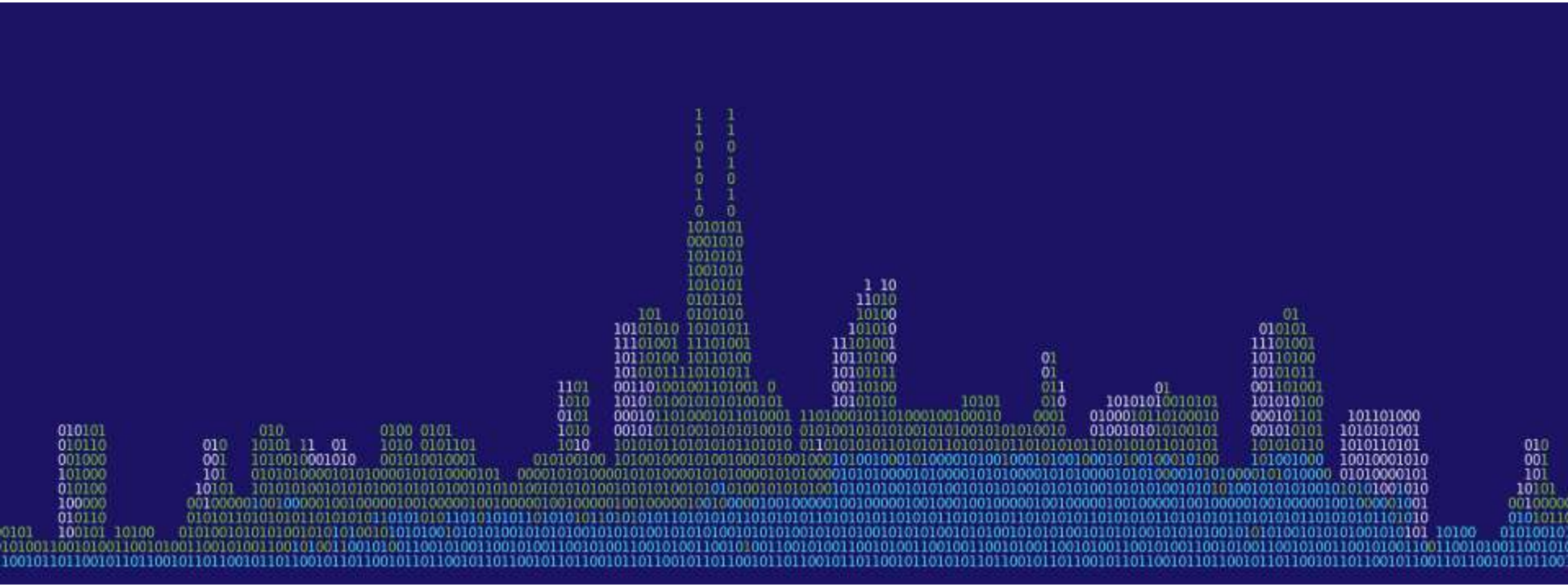


Grid Technology Commercialization

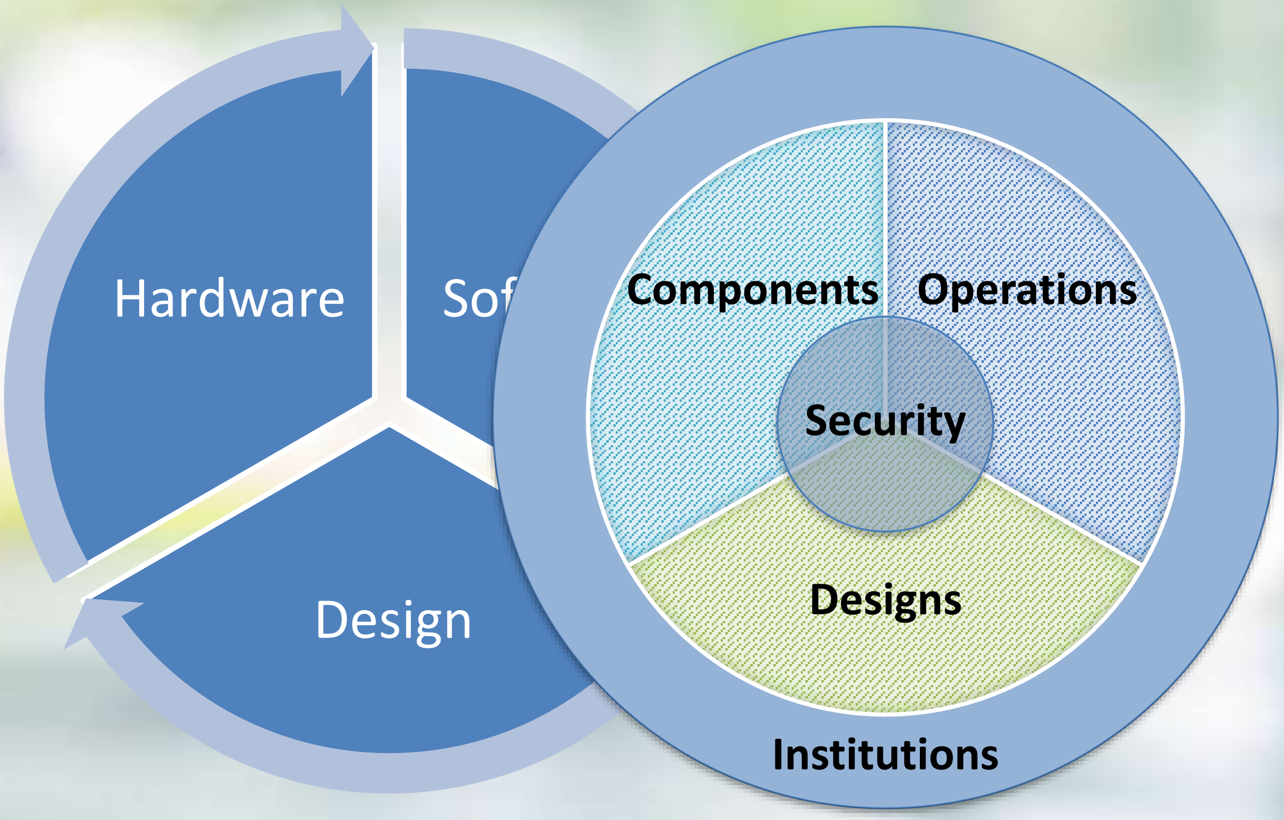


Interaction between Policy, Markets, and Technology.

Consider, the City as a machine.



System Engineering Principles

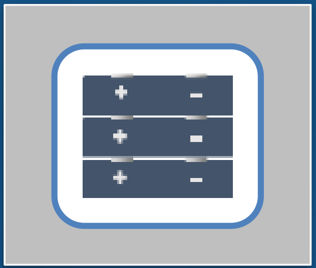


Advanced Grid R&D Technology Portfolio

Microgrids

Transactive Energy

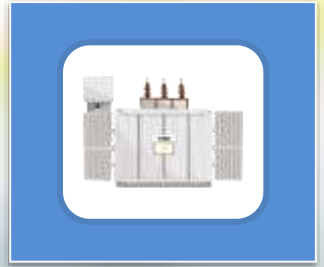
Advanced/Low-Cost Sensors



Energy Storage Systems

Synchrophasors

Advanced Grid Modeling



Advanced Power Grid Components

Advanced Distribution Capabilities

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Tailored Solutions: New Orleans Microgrid

NEW ORLEANS, LA

CHALLENGE

The heightened risk from hurricanes, floods, and other coastal disasters

SOLUTION

Identifying approaches to effectively use local distributed generation and renewable energy resources as well as cost-effective grid resilience enhancements can help reduce the severity of power outage impacts.

IMPACT

The City of NOLA, the local electric utility Entergy, and relevant stakeholders can use these conceptual recommendations to rank energy infrastructure improvement options and set improvement implementation and funding priorities.

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The Need for Microgrids

The grid needs to develop redundancy to protect critical infrastructure through the opening of additional value streams.

Sensitive loads are vulnerable to major disruptions.

Grid infrastructure needs to maintain reliability regardless of generation sources.

Intentional physical attacks could cause major damage.

Customers are seeking new opportunities to provide grid services to operators and tenants.

Microgrid Value Proposition

Microgrid Applications

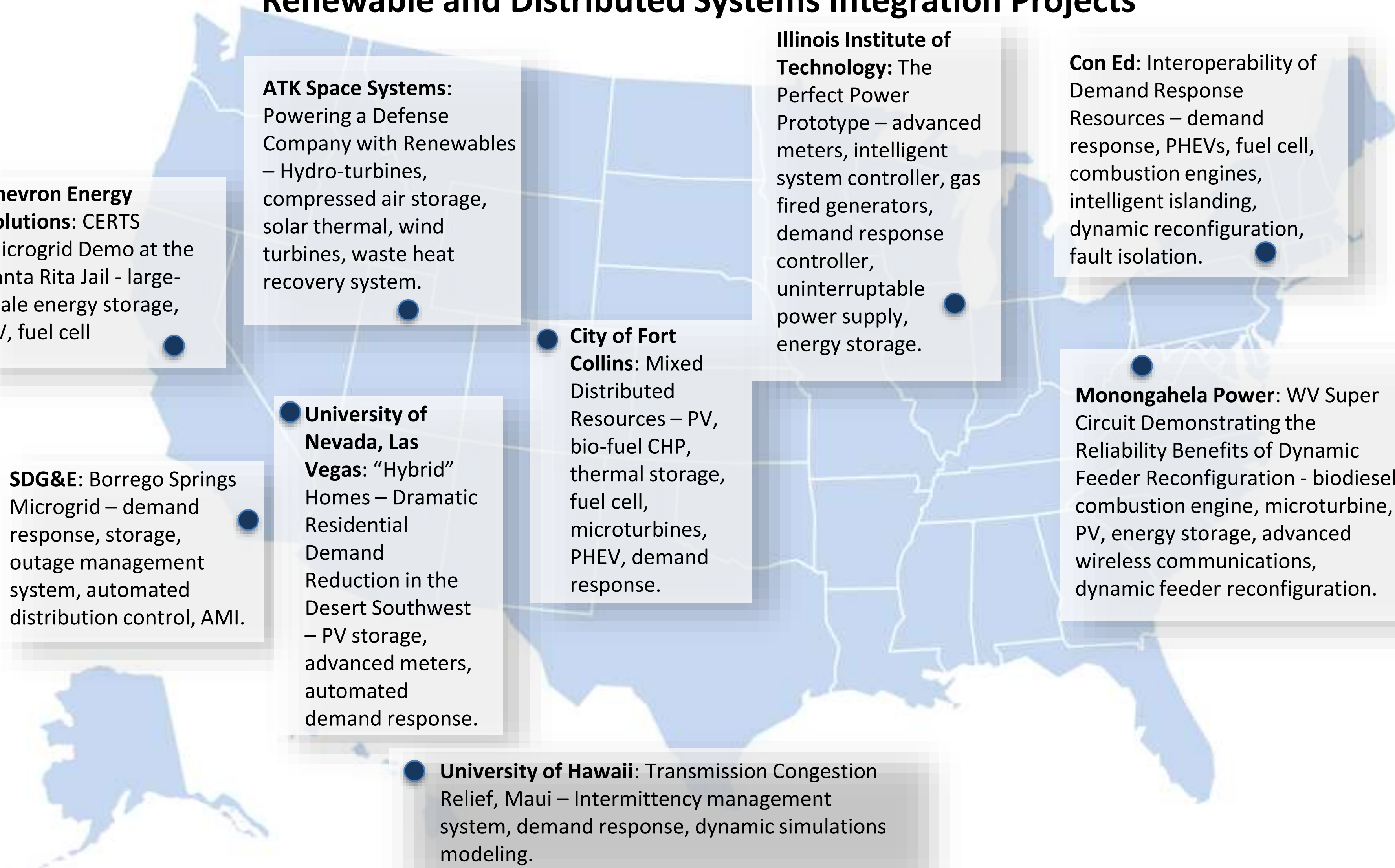
- Intentional islanding for safety and reliability
- Energy surety during outages and emergency conditions
- Peak-shaving and provision of other grid services (i.e. ancillary services, demand response)
- Enabling integration of distributed energy resources
- Enhance local reliability and power quality
- Smoothing of intermittent and variable resources
- Arbitrage of energy price differentials

Multiple Objectives

Flexibility	Maximizes electricity produced and consumed from all types of resources including renewables
Economic	Responds to real time changes in electricity prices to minimize total energy and operational costs
Reliability	Serves as a grid resource in grid connected mode and switches to island mode upon detecting a contingency
Resilience & Security	Ensures that critical loads can be served for sustained periods of time during and after catastrophic events

DOE Demonstration Projects

Renewable and Distributed Systems Integration Projects



Chevron Energy Solutions: CERTS Microgrid Demo at the Santa Rita Jail - large-scale energy storage, PV, fuel cell

ATK Space Systems: Powering a Defense Company with Renewables – Hydro-turbines, compressed air storage, solar thermal, wind turbines, waste heat recovery system.

Illinois Institute of Technology: The Perfect Power Prototype – advanced meters, intelligent system controller, gas fired generators, demand response controller, uninterruptable power supply, energy storage.

Con Ed: Interoperability of Demand Response Resources – demand response, PHEVs, fuel cell, combustion engines, intelligent islanding, dynamic reconfiguration, fault isolation.

SDG&E: Borrego Springs Microgrid – demand response, storage, outage management system, automated distribution control, AMI.

University of Nevada, Las Vegas: "Hybrid" Homes – Dramatic Residential Demand Reduction in the Desert Southwest – PV storage, advanced meters, automated demand response.

City of Fort Collins: Mixed Distributed Resources – PV, bio-fuel CHP, thermal storage, fuel cell, microturbines, PHEV, demand response.

Monongahela Power: WV Super Circuit Demonstrating the Reliability Benefits of Dynamic Feeder Reconfiguration - biodiesel combustion engine, microturbine, PV, energy storage, advanced wireless communications, dynamic feeder reconfiguration.

University of Hawaii: Transmission Congestion Relief, Maui – Intermittency management system, demand response, dynamic simulations modeling.

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