The Microgrid Phenomenon

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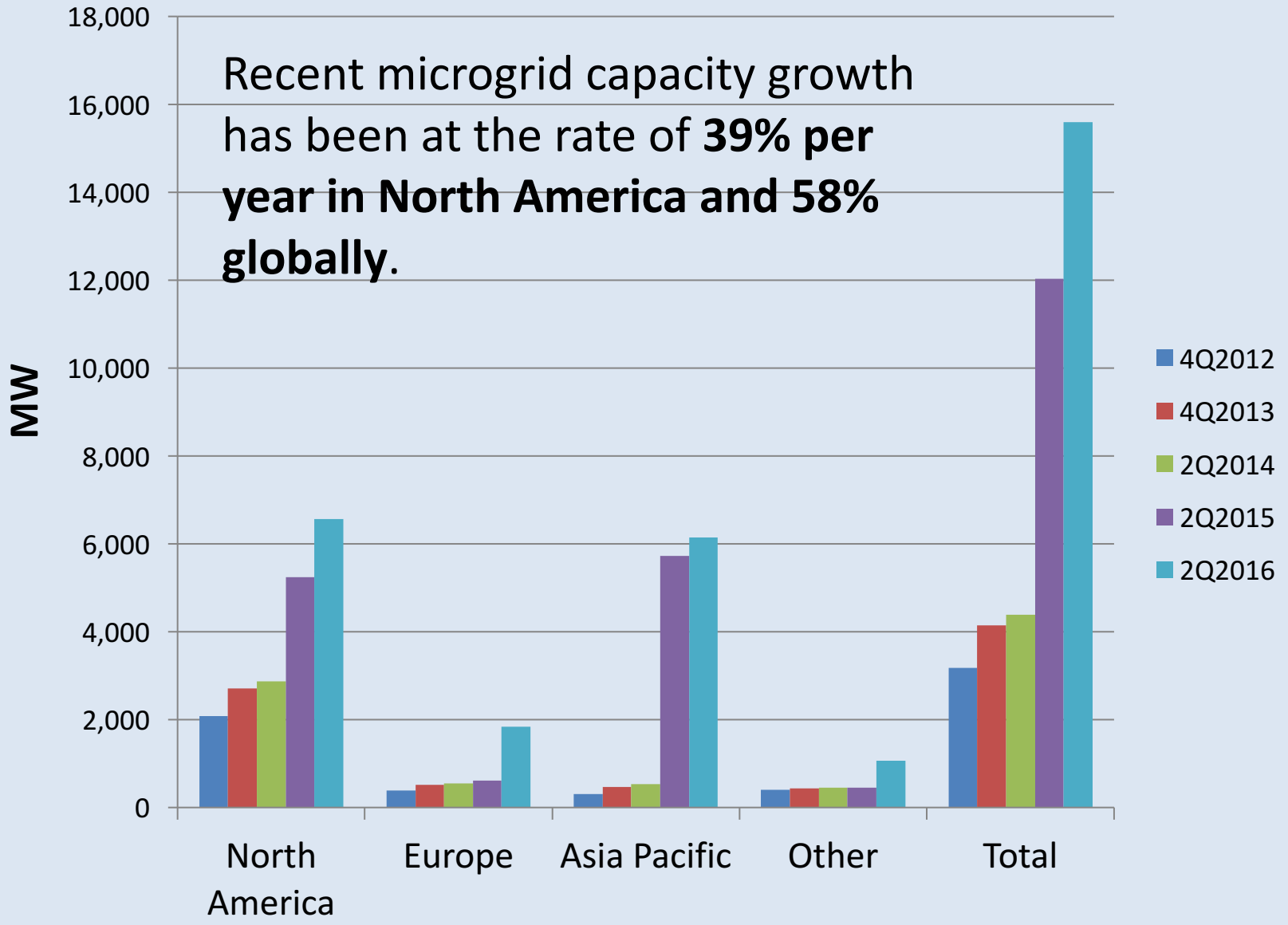
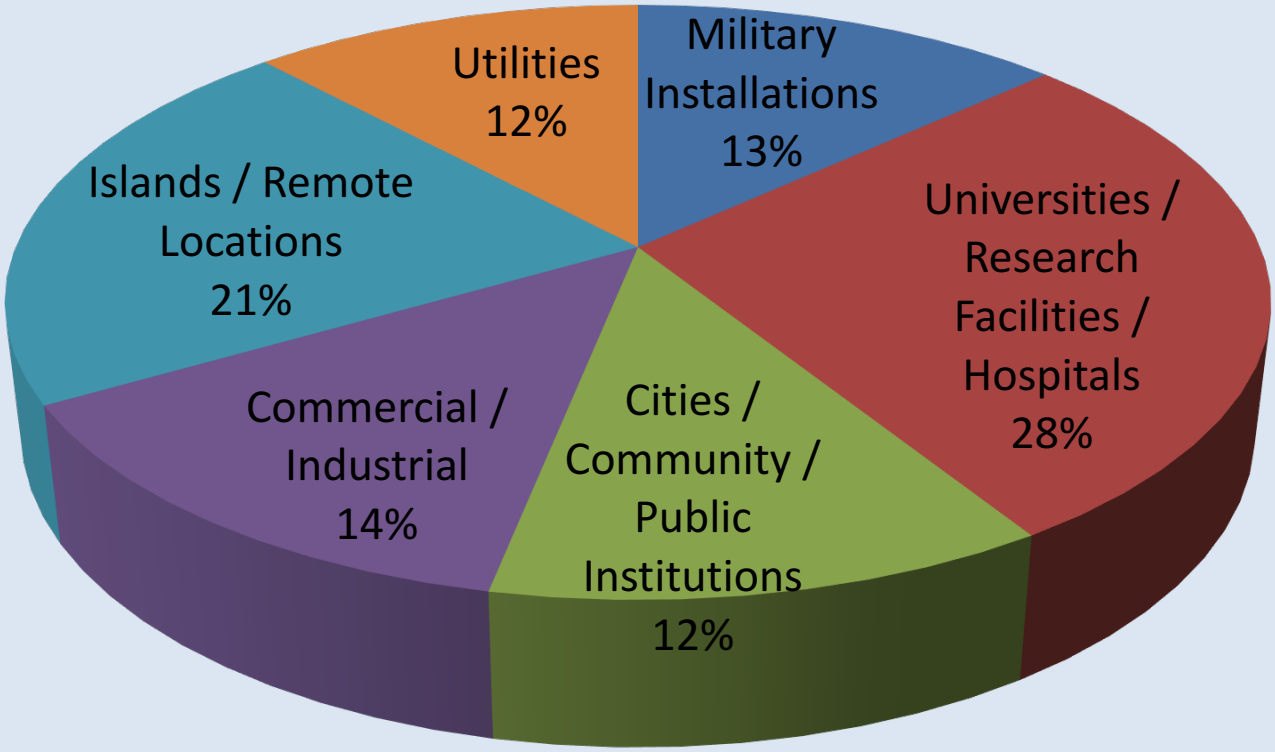
Global Trends in Microgrid Capacity



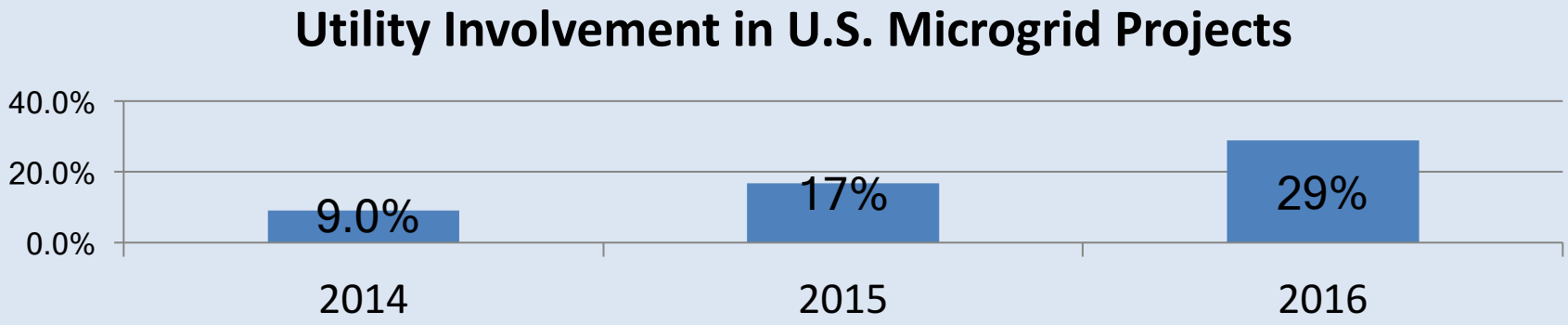
Source Data: Navigant

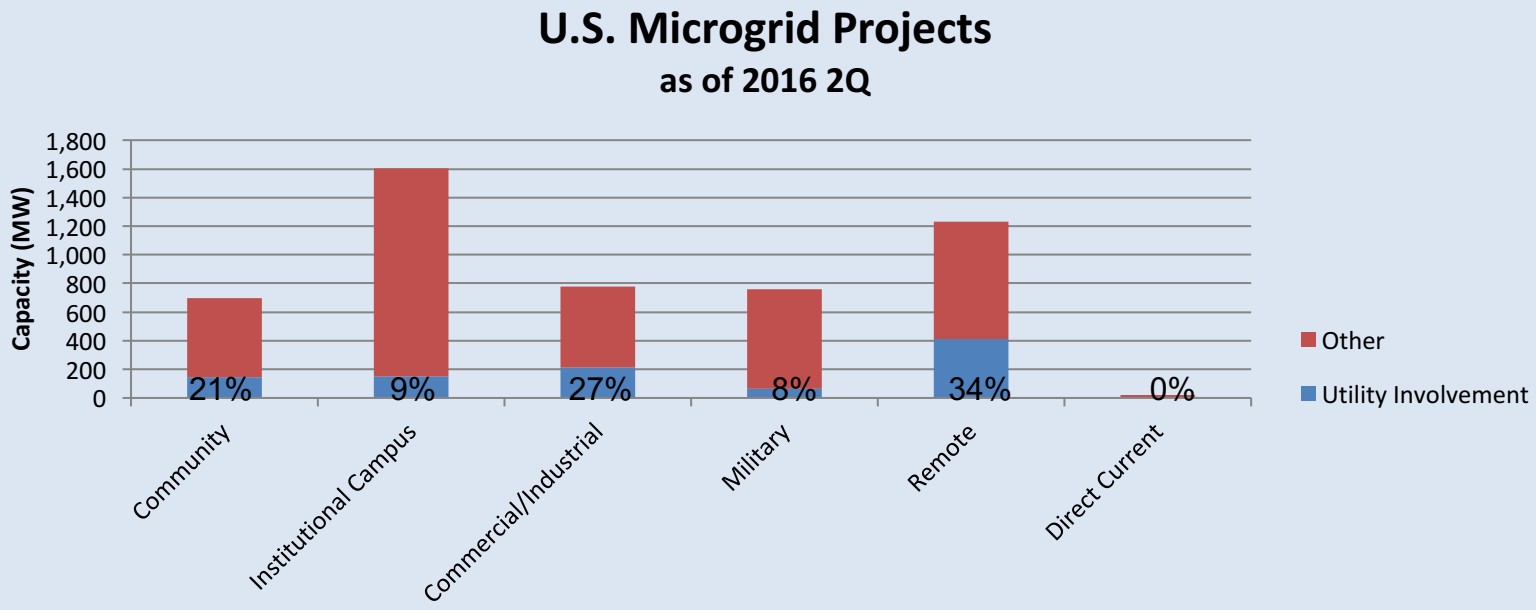
Who Is Building Microgrids in the U.S.?



Source Data: Navigant Research

Utility Involvement in Microgrid Projects is Growing Rapidly





Benefits for Utilities

- Improved system reliability
- New source of ancillary services
- Reduced needs for capital infrastructure investment
- Greater capacity to accommodate intermittent renewable resources
- **Ownership provides new revenue stream**

Benefits of Utility Involvement

1. Systems would be **less encumbered by legal and regulatory uncertainty** / could be deployed within the current regulatory framework
2. Uninhibited customer recruitment and participation would allow DERs to be **optimally sized**
3. **Cost savings** by avoidance of duplicate wires investment
4. Able to **leverage utility's knowledge and expertise** to strategically locate microgrids and maximize overall value to grid
5. Utility ownership will **prevent arbitrary cessation of operations and abusive or deceptive business practices**

Potential Areas for Partnering

Interconnection Facilities

System Design

Project Financing

Microgrid Management

Case Example: St. Paul Island Alaska

- **The Problem**: High electricity costs and reliability issues at the island's airport and accompanying industrial facility
- **The Solution**: TDX power installed a microgrid
  - A 225 kW **wind turbine**
  - Two 150 kW **diesel generators**
- **The Mechanics:**
  - Heat recovery from diesel generators used for space heating (CHP)
  - Excess wind energy diverted to secondary loads

Economics

- **Costs:**
  - **$1 million (with no grants)**
  - **Incremental O&M: $60,000/year**
- **Benefits:**
  - Reduced electricity charges: $200,000/year
  - Reduced diesel fuel costs
  - 99.9% system availability / less than 8 hours/year downtime

Case Example: Peña Station NEXT - Denver
A Public/Private Partnership

Five Core Elements

- 1 MW / 2 MWh Lithium ion battery system
- 1.6 MW carport solar PV
- 259 kV rooftop solar PV
- Panasonic's Denver operations hub building (serves as initial anchor load)
- Switching and control systems

Intended as pilot project under **Xcel Energy's $10.3 million battery demonstration project**.

Benefits/Services

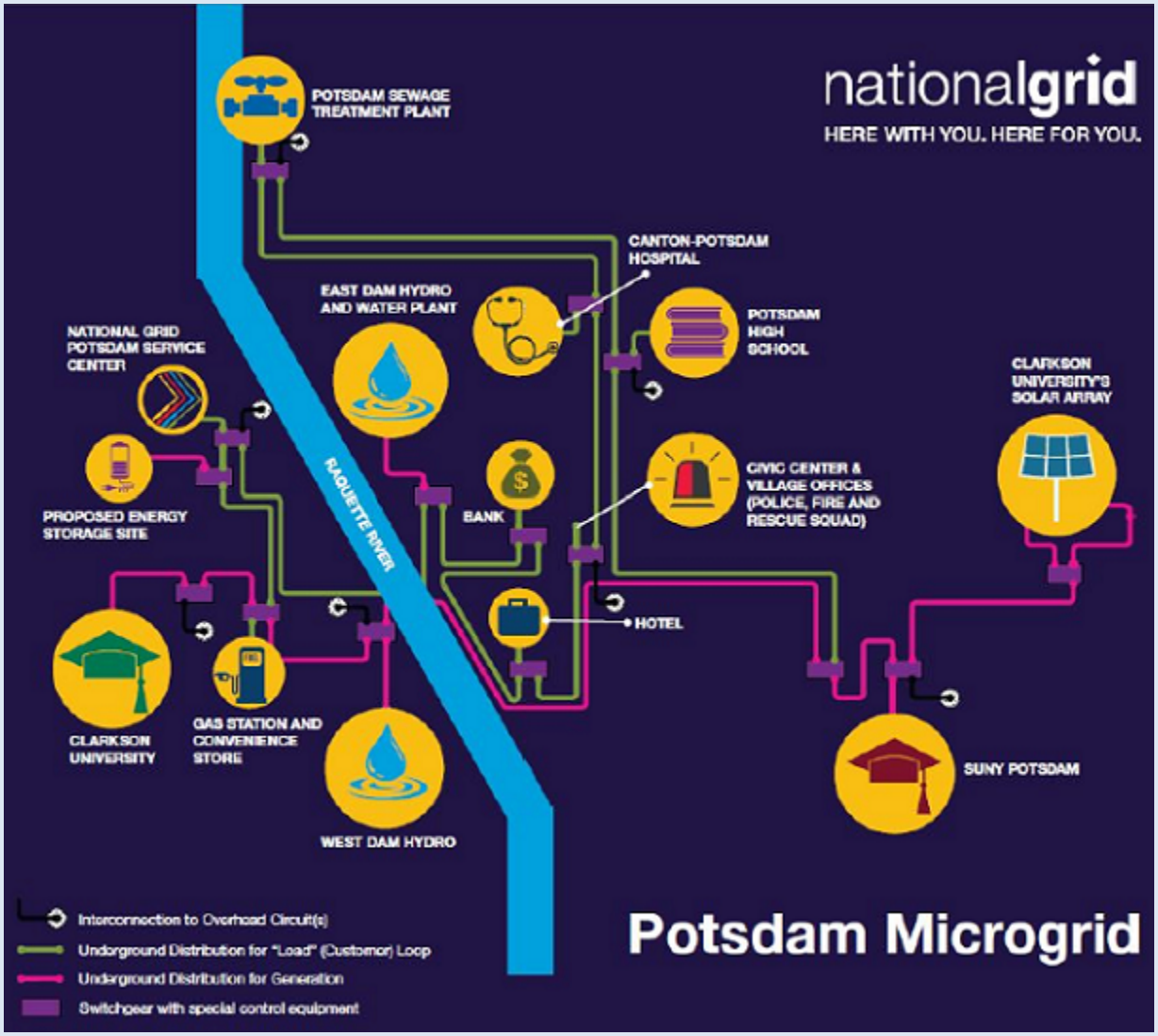
- Solar grid integration
- Grid peak demand reduction
- Energy arbitrage
- Frequency regulation
- Resilience through backup power

Other stakeholders:

- **Younicos** (advanced energy storage solution provider)
- City and county of **Denver** and **Denver International Airport**
- **L.C. Fulenwider, Inc.** (real estate developer)
- **Panasonic** (anchor corporate tenant)

Case Example: Potsdam, NY

- **The Problem**: Intense storms producing multiple-day outages
- **The Solution**: Potsdam resiliency microgrid serving critical facilities
- **Major Stakeholders:**
  - Clarkson University
  - SUNY Potsdam
  - Village of Potsdam Offices
  - Canton-Potsdam Hospital
- **Funding**
  - DOE: $1.2 million
  - GE: $300,000
  - NYSERDA: $381,000



Potsdam, NY Microgrid

Value Flow

Case Example:
Marine Corps Air Station Yuma

- Owned, Operated, and Maintained by **Arizona Public Service**
- Will provide **100% of facility's electricity** requirements during general outage
- **Provides grid stabilization and peaking power to general grid** during regular operations

- Project site covers **1 acre** of land
- **22 MW** generating capacity
- Currently powered by diesel engines, but **built to accommodate solar and energy storage**

APS Microgrid Projects

- Military Base
  - 22MW Tier 4 diesel generation
  - In service December 2016
  - 26 Autonomous Frequency Response events since February 2017
  - 1 dispatch for capacity event
  - Capable of adding energy storage and solar PV in future

- Data Center
  - 11MW Tier 4 diesel generation; Integrated UPS (Phase 1)
  - In service December 2016
  - 17 Autonomous Frequency Response events since April 2017
  - 1 dispatch for capacity event
  - Capable of adding solar PV and additional energy storage capacity
  - DC has requested to begin Phase 2 planning (Add 22MW)
  - DC full build out will be ~60MW

Case Example: Green Mountain Power, Stafford Hills, Vermont

- Built on a brownfield site as part of an urban revitalization effort in Rutland City, Vermont.
- Solar plus storage microgrid.
- 2 MW of solar panels
- 2.4 MWh battery

Green Mountain Power, Addison County Virtual Power Plant, Vermont

- GMP is a partner in this project.
- GMP installed solar plus storage microgrids on 14 homes – free of charge.
- The microgrids were installed for low-income tenants.
- GMP aggregates home microgrids into a virtual power plant that it can discharge during periods of high demand.
- *Project Goal – lower the transmission and capacity charges it pays to ISO New England & ease costs for low-income customers.*

The Microgrid:

A **"Foul Weather"** Friend!!!

The **Enchanted Rock** microgrid kept **21 convenience stores and gas stations** in the Houston area up and running during **Hurricane Harvey**.

A microgrid in St.Croix is still providing power after much devastation and general outages in the aftermath of **Hurricanes Harvey, Irma, and Maria**.

APS's two microgrids (Yuma Station and Aligned Data Centers) provided much needed peaking power during the **heat wave** in Phoenix last June.

Microgrids in Haiti facilitated restoration of power after **Hurricanes Irma and Matthew**.

Microgrid Issues for Utilities

- **Maximize stakeholder involvement** in design and subsequent phases of the project
- **"Level playing field"** for ownership of distributed energy resources
- **Cost recovery**: when is recovery through base rates justified?
- **Justification** of microgrid when reliability benefits provided by it are not least cost
- **Fully utilize available financing sources** (e.g., grants, prizes)

Microgrid Benefits

A Balancing Act

Private capital providers for microgrids must get a **return** on their investment, but microgrid users must have an **incentive** to be part of one.

Thank You!

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