



MICROGRIDS & VPPS

ASSOCIATION OF
MUNICIPALITIES OF ONTARIO
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NAVIGANT

ENERGY CLOUD IS MADE UP OF A DIVERSE SUITE OF DISTRIBUTED ENERGY RESOURCES (DER) TECHNOLOGIES

- Emerging infrastructure is far more **integrated, dynamic, and complex**

DISTRIBUTED GENERATION (DG)

Includes the generation of electricity from many small energy sources, including renewables; typically mass-produced, small, and site-specific

DIGITALIZATION OF THE GRID:

- Smart inverters
- Smart meters
- Advanced sensors, controls, and operation systems
- Behind-the-meter (BTM) technologies and solutions
- Demand response (DR)

MICROGRIDS AND VIRTUAL POWER PLANTS

Applications or groupings of distributed energy resources (DER) that operate either connected or independent from a traditional centralized grid

ENERGY STORAGE

Devices or physical media that store energy to perform useful operation at a later time; balance the supply and demand of energy; improve power quality

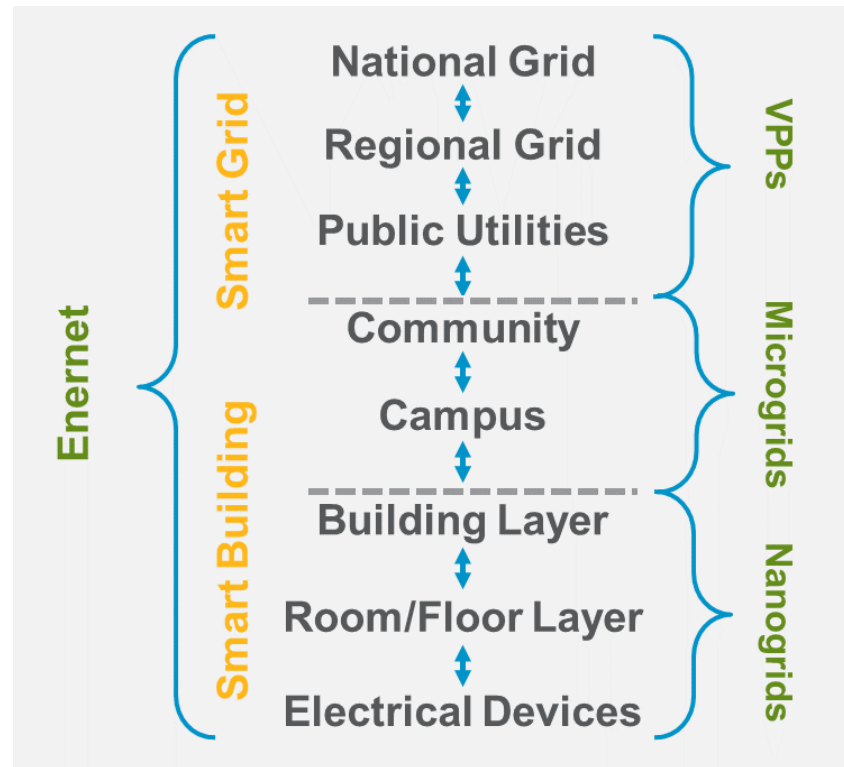
BUILDING ENERGY MANAGEMENT SYSTEMS

Digital control systems installed in buildings; enables energy efficiency, DR, and automated DR

(Source: Navigant Consulting)

NANOGRIDS, MICROGRIDS AND VPPs: EMERGING ENERNET LANDSCAPE

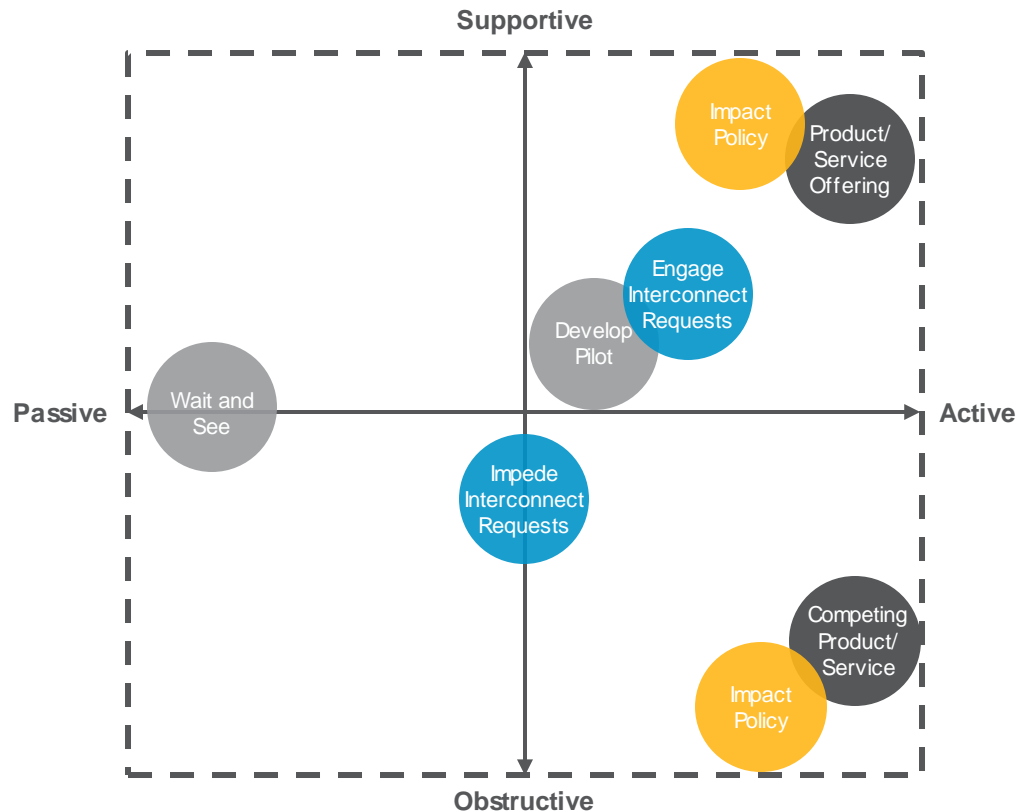
Enernet Links Up Nanogrids to Microgrids to VPPs



(Sources: EMERGE Alliance, Navigant Research)

ROLE OF UTILITY AS MICROGRID GATEKEEPER

Mapping Utility Microgrid Strategies



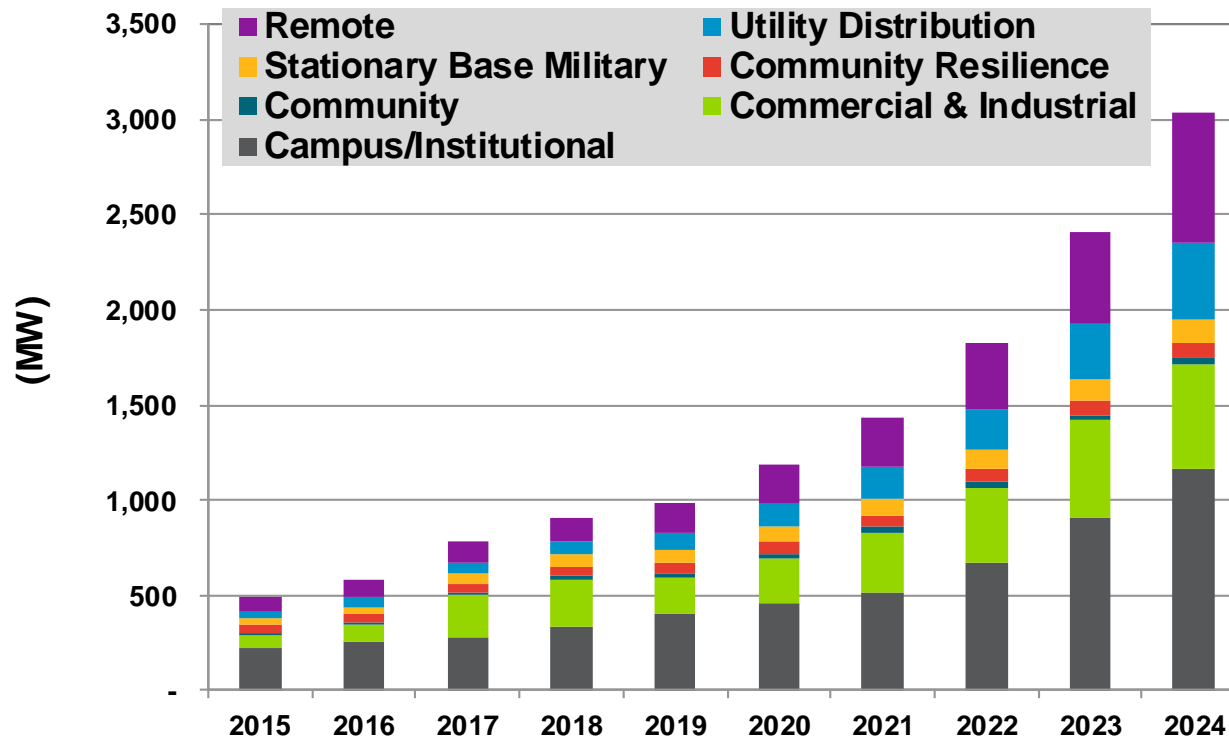
(Source: Navigant Consulting)



MICROGRIDS IN NORTH AMERICA

MICROGRIDS CAPACITY FORECAST: NORTH AMERICA

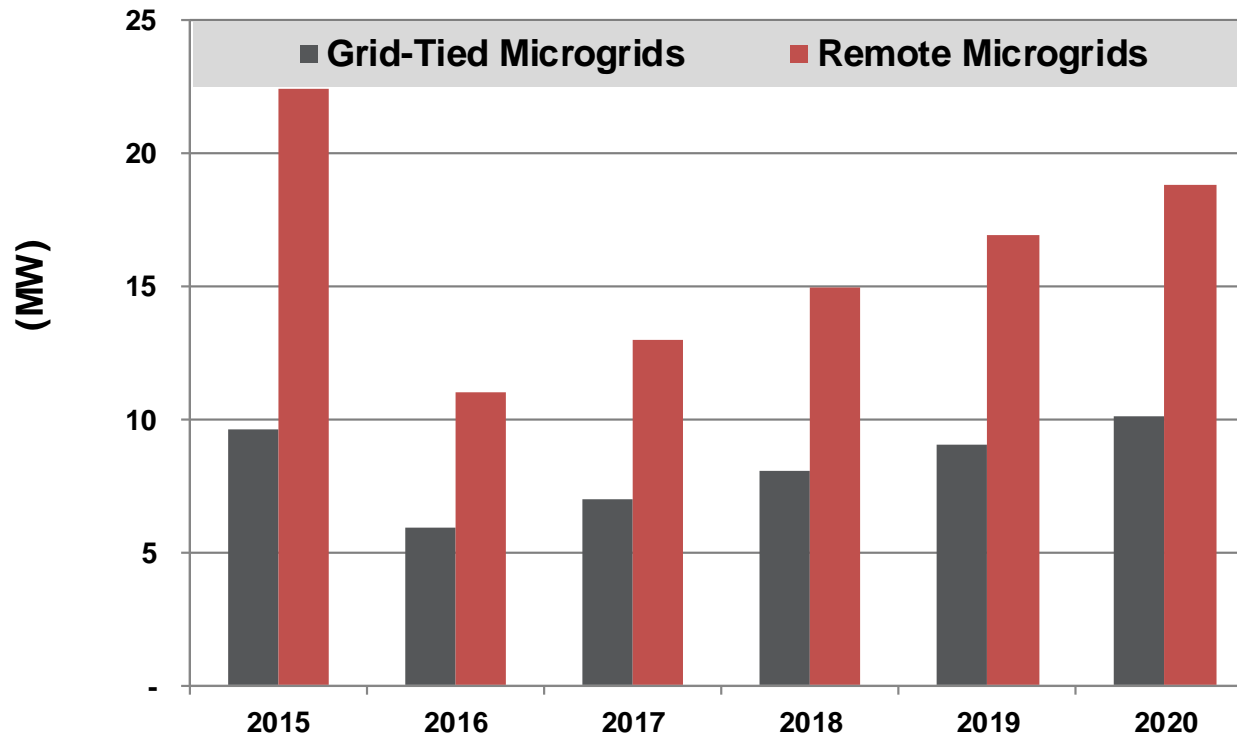
Microgrid Capacity by Segment, North America: 2015-2024



(Source: Navigant Research)

REMOTE MICROGRIDS IN THE LEAD IN CANADA*

Annual Microgrid Capacity by Segment, Canada: 2015-2020

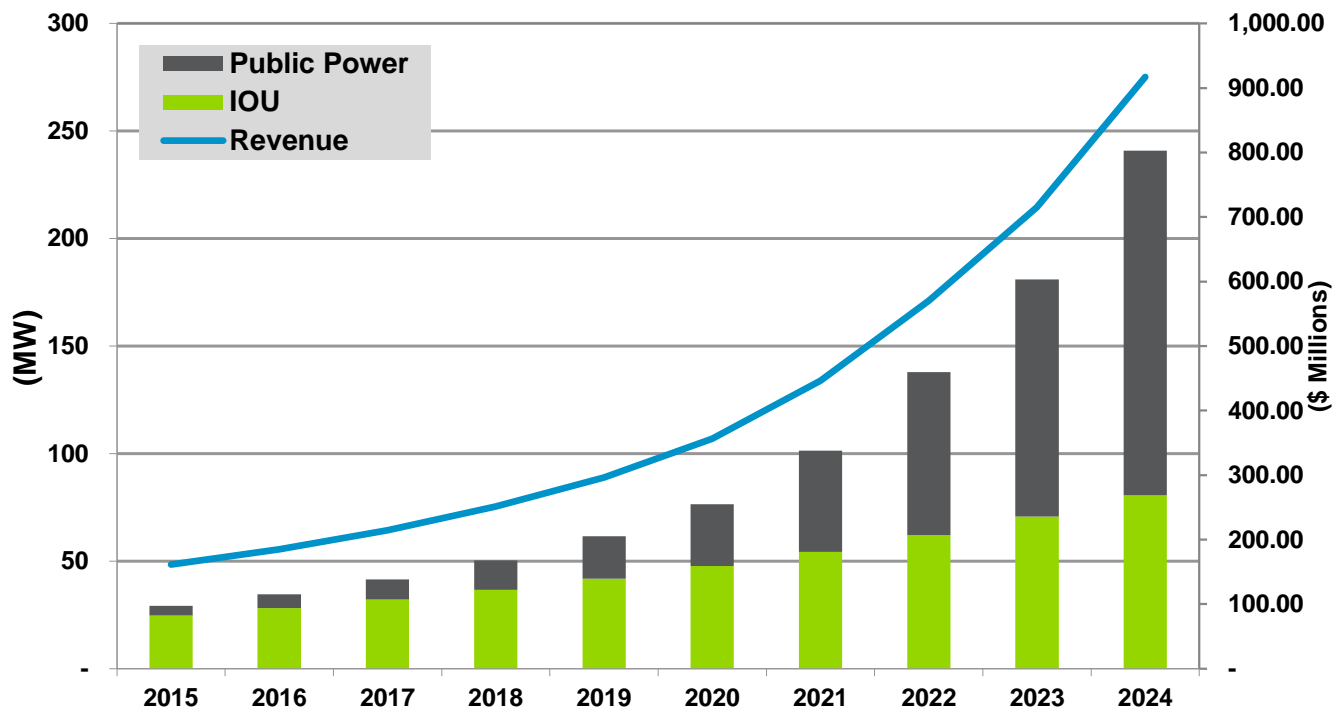


(Source: Navigant Research)

*Proposed 100 MW in SSM, Ontario could radically alter this assumption.

PUBLIC VS. PRIVATE UTILITY MICROGRID DEPLOYMENT TRENDS IN THE U.S.

Annual UDM Capacity & Implementation Revenue, United States: 2015-2020



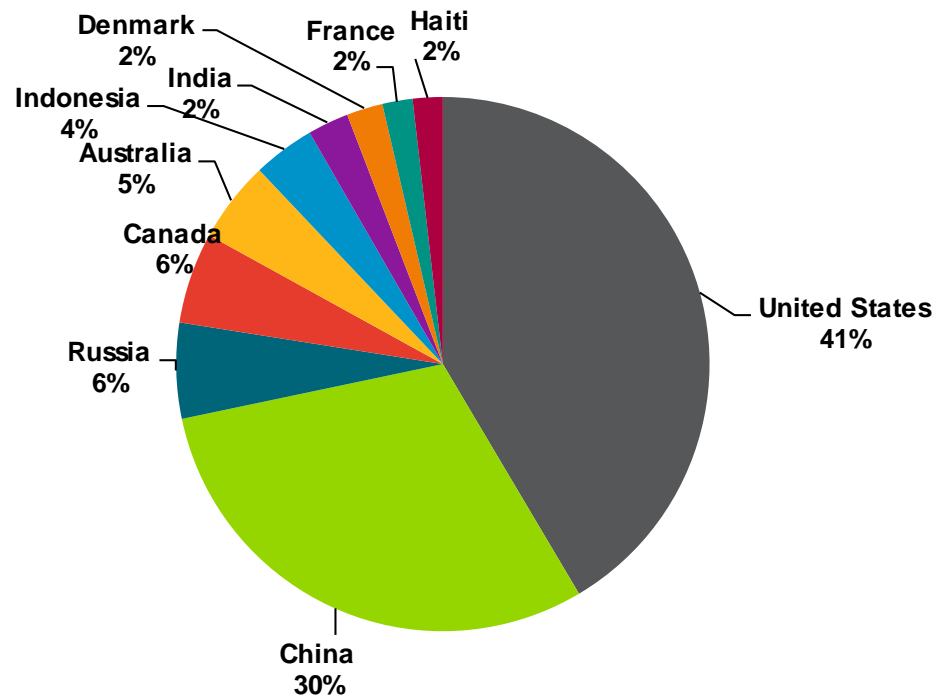
(Source: Navigant Research)



**GLOBAL
MICROGRIDS
GROWTH
TRENDS**

CANADA RANKS IN TOP 10 COUNTRIES FOR MICROGRIDS

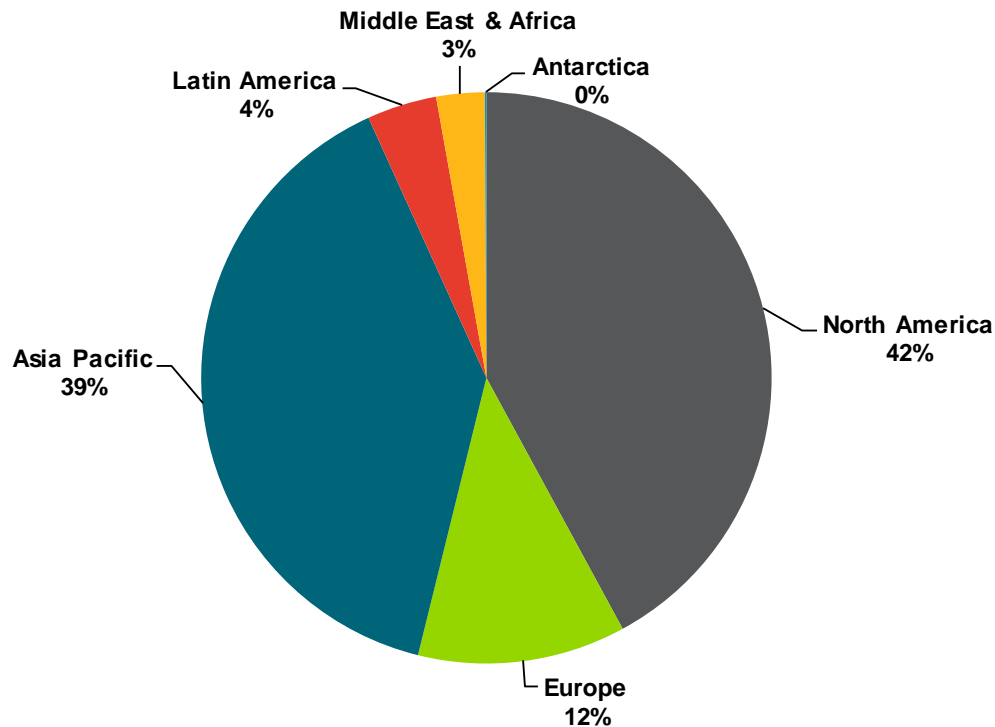
Total Microgrid Capacity Market Share by Country, World Markets: 2Q 2016



(Source: Navigant Research)

NORTH AMERICA IS BEST OVERALL MICROGRID MARKET

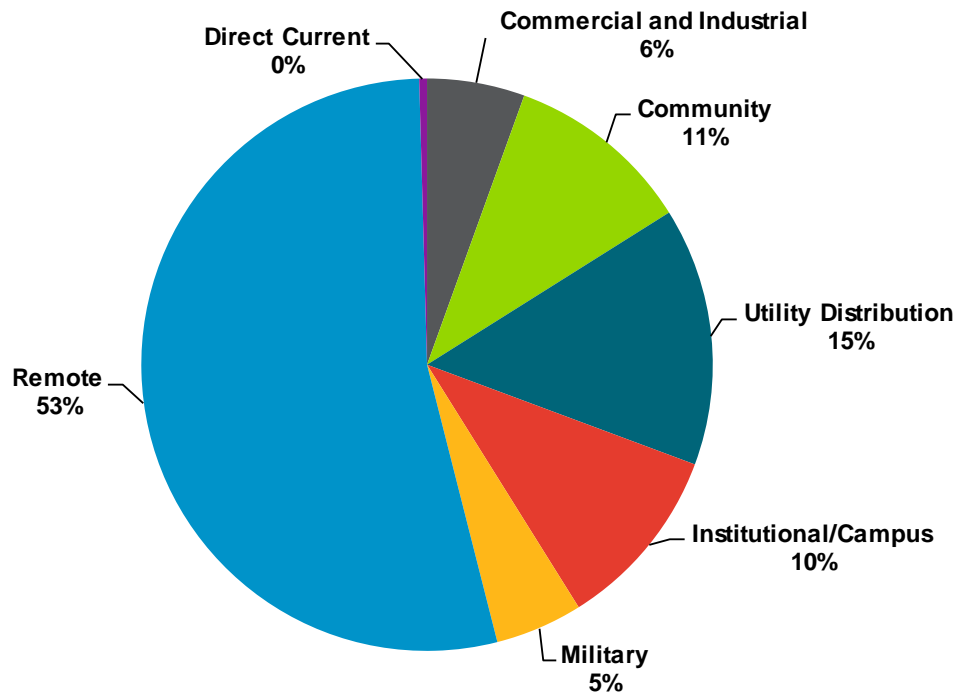
Total Microgrid Power Capacity Market Share by Region, World Markets: 2Q 2016



(Source: Navigant Research)

REMOTE MICROGRIDS CLEAR GLOBAL SEGMENT LEADER

Total Microgrid Power Capacity Market Share by Segment, World Markets: 2Q 2016



(Source: Navigant Research)



VIRTUAL POWER PLANTS

THREE CLASSES OF VIRTUAL POWER PLANTS

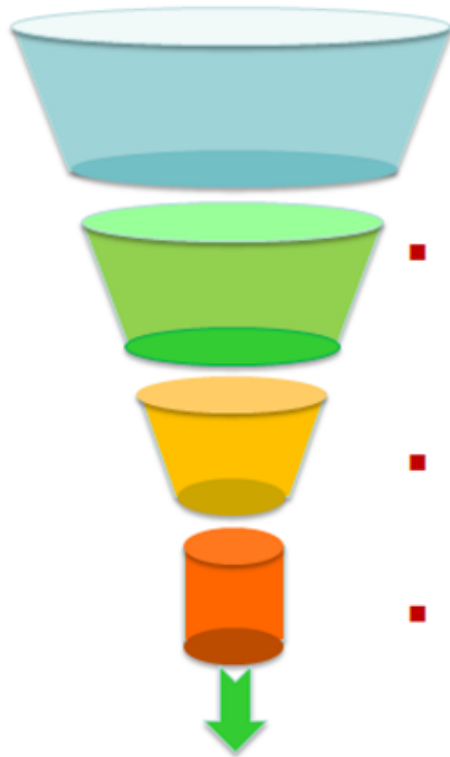
Mixed-asset VPPs enhanced by battery energy storage assets are poised to become clear VPP market leader

Classes	Description	Strength	Weakness
DR VPP	<ul style="list-style-type: none"> • Traditional DR markets • Software aggregation 	<ul style="list-style-type: none"> • Low cost, flexible 	<ul style="list-style-type: none"> • Uneven markets • Policy uncertainty
Supply-side VPP	<ul style="list-style-type: none"> • Renewable generation • Smart grid enabled • Software aggregation 	<ul style="list-style-type: none"> • Large, stable vendors 	<ul style="list-style-type: none"> • Niche markets (EU) • Few projects
Mixed-asset VPP	<ul style="list-style-type: none"> • Unites DG + DR • Resource flexibility • Enhanced by storage 	<ul style="list-style-type: none"> • Large pool of solar PV+ES nanogrid assets • IT innovation • New business models 	<ul style="list-style-type: none"> • Controls standards • Immature AS markets

(Source: Navigant Research)

POWERHOUSE VPP BY POWERSTREAM & SUNVERGE

VPP Customer Acquisition Strategy

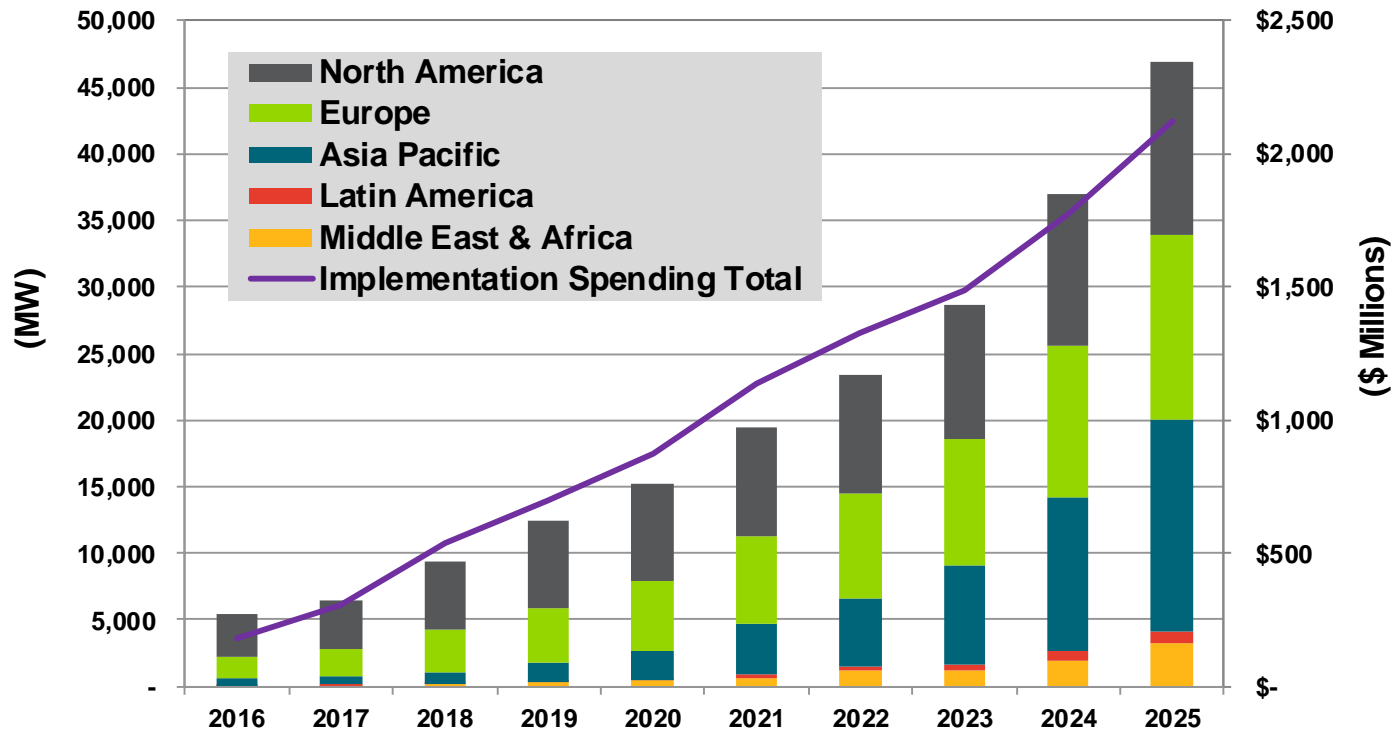


- **System Benefits:** Customers on feeders with congestion, voltage, resiliency needs
- **Customer Demographics:** Income, age, EV drivers, current CDM program participants
- **Energy Profiling:** Identify load profiles that match well with system
- **Physical Limitations:** Requirements for solar, roof space, and configuration

(Source: Powerstream)

MARKET FORECAST: TELEMETRY, DEVICE CONTROLS & SOFTWARE

Total Annual VPP Capacity & Implementation Spending by Region, World Markets: 2016-2025



(Source: Navigant Research, Virtual Power Plant Enabling Technologies Report, 3Q 2016)



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