NYISO DER Study

Stakeholder Final Presentation

August 26 2014

Discussion Topics

1	Study Background
2	Summary of Findings
3	Summary by DER Type
4	Additional Q&A and Next Steps

Project Objectives

A comprehensive review of Distributed Energy Resource (DER) technologies, technical potential and market drivers, regulatory and environmental policies, and treatment in other balancing authority and utility regions.

- Categorize DER technologies
- Identify DER uses, configurations, and customer motivations
- Describe regulatory and market-based drivers for DER adopters
- Detail current and potential DER market penetrations in New York
- Assess the various forms of treatment of DERs in other ISOs/RTOs and utility regions

Study Definition of DER

- Distributed Energy Resource technologies are “behind-the-meter” power generation and storage resources typically located on an end-use customer’s premises, and operated for the purpose of supplying all or a portion of the customer’s electric load. Such resources may also be capable of injecting power into the transmission and/or distribution system, or into a non-utility local network operating in parallel with the utility grid.
- Distributed energy resources include such technologies as solar photovoltaic, combined heat and power or cogeneration systems, microgrids, wind turbines, micro turbines, back-up generators and energy storage.

Study Outline

1. Introduction
2. Behind-the-Meter Applications
   i. DER Applications & Benefits
   ii. Challenges and Constraints
   iii. Looking at the Larger Picture
3. State of Distributed Resources
   i. Technology Assessment
   ii. Market Penetration
   iii. Technical Potential
   iv. Environmental Requirements
4. Retail Rates, Regulations and Incentives for Distributed Energy Resources
   i. The Role of Rates, Regulations, and Incentives on Customer Economics
   ii. Retail Rates, Regulations, and Incentives
   iii. Government Incentive Programs
   iv. Example Case Studies of Customer Economics
5. Treatment of DERs in ISOs/RTOs
   i. Market and Business Rules and Practices applicable to DER
   ii. Metering
   iii. Telemetry Requirements
   iv. Measurement & Verification

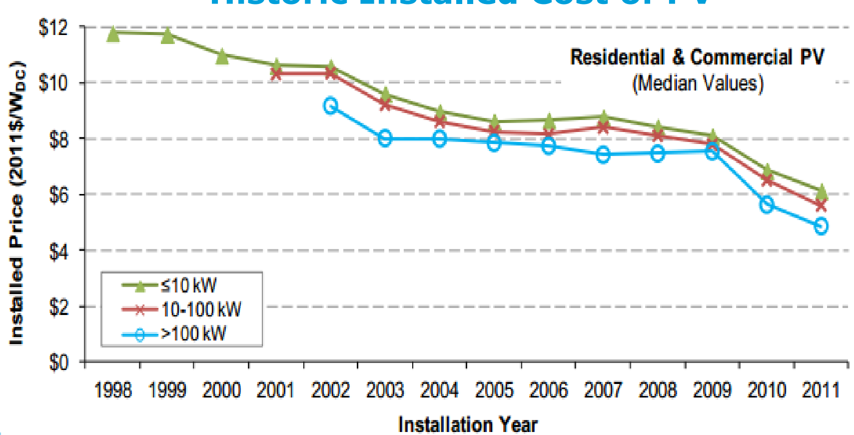
Discussion Topics

DNV·GL

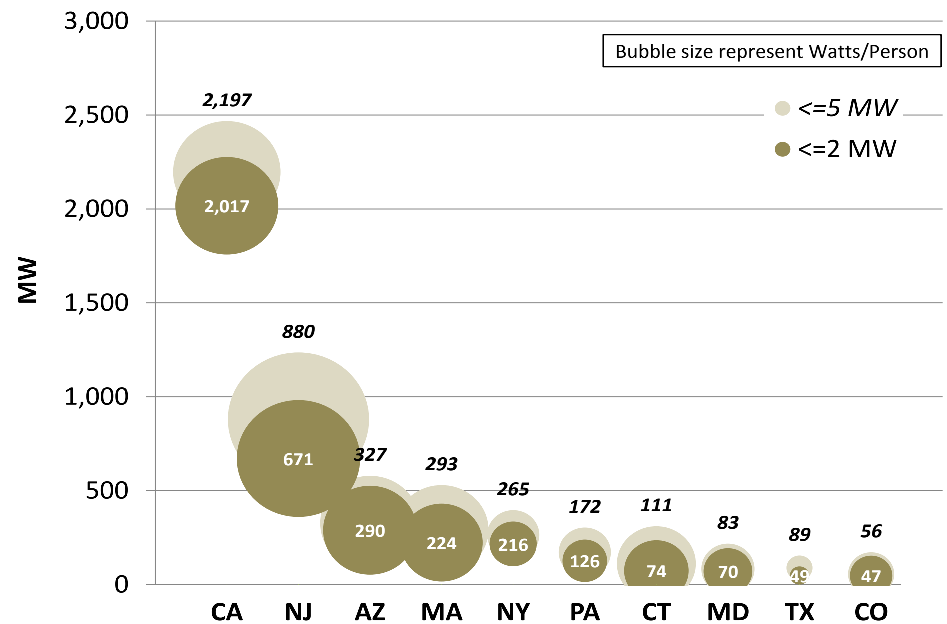
Is DER Adoption Likely to Last?

- **Adoption is Relatively Strong and Growing**
  - New York ranks fifth in the country in total installed DER capacity (PV, CHP and ES combined) for installations of 2MW or less
  - PV installations dominate in most states with high DER penetration, but in New York 57% of DER capacity comes from CHP, 41% from PV and 2% from energy storage.

Historic Installed Cost of PV



DER Capacity by State



- **Cost and performance have improved and are expected to continue**
  - PV in particular but also energy storage technologies

Source: LBNL 2012, U.S. Census data, NREL Open PV Project, DOE and ORNL

Is DER Adoption Likely to Last? (cont'd)

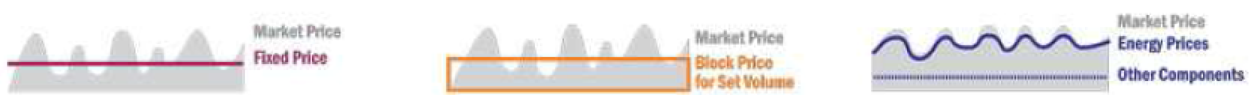
- **There is Sizeable Remaining Technical Potential for DERs in the U.S. and in New York**
  - New York ranks high in potential for rooftop PV and small-scale CHP
- **Customers May Benefit from DER Adoption through Reduced Utility Costs and Charges, Improved Power Quality, and Access to New Revenue Streams. However, Challenges Remain:**
  - Variety of policies, requirements and tariffs across jurisdictions
  - Determining fair compensation and associated cost allocation for the benefits of DERs to the grid
  - Engineering can be costly and complex if no turn-key solution is available
  - Financing can be difficult to obtain if no turn-key solutions are available
  - Customers must weigh the payback of investment in DERs versus the payback from investment in core business
  - Environmental and safety requirements can limit the installation or operations of some DER assets

What Influence do Federal, State and Local Policy and Grid Operator Rules have on DER Adoption and Integration?

- **Incentives Can Help Align Customer and Grid Operator Goals**
  - Utilities and market signals could potentially motivate investment in particular locations or affect a shift in operations to align customer benefits with grid benefits, which could result in the ability defer infrastructure investments.

- **Customers Encounter a Number of Economic Signals from their Load Serving Entity, Wholesale Operator, and Local, State and Federal Government**
  - Rate structures can vary, including fixed, variable or a combination of the two, which will influence DER operations from an economic perspective
  - Simplified and expedited interconnection standards promote DER adoption
  - A variety of retail rate offerings are available in New York, ranging from fixed charges to time-of-use charges to hourly pricing.

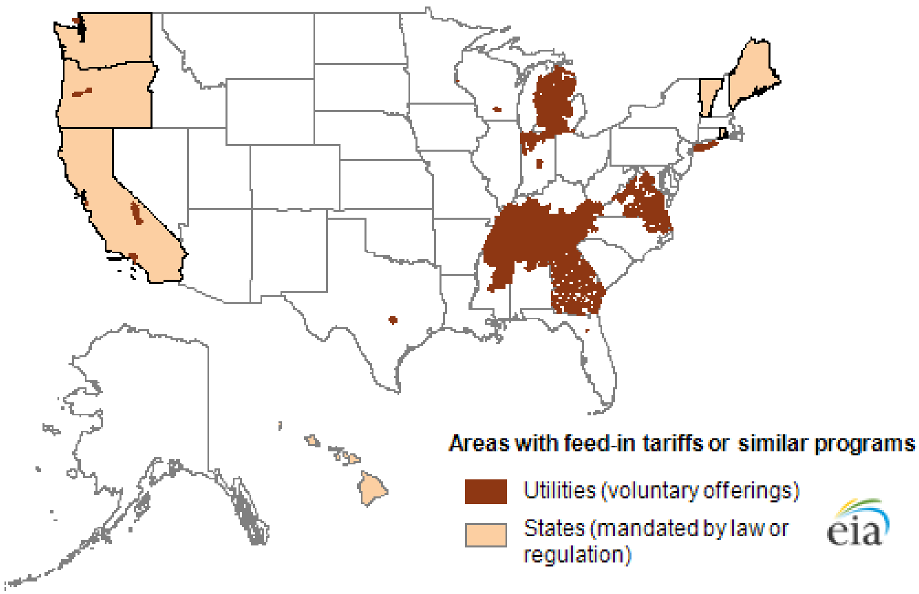
Example of Fixed and Variable Rates



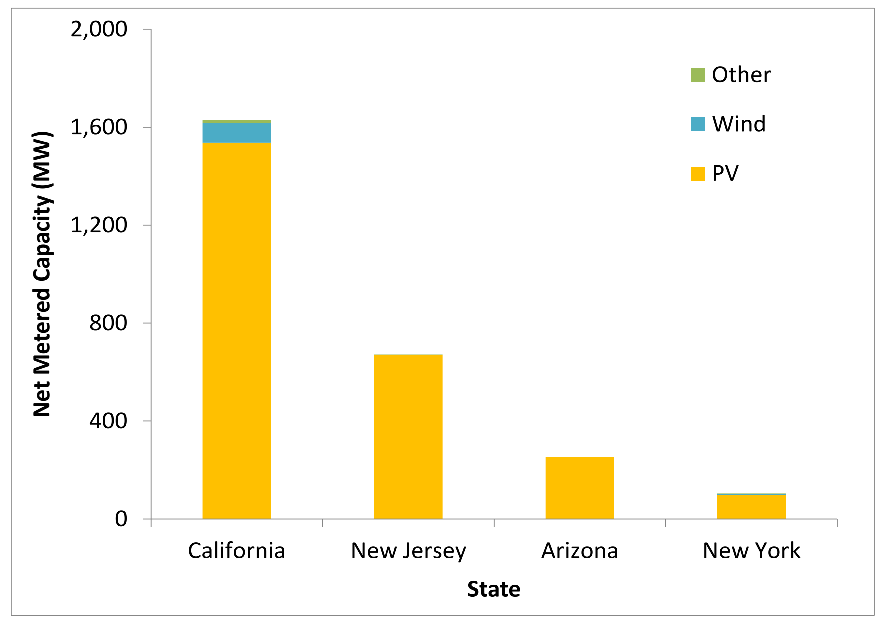
What Influence do Federal, State and Local Policy and Grid Operator Rules have on DER Adoption and Integration? (cont'd)

- **A Number of Federal, State and Local Incentives Exist which Influence DER Economics**
  - Including Net Metering rules and Feed-In-Tariffs
  - Programs targeting renewables and sustainability

FIT programs across the U.S.



Net Metered Capacity by State

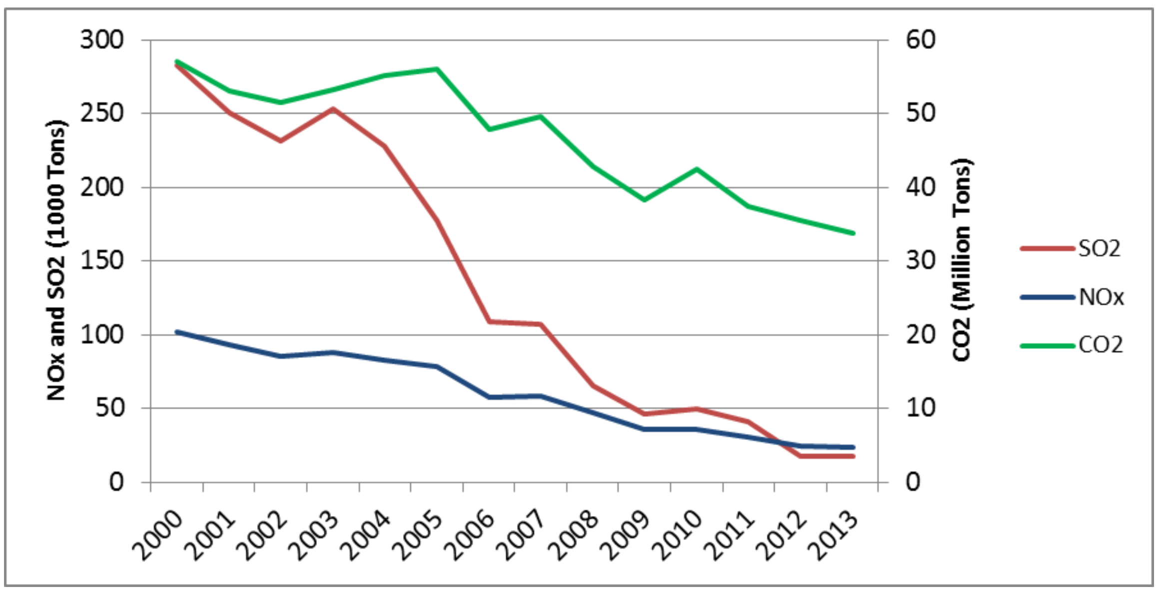


Source: EIA

What Effect will DER Adoption have?

- **The Emissions Impacts of DERs Depend on DER Type and Will Likely Evolve Over the Next Several Years as Policies Regulating Central and Distributed Generation Evolve**
  - Central generation has become cleaner in recent years
  - Emissions standards are becoming more stringent
  - DERs help avoid transmission and distribution losses and CHP or Fuel Cells can improve overall efficiency by meeting local heating or cooling needs

Emissions from Central Generation in NY State



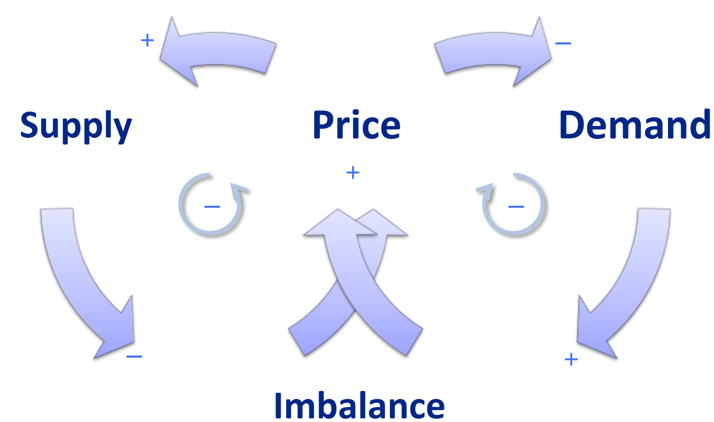
Source: EPA Air Markets Program Data 2014

What Effect will DER Adoption have? (cont'd)

- **DERs Can Potentially Increase Variability in Load and Create Forecast Error**

Resource	Variability Drivers
PV	Solar radiation, atmospheric conditions and PV technology type
CHP	Temperature, conforming load, or prices (where CHP could be applied to price management applications or could be price-responsive)
Distributed storage	PV smoothing requirements (where storage is applied to PV integration applications) or prices (where storage could be applied to wholesale programs or price management applications)
Microgrids or customers with multiple assets	Temperature, conforming load, prices, or PV smoothing requirements

- **Integration of DERs Should Consider Effects on Market and System Dynamics**
  – Demand responding to price, without feedback or price elasticity information available to market operators, can result in imbalances between supply and demand which in turn can lead to fluctuations in price, supply and demand.

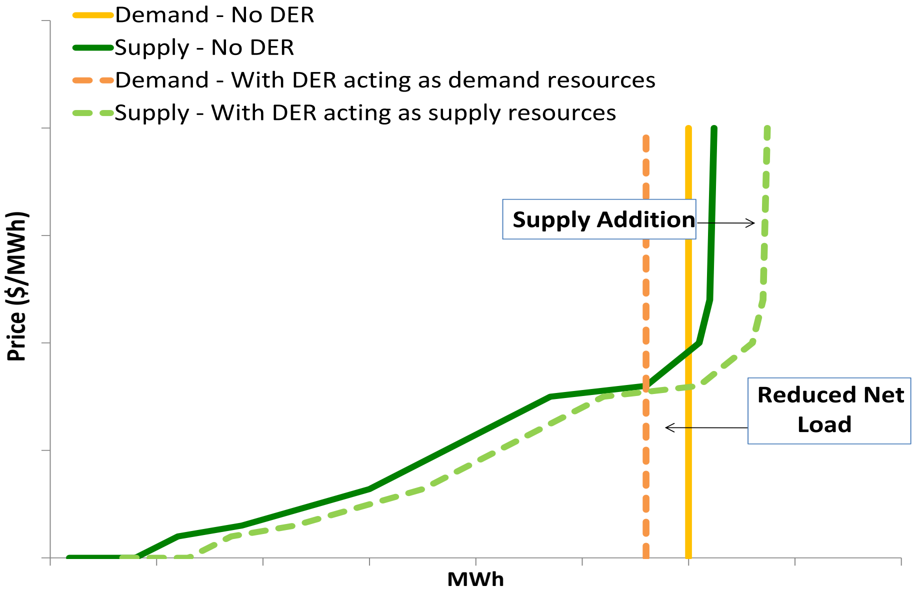


Source: DNV GL 2012

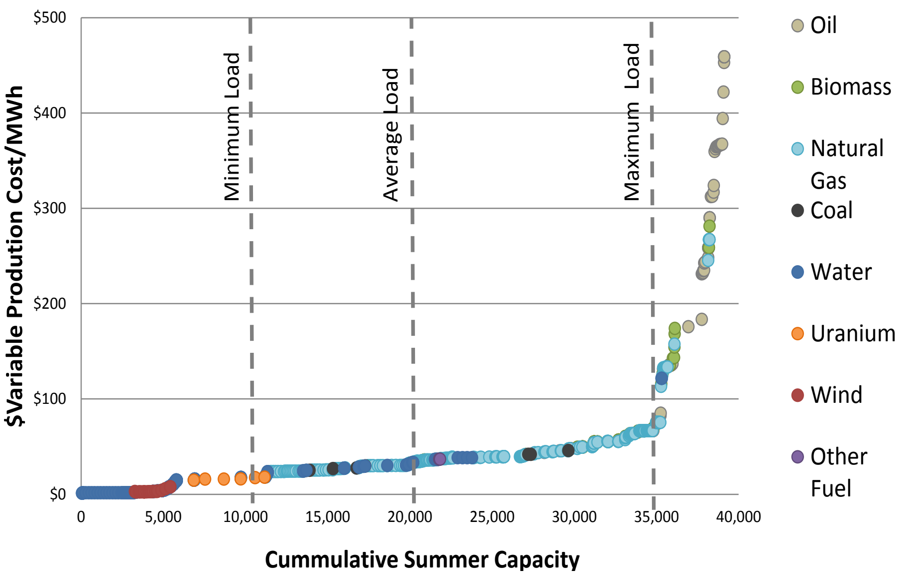
What Effect will DER Adoption have? (cont'd)

- **Planning for DER Integration Should Consider the Portfolio of Other Resources Available**
  – The generation portfolio mix will determine the net effect of the aggregate net load reductions

Illustration of Increased Supply and Reduced Demand



Sample Supply Curve by Resource Type for New York



Source: EIA

What Effect will DER Adoption have? (cont'd)

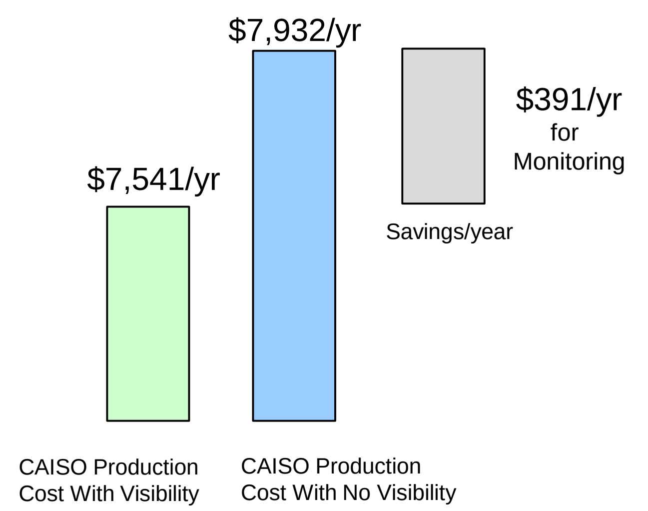
- **Additional Consideration Should be Given to the Integration of DER in Long-Term Planning**
  - Transmission elements and large generators have long lives and are generally assumed to be available over the 10 year planning horizon. Adjustments for new entrants and retirements are required to go through structured interconnection or retirement processes.
  - DERs are customer-sited and may enter or exit on short notice or no notice. This could create considerable uncertainty regarding transmission security and resource adequacy for the bulk system.
  - If the price is right, DER resources are available on relatively short notice in times of intense need. Alternatively, competing economic forces may result in lower-than-predicted turn out in given years.

What is Required for Successful DER Integration?

- **The Integration of DERs Must Maintain Grid Stability and Power Quality for all Customers**
  – The integration of DERs must be considered in light of operational requirements at the distribution level, for example:
    – Distribution grid operators are required to provide voltage service within a limited range
    – In New York, utilities are subject to service reliability and quality standards

- **Despite the Current Challenges Associated with DER, Several Initiatives Could Help Mitigate Challenges**
  – Visibility to DER operations can reduce production costs, as illustrated in the adjacent CAISO example

CAISO Benefits in millions $ for 2020



Source: DNV GL 2012

What Precedence Exists for Integration of DERs and What Adjustments are Currently Underway?

- **Integration of Demand Response and Energy Storage Provides a Starting Point for Integrating of DERs into the Wholesale Markets**
- **Meaningful Measurement and Verification is Important as it Provides the Basis for Fair and Transparent Financial Flows to and from Market Participants or Ratepayers and Can Support Other Operator Functions**
  – The ideal performance evaluation methodology is designed for accuracy, flexibility, reproducibility, and simplicity, among other features

Use of Measurement and Verification for Demand Response Purposes

Enrollment	Operations/ Dispatch	Event	Settlement	Evaluation	Planning
Individual Capacity	Available Capacity		Individual Asset Reductions	Combined Reductions	Future Combined Reductions
• What could each unit deliver?	• What can the combined assets deliver now?		• What did each asset deliver?	• What did the combined assets deliver? • What will they deliver?	• What could the combined assets deliver?

Source: DNV GL 2014

What Precedence Exists for Integration of DERs and What Adjustments are Currently Underway? (cont'd)

- **Telemetry and Metering Provide the Means for Monitoring and Settling Demand Response Resources in the Markets**
  - Wholesale markets:
    - In most ISO/RTOs, telemetry is required for participation in the regulation market. Some others require it for spinning reserves as well
    - Metering systems can be used for notification as well as for settlement
  - The primary use of metering at the utility level is for financial settlements

- **Additional Modifications to Current Approaches around DERs are Being Considered**
  - Meter requirements and access to meter data is a complex issue that will need to be addressed in order to allow for seamless integration envisioned for DERs
  - The challenge is to identify the rules that obtain the greatest telemetry benefits in terms of visibility, security and controllability of such resources, while balancing the cost and administrative activities

Discussion Topics

1. Study Background
2. Summary of Findings
3. **Summary by DER Type**
4. Additional Q&A and Next Steps

DER Trends Summary

- PV is leading the way nationally
  - Rapid development in cost reduction and performance improvements over past 20 years
  - Largest adoption among DERs across U.S. and sizeable adoption in New York in recent years
    - 80%-90% of total DER installations 2 MW or less in the U.S.
- Energy Storage costs are trending downward and penetration is expected to grow
- CHP is a relatively mature technology and has more experience in the market
  - Costs are not expected to decline as rapidly as PV or energy storage though some innovations are still occurring
- New York ranks relatively high in DER adoption across the U.S.
  - Top 5 states for total DER installations 2MW or less
  - Top 10 states for cumulative installed PV, energy storage, and CHP under 2MW

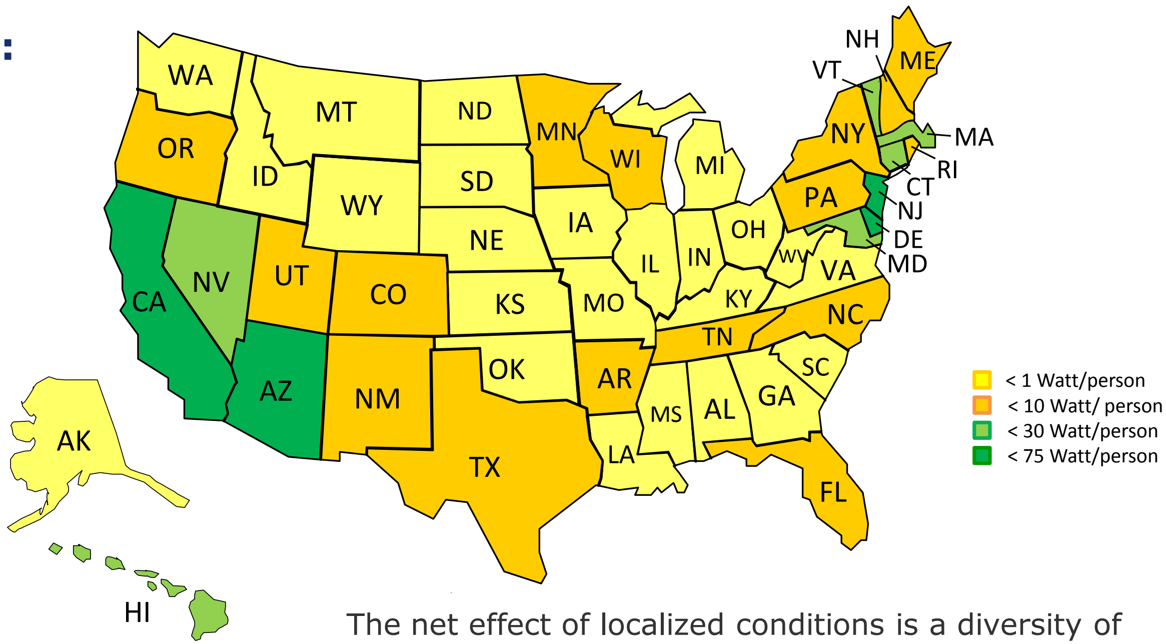
DER Value Varies by Region & Across Studies

Behind-the-Meter Applications

The nature of DER benefits depends greatly on the mix of DERs on the grid and on the ability to coordinate DER activities in a way that aligns grid interests with individual customer interests.

Regional circumstances include:

- DER resource characteristics
- Load growth
- Level of congestion
- Utilization & need for upgrades / increased capacity
- Reliability standards & market rules
- Generation mix
- Information about marginal resources, ancillary needs, and value of capacity versus energy



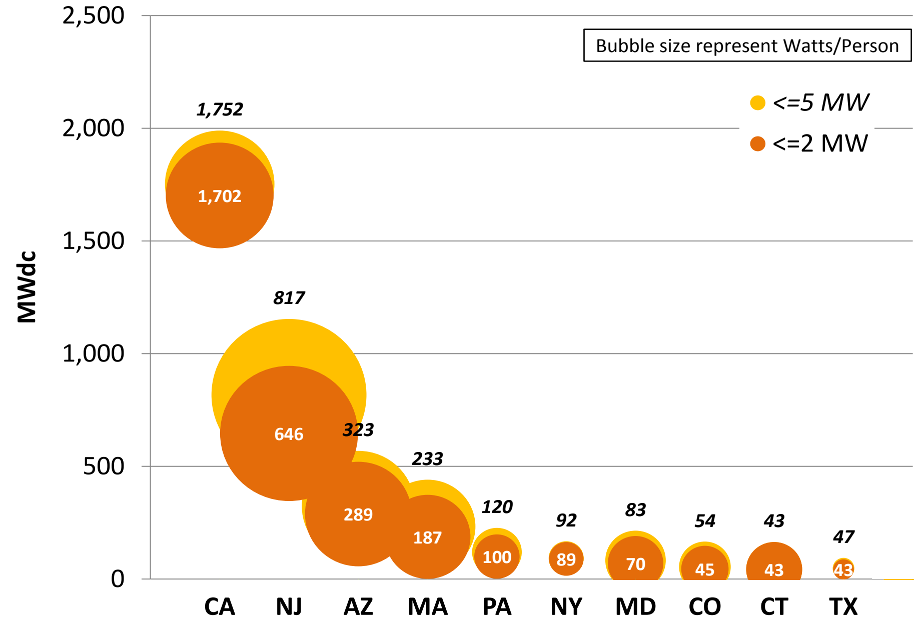
The net effect of localized conditions is a diversity of adoption across the United States and within states. The figure illustrates the diversity of installed capacity of PV units less than 2 MW across the United States in average capacity per person.

Source: NREL Open PV Project, RMI 2013

Photovoltaic Solar (PV) Snapshot

- New York ranks 6th in installed capacity from distributed PV according to NREL Open PV database
- NREL estimates that New York has
  - 89 MW of PV sourced from installations under 2MW, with the average size being 13 kW.
  - 92 MW for all installations under 5MW
- Incentives for PV across the country include
  - Net Metering (NY, nationally)
  - Value of Solar Tariff (Austin Energy)
  - Feed-in-Tariffs (CLEAN Solar Initiative FIT from LIPA, nationally)
  - Federal incentive programs such as tax credits (30% ITC), loan and grant (REAP) programs (nationally)
  - Renewable Portfolio Standards with DG targets (New York RPS with Customer-Sited Tier)
  - NY-Sun, NY Green Bank, NYSERDA Solar PV Financial Incentives Program and other state-level and local programs

PV Installed in Top 10 States



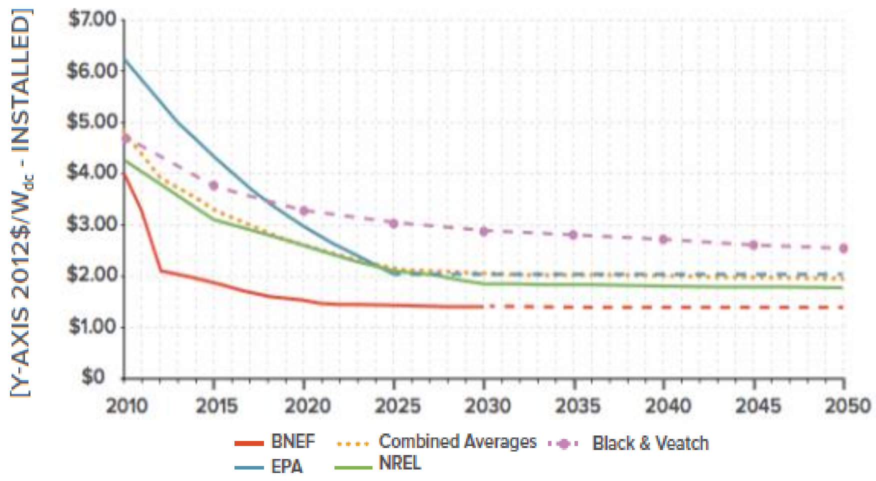
PRELIMINARY CONTENT – FOR DISCUSSION ONLY

Source: Derived from U.S. Census and NREL Open PV Project for all data in chart

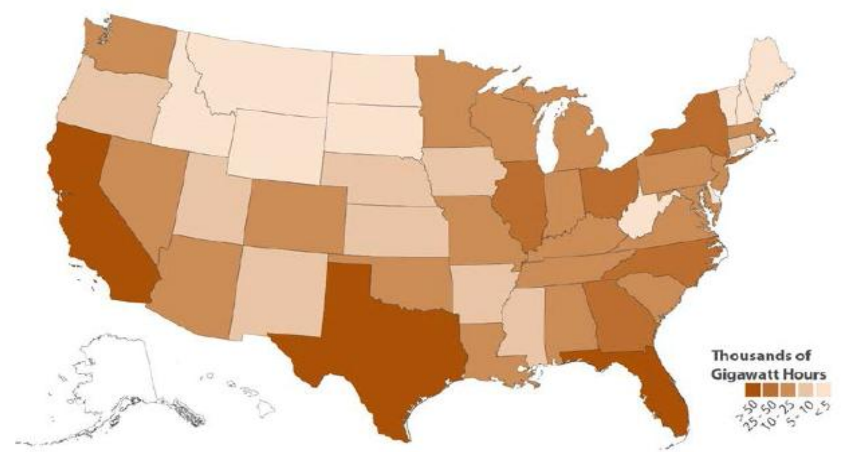
Photovoltaic Solar (PV) Snapshot (cont'd)

- Forecasts suggest PV costs will continue to decline, as illustrated in top chart
- NREL estimated the total annual technical potential for rooftop PV across the country, based on solar availability and rooftop space, in 2012 (see figure below)
  - New York ranks 7th with an estimated 25 GW of capacity (28,780 GWh)
- NYSERDA estimates a total technical potential for residential PV of
  - 881 MW (2,836 GWh) by 2020
  - 2,615 MW (8,223 GWh) by 2030
- For commercial PV, NYSERDA estimates a total technical potential of
  - 1,174 MW (3,706 GWh) by 2020
  - 3,487 MW (10,745 GWh) by 2030

Commercial PV Installed Cost



PV Technical Potential



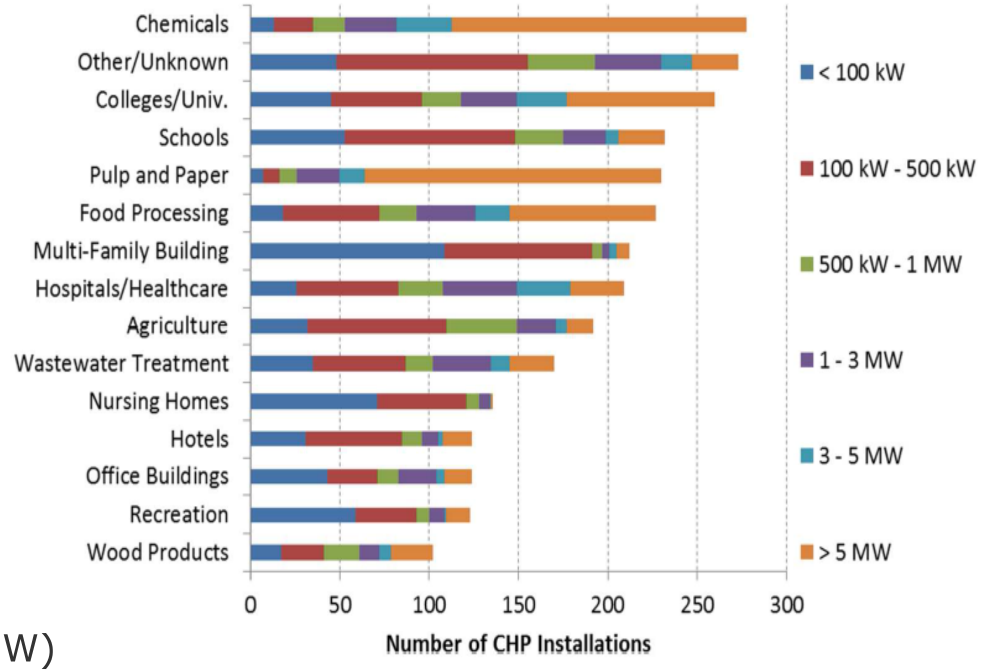
PRELIMINARY CONTENT – FOR DISCUSSION ONLY

Sources: RMI 2014, NREL/TP-6A0-44073, NYSERDA 2014

Combined Heat and Power (CHP) Snapshot

- CHP technologies are generally well developed technologies.
  - Majority of U.S. installations are Combined Cycle
  - Small-scale CHP mostly microturbines and reciprocating engines
- The vast majority of CHP units installed today (in New York State and in the U.S.) are greater than 5 MW
- Relevant incentives for CHP include
  - Federal incentive programs (nationally)
    - tax credits (10% ITC for CHP below 50MW)
    - loan and grant programs (such as Rural Energy for America Program)
  - Many energy efficiency targets include CHP
  - Limited access to Net Metering (micro-CHP up to 10kW in NY, SGIP in CA)
  - NYSERDA programs include CHP Performance Program and CHP Acceleration Program
  - NYC has several initiatives targeting CHP under the State Energy Plan

National CHP Installations by Size and Industry



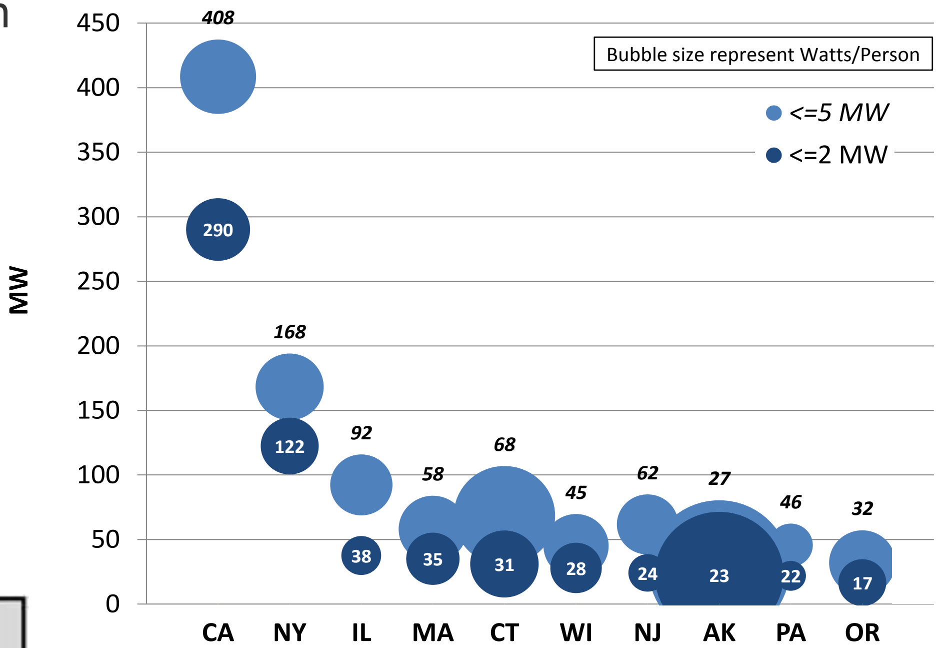
PRELIMINARY CONTENT – FOR DISCUSSION ONLY

Sources: ORNL Combined Heat and Power Installation Database, last updated 7/25/2013

Combined Heat and Power (CHP) Snapshot (cont'd)

- California and New York lead the nation in total installed CHP capacity for units under 2 MW.
  - New York with 122 MW, primarily natural gas reciprocating engines
  - New York 5th in per person capacity with 6.2 watts/person

CHP Installed in Top 10 States



CHP Technical Potential in NY State

Size Range	Industrial		Commercial		Total	
	Sites	MW	Sites	MW	Sites	MW
State Total						
50 to 500 kW	3,894	300	16,048	1,240	19,942	1,540
500 kW to 1 MW	428	195	3,867	1,584	4,295	1,778
1 MW to 5 MW	434	685	1,280	2,256	1,714	2,940
5 MW to 20 MW	63	488	149	1,240	212	1,728
> 20 MW	9	280	7	210	16	490
Total	4,828	1,948	21,351	6,529	26,179	8,477

- New York is estimated to have large technical potential for small-scale CHP

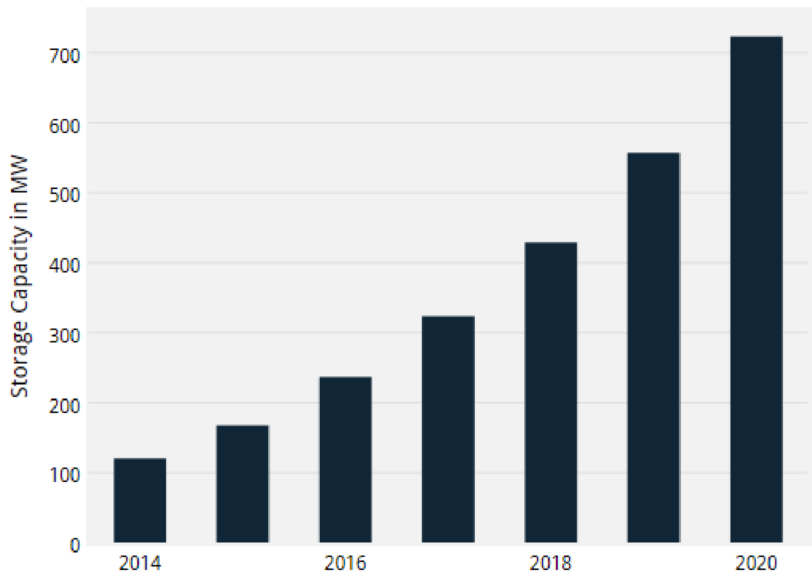
PRELIMINARY CONTENT – FOR DISCUSSION ONLY

Sources: NYSERDA 2014, ORNL Combined Heat and Power Installation Database, US Census data

Energy Storage Snapshot

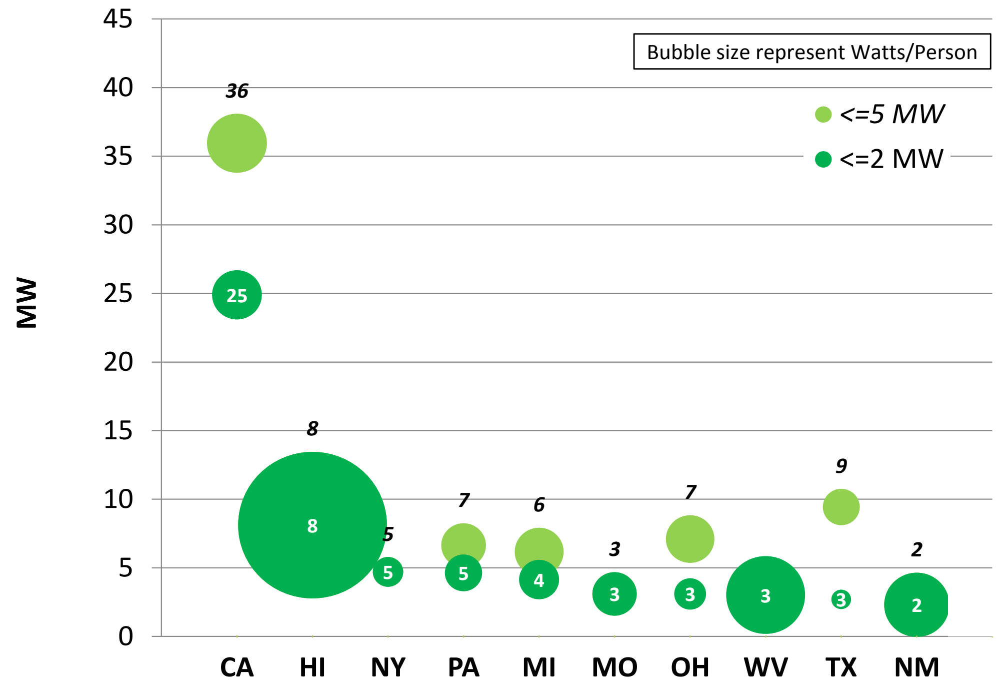
- Cumulative storage capacity for storage under 2 MW is currently greatest in California, Hawaii and New York
  - 77MW nationwide, 4.7MW in NY
- Projections for future capacity of small-scale distributed storage indicate over 700MW by 2020.

Forecast Capacity of Distributed Storage in U.S.



PRELIMINARY CONTENT – FOR DISCUSSION ONLY

Energy Storage Installed in Top 10 States



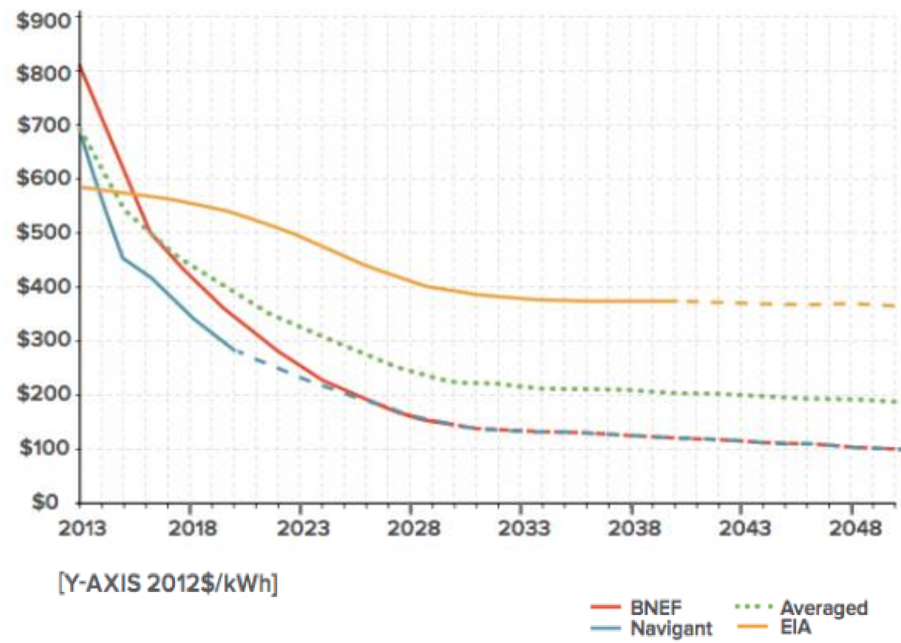
- Projection for NY are limited, though Navigant estimates 75MW of demand side storage by 2020; 201MW by 2030.

 Sources: Navigant 2013, GTM Research 2014

Energy Storage Snapshot (cont'd)

- Cost of battery energy storage technologies are coming down and are predicted to decline further, along with improvements in efficiency and performance
- Energy storage can support policy goals such as peak load reduction and system reliability, as outlined in the PSC REV initiative
- Con Edison and NYSERDA offers The Demand Management Program with incentives available for
  - Battery and thermal storage technologies
  - Energy improvements that contribute to the reduction of the system-coincident peak demand during the summer months
  - Projects that achieve a peak reduction of 500 kW or more can also earn additional bonus incentives

Battery Energy Storage Price Projections

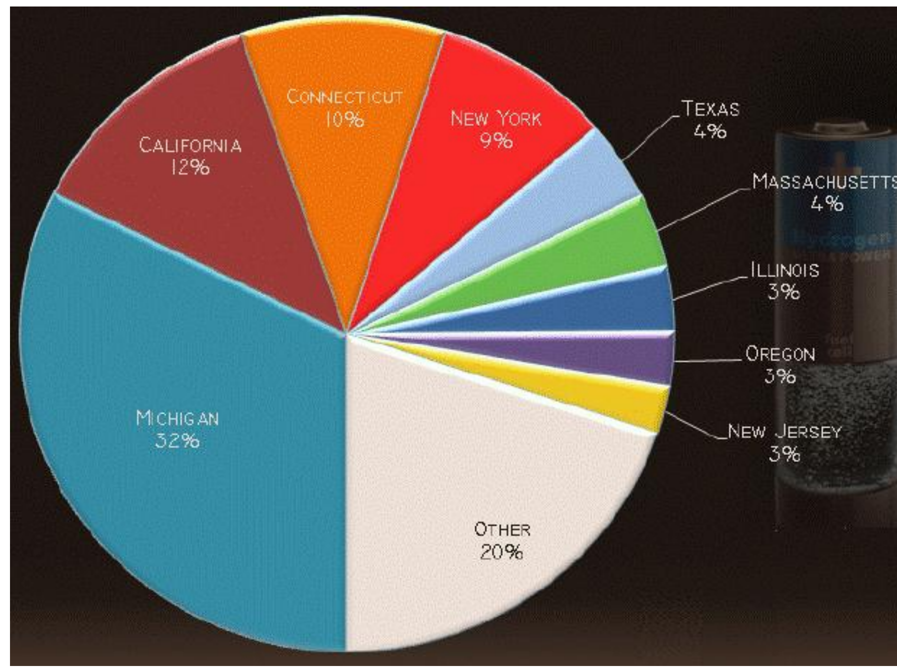


Source: RMI 2014, ConEdison

Fuel Cell Snapshot

- Over the years, fuel cell costs have declined and durability has increased
  - The cost of electrolyzer stacks has been reduced by 60% since 2007
- Fuel cell markets are currently growing in stationary applications globally, though domestic growth rates are much slower
- Investment in fuel cells in the United States has been relatively strong and research continues
  - U.S. investors made the largest cumulative investment globally in fuel cells between 2000 and 2011, at $815 million
- Department of Energy goals for stationary fuel cells by 2015 include a $750/kW cost target with 40% efficiency and 40,000 hour durability

Fuel Cell Patents by State

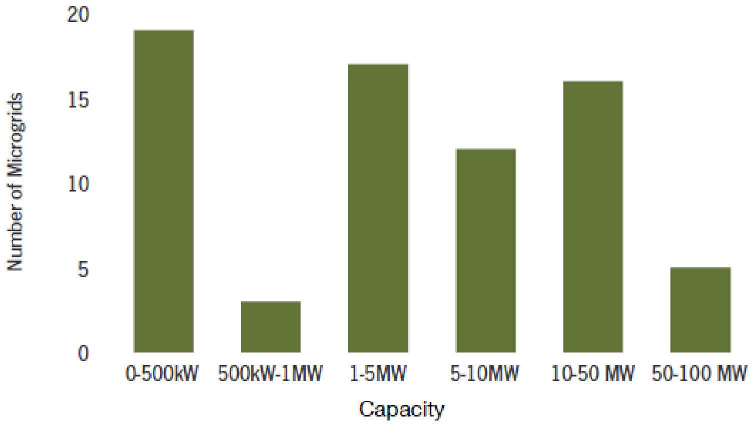


 Sources: Heslin Rothenberg Farley & Mesiti P.C. 2014

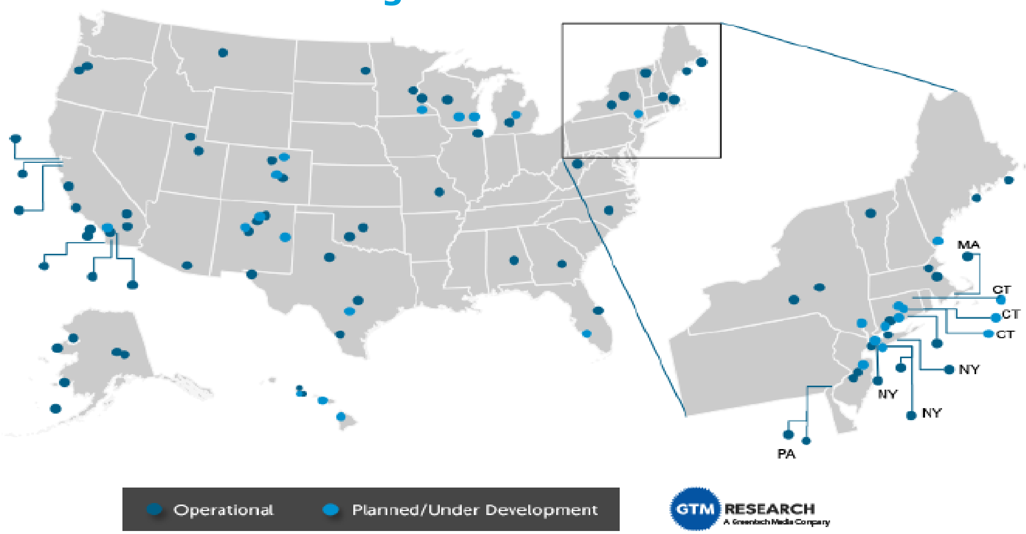
Microgrid Snapshot

- Current operational capacity in the U.S. is estimated around 1 GW
- Installations range from less than 1MW to 50MW, the majority smaller scale.
- Estimates of technical and economic potential vary quite dramatically with Navigant estimating
  - 2,022 MW by 2017 in campus applications and stationary military bases segments
- The PSC, NYSERDA and the Department of Homeland Security and Emergency Services are currently conducting a feasibility study of microgrids in New York to assist with disaster response.

Operational Microgrid Capacity in the U.S.



Microgrid Locations in the U.S.



Sources: GTM Research 2014 Navigant 2012, A.7049/Crespo; Chapter 221 of 2013

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4	**Additional Q&A and Next Steps**

Next Steps and Q&A

- The final report will be posted to the NYISO’s website once available
  - All charts and references in presentation are discussed in detail in the report
- Market Participants will be notified when it is published

QUESTIONS?

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