Combined Heat and Power: The Ideal Anchor for Microgrids

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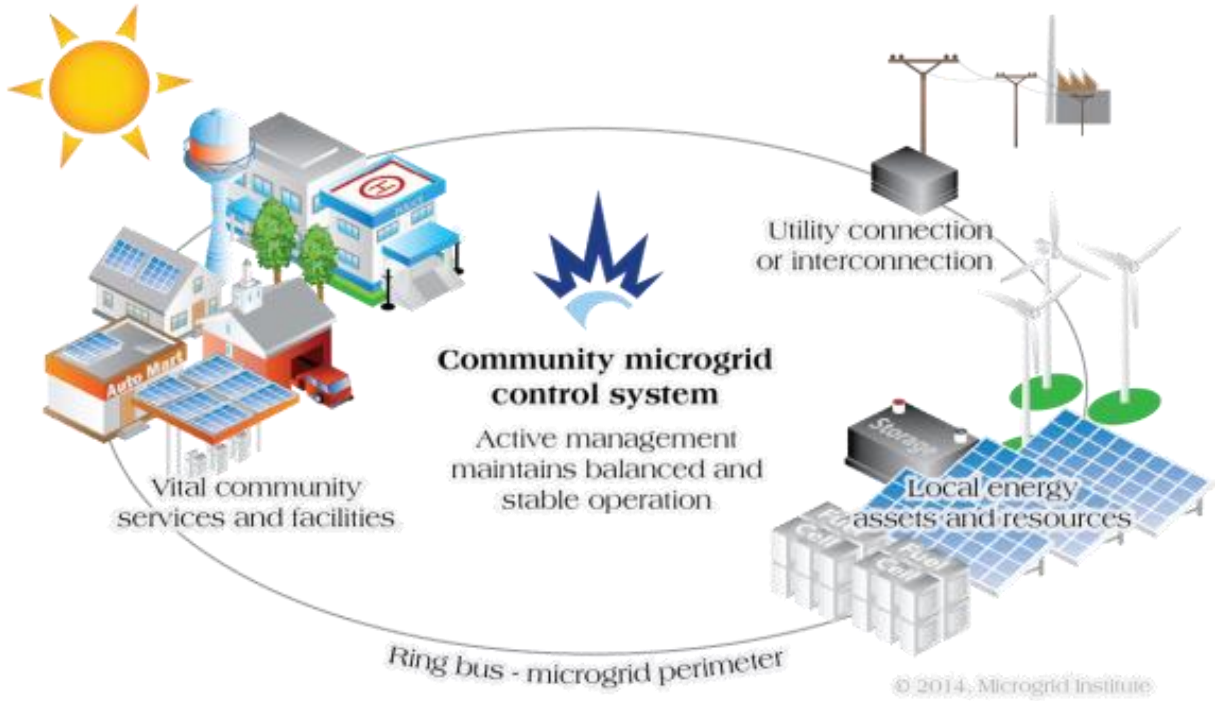
What is a Microgrid?

- How would you define a microgrid?
- If you ask 10 different people, you could get 10 different answers
  - A network of distributed energy resources
  - Decentralized electricity generation for multiple buildings
  - A local power system that can isolate itself from the utility grid
- There are several types of microgrids, so all of these answers can be accurate…but there are also many misconceptions
- Some universities have a single CHP unit that sends electricity to multiple buildings – for years it has just been considered on-site power, but now they call it a microgrid

A Microgrid's Most Important Functions

- Distributed energy with the ability to isolate from the utility grid
  - Multiple energy sources serving a group of interconnected loads
- An active management system to maintain stable operation of all microgrid resources, both with and without utility power
- Self sustainability for critical loads during power outages



Increased Interest in Microgrids for Resiliency

- Could gas stations, supermarkets, emergency response facilities and other critical buildings be tied to a common source of power that is immune from power outages?
  - Yes, but it gets complicated…
  - With multiple entities involved, who owns the resources? How is the power sold? What sort of regulations are involved?
  - What types of power generation would make the most sense? How should the resources be configured, controlled and utilized?
- Most of these questions are best handled on a case-by-case basis, but one thing has become clear: <u>all microgrids need a strong, stable source of baseload power, or an “anchor”</u>

Ideal Applications for Microgrids

- Microgrids are easiest to implement in institutional campus settings, like military facilities, government buildings, hospitals, and universities
  - All buildings owned/operated by a single entity
  - Backup power and ability to sustain grid outages is critical, especially for hospitals and military facilities
- Microgrids could be tied to district energy “downtown loops”, providing steam, hot/chilled water *and electricity* to various commercial/industrial/institutional facilities
  - More challenging when each facility is owned and operated by separate entities with different requirements and goals
  - Developing ways for these separate entities to work together and get around regulatory barriers is of critical importance to the success of microgrids

Natural Gas CHP as an Anchor for Microgrids

- An ideal anchor for microgrids provides reliable baseload power, even when the electric grid is down
- Natural gas CHP systems are best-suited for this role
  - CHP currently leads all technologies in microgrid DG deployments
  - Natural gas supply lines are rarely affected by hurricanes, blizzards, or other natural disasters
  - With CHP systems, heat can be efficiently captured and utilized for hot water, chilled water, and steam production

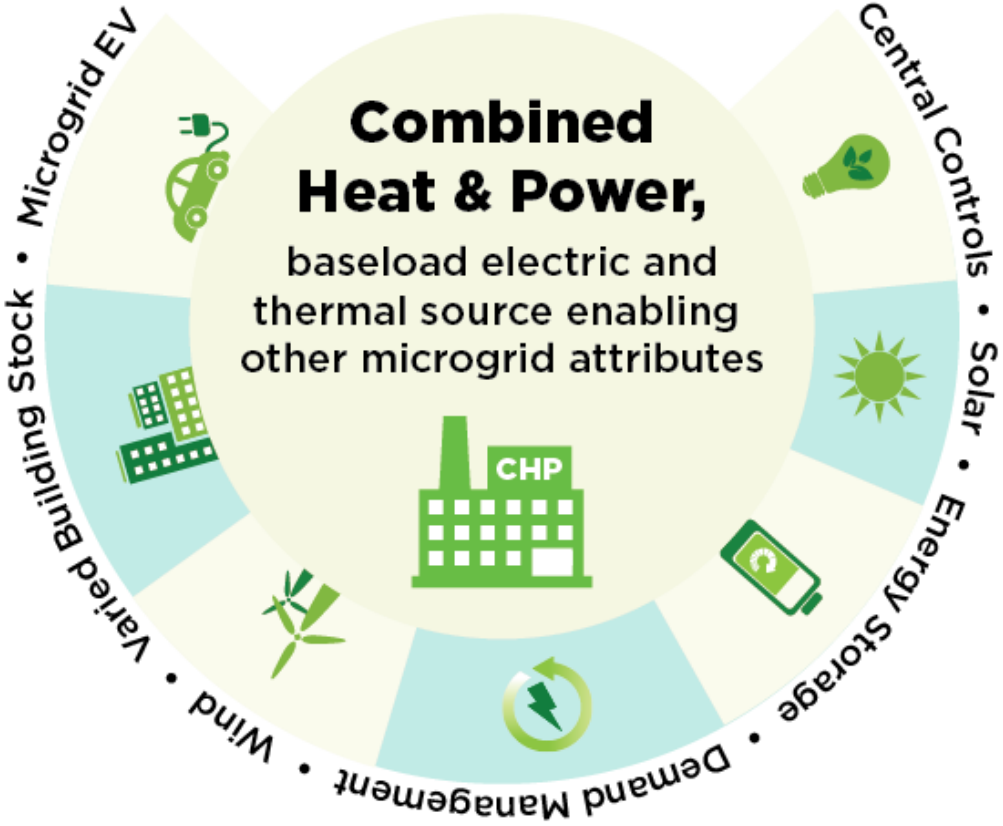
Unison Energy CHP Installation

- With district energy networks, CHP can replace boilers, producing steam, hot/chilled water, and electricity for connected facilities
  - Much of the infrastructure is already in place, while renewable energy and storage can be strategically added to the system

Incentives for Microgrids

- Financial incentives will help CHP owners, communities, and utilities take the first steps in turning distributed resources into microgrids
  - California, Connecticut, Maryland, New Jersey and New York are leading the way, with microgrid solicitations and emerging programs
- Connecticut's DEEP allotted a total of $23 million in funding to 11 pilot microgrid projects in 2013 and 2014, with another $30 million available for new grants as of November 2015
  - To be eligible for funding, microgrids must serve critical facilities like hospitals, police departments, and wastewater treatment facilities
  - Must act as a single controllable entity with islanding abilities
- NY Prize from NYSERDA: Awarded $40 million in funding for 83 community microgrid projects in July 2015
  - Originally planned to award 25 community microgrids $100,000 each for 25 feasibility studies, but increased the pool when 130 applications came in

CHP Systems Enable Other Microgrid Attributes



- With a CHP system providing baseload electric and thermal energy, microgrids can add:
  - Solar and wind resources
  - Energy storage
  - Demand management
  - Electric vehicle charging
- CHP systems improve efficiency and reduce emissions compared to separate electricity and heat
  - With renewable systems added to the microgrid, very significant emission reductions are possible

Existing and New CHP/DE Systems Can Serve as Foundations for Future Microgrids

- Microgrids are not always planned out in advance – they often evolve over time as on-site generation capabilities develop, along with a desire to eliminate dependence on utility power
- There is currently more than 82 GW of U.S. CHP capacity from over 4,400 installations, with systems located in every state
- CHP Installations are increasing every year, and ICF expects the market to expand greatly in 3-5 years due to several factors:
  - Smaller packaged CHP systems with high replicability
  - More “own-operate” PPA-style business models (like Solar City for CHP)
  - EPA’s Clean Power Plan and other environmental regs may increase CHP incentives and awareness of benefits

Locations of Current CHP Systems

- Over 82 GW from over 4,400 sites – many of which could become the foundations for future microgrids (Source: DOE CHP Installation Database and CHPA)

Evaluating the Potential for Microgrids

- With specific locations of installed CHP systems, opportunities for interconnected microgrids can be identified
  - Existing CHP systems can serve as a starting point
    - Model existing CHP installations with GIS tools
    - For multiple CHP systems located in close proximity, identify strategic opportunities for interconnected microgrids that could serve critical facilities
  - Model loads to be served, adding existing/potential renewable energy, storage, and microgrid interconnection/islanding capabilities
  - Evaluate microgrid options, considering potential barriers, incentives, resiliency benefits, and economic viability
- Run optimization algorithm, using these inputs to determine ideal microgrid locations and configurations

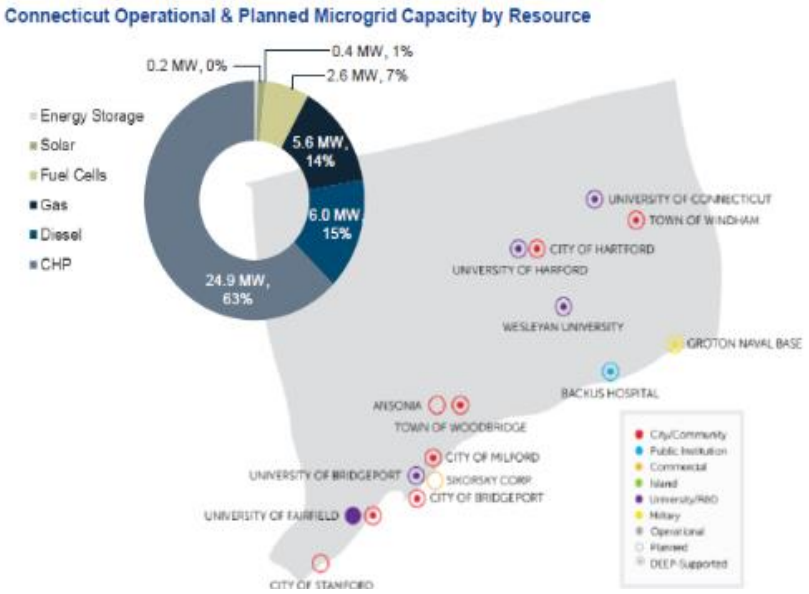
Case Study: CHP Microgrid at UC San Diego

- 92% of UC San Diego's annual 250 GWh is generated through the microgrid system, which has grown over the years to include:
  - 30 MW CHP plant, serving as the microgrid anchor
  - 2.8 MW biogas fuel cell, using ADG from wastewater treatment plant
  - 1.2 MW of solar PV panels distributed throughout the campus
- Data from assets is synchronized with OsiSoft PI System to efficiently maximize available resources

- UC San Diego has a growing electric vehicle fleet with smart-charging capabilities
- Plans to expand microgrid capabilities to cover all campus electricity requirements

Case Study: Fairfield, CT Community Microgrid

- First operational community microgrid from CT grant program
  - $1.1 Million Connecticut DEEP grant awarded in July 2013, with another $130,000 provided from the Town of Fairfield
  - 300 kW natural gas generator and 60 kW CHP engine providing baseload power for microgrid
  - 47 kW from solar PV
  - Energy efficiency measures also implemented
- The microgrid encompasses police and fire stations, an emergency communications center, a cell phone tower, and a public shelter



Source: GTM Research

Conclusions

- Microgrids will be an important part of America's energy future
  - Resiliency for critical facilities during power outages
  - Can be implemented at campuses, communities, and DE networks
  - More efficient and fewer emissions than utility power
- While they can be enhanced by renewable energy and storage, microgrids require a stable source of baseload power that can withstand heavy storms and sustained power outages
- Natural gas CHP systems are the ideal microgrid anchor
- Existing CHP installations can serve as foundations for future microgrid development
- Financial incentives will be critical to the development and deployment of microgrid technologies

Thank You!

Questions & Contact Information

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