

Chicken or Egg?

The Role of Microgrids in Grid Modernization



...it was me, right?

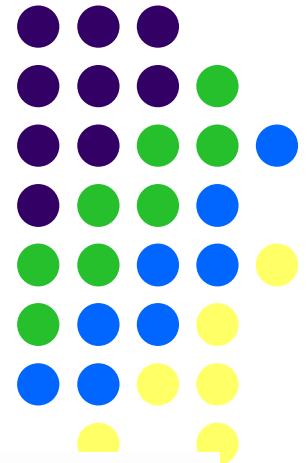
ICEPAG 2019

26 March 2019

University of California - Irvine

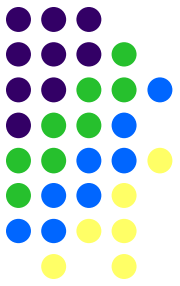
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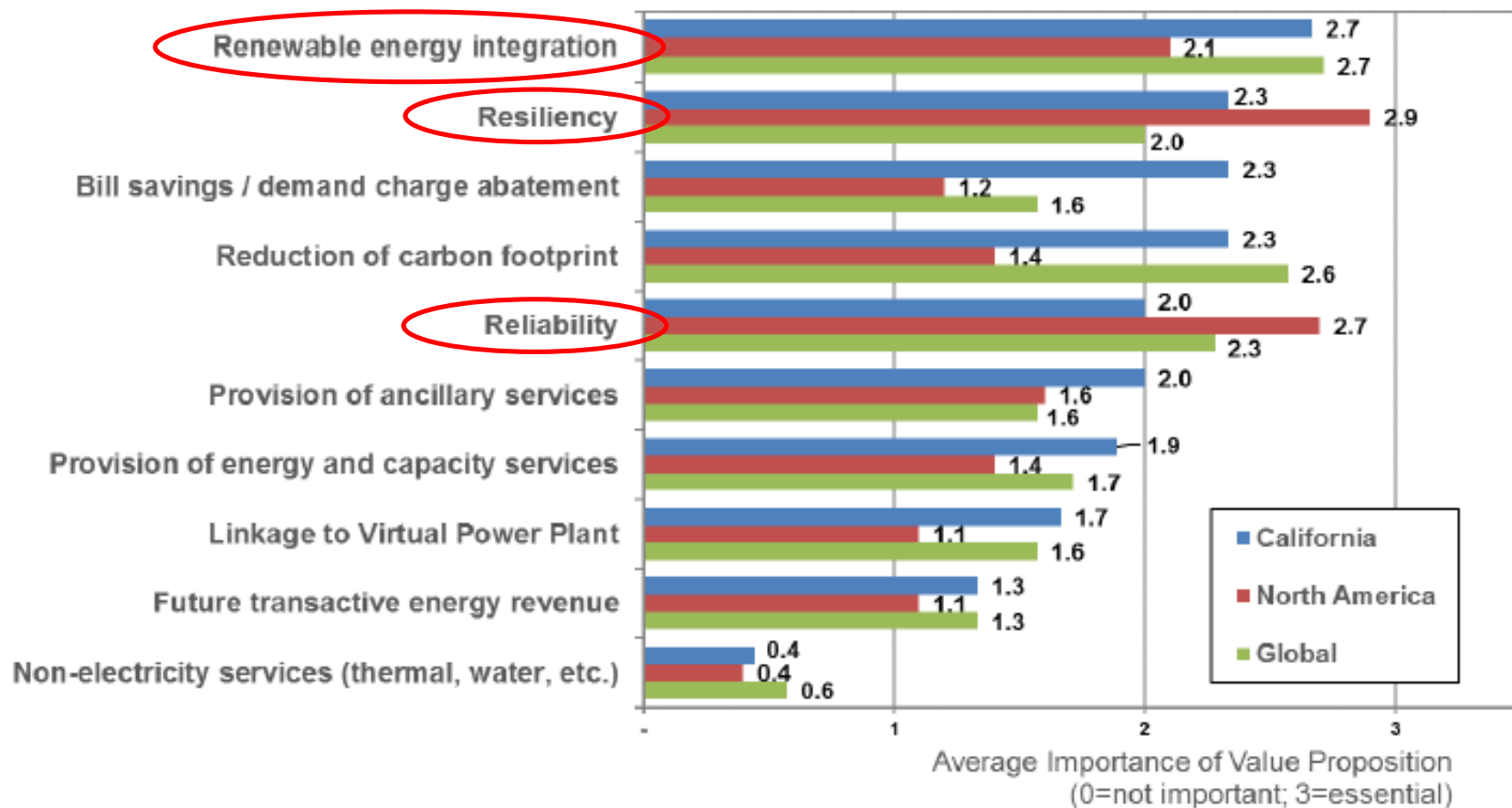
So, What Exactly *IS* a Microgrid???



- Definition not standardized, but here's mine:
 - Multiple distributed energy resources (DERs)
 - Coordinated, interconnected operation of DERs
 - Application of the Internet of Things (IoT)
 - Well-defined geographically
 - College campus, neighborhood, substation, circuit
 - Single point of interconnection with the larger grid
 - Grid operator “sees” a single grid resource
 - Fence line-gate concept
 - Able to be islanded during grid outages
 - Provides increased resiliency and reliability.

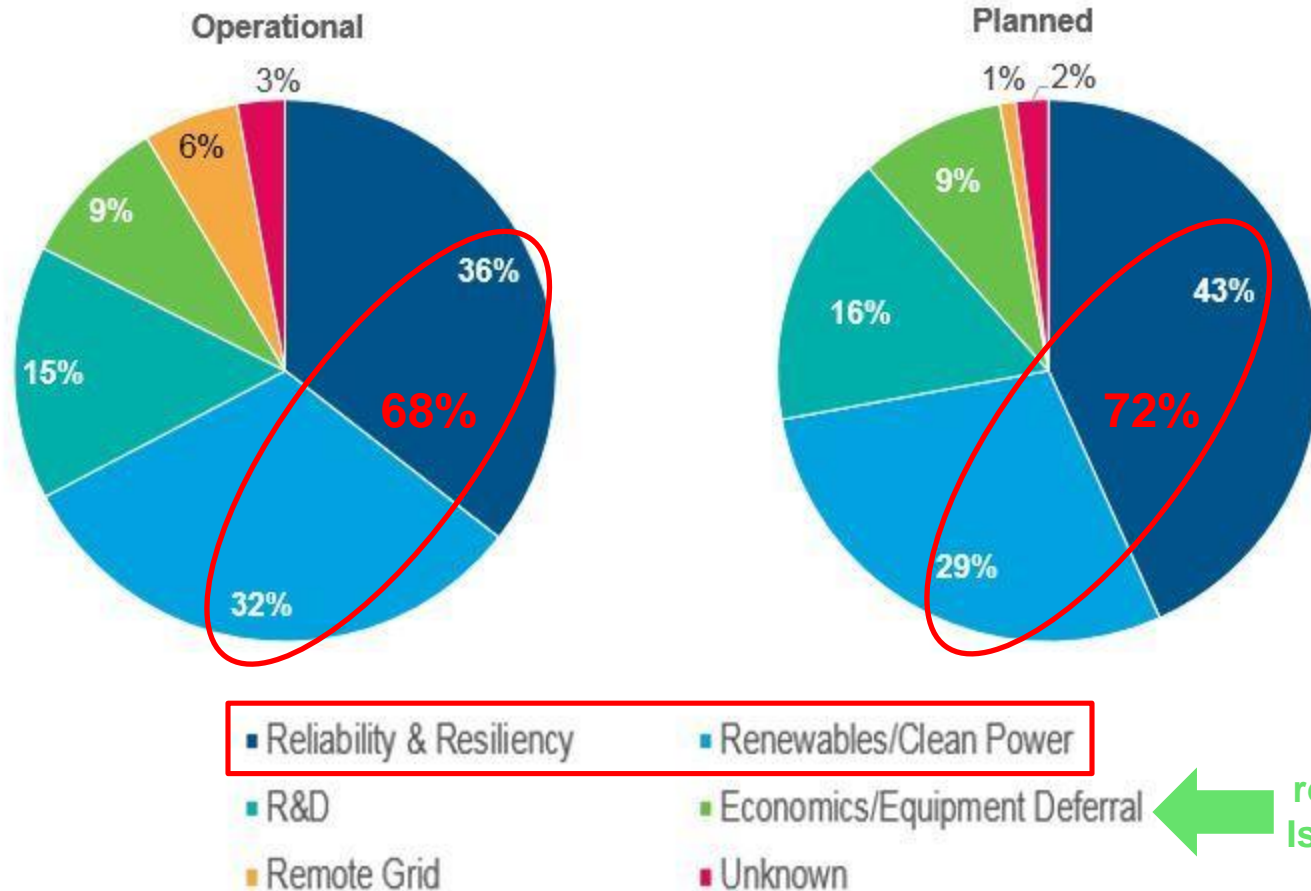
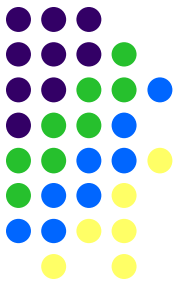
VALUE PROPOSITIONS DRIVING MICROGRIDS TODAY

Case Study Value Proposition Rankings – All Regions



Source: Navigant

Microgrid Drivers: Resiliency, Reliability, and Renewables

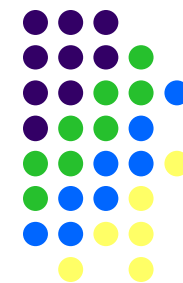
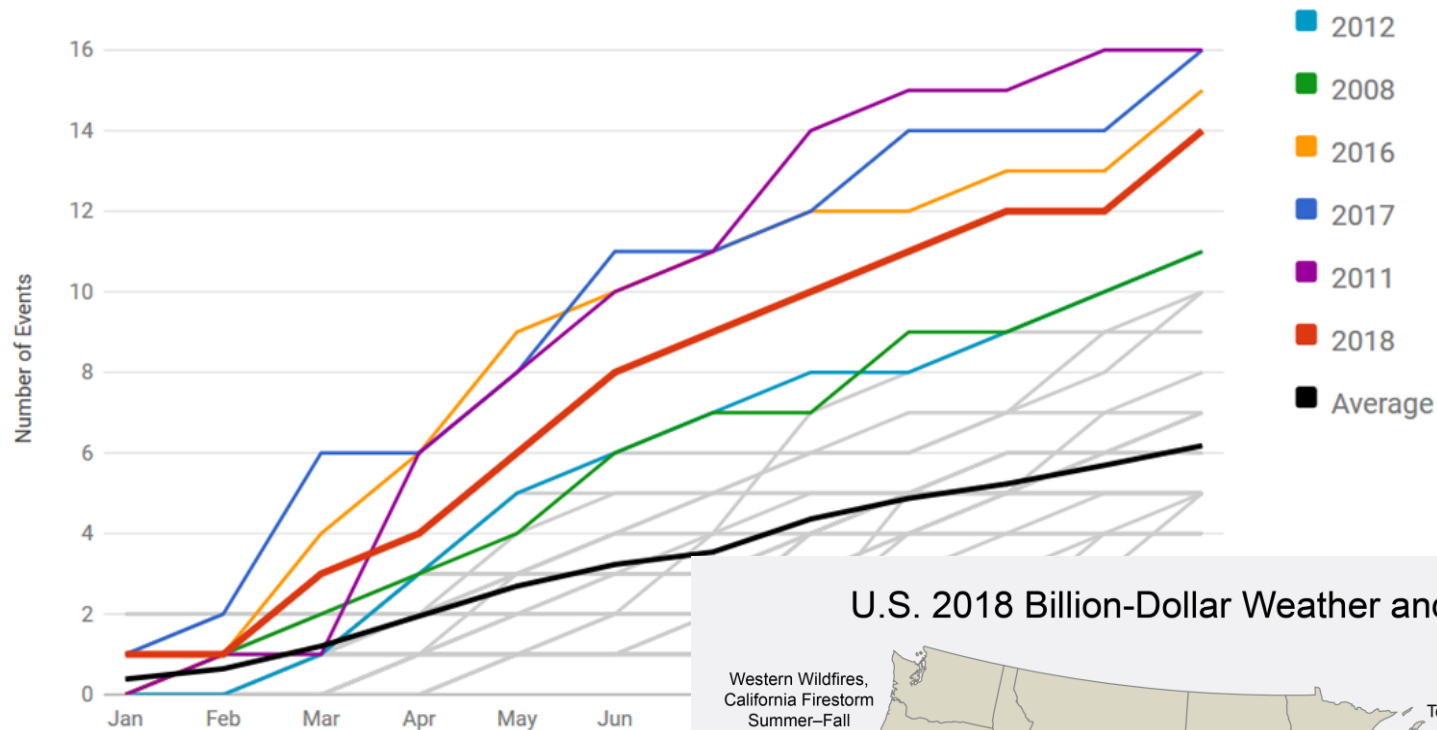


Ostensibly **NOT** a major driver, but reliability & resiliency issues result in major economic impacts.

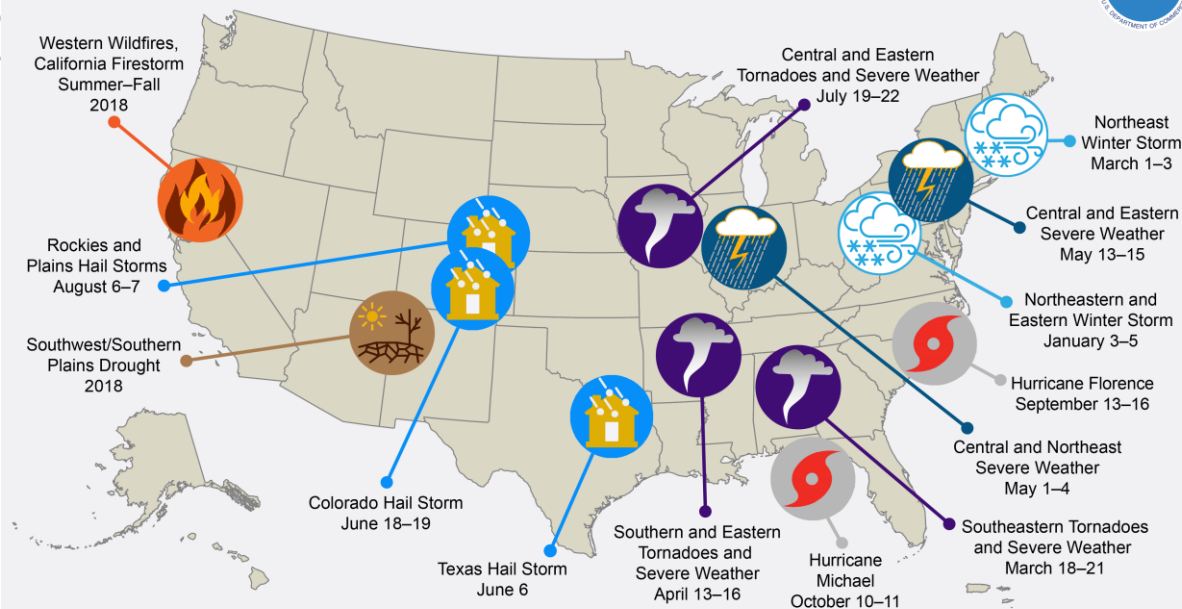
Source: ICF, 10/17/18, *Four Trends Driving the Future of Microgrids*, <https://www.icf.com/blog/energy/microgrid-database>.

1980-2018 Year-to-Date United States Billion-Dollar Disaster Event Frequency (CPI-Adjusted)

Event statistics are added according to the date on which they ended.



U.S. 2018 Billion-Dollar Weather and Climate Disasters



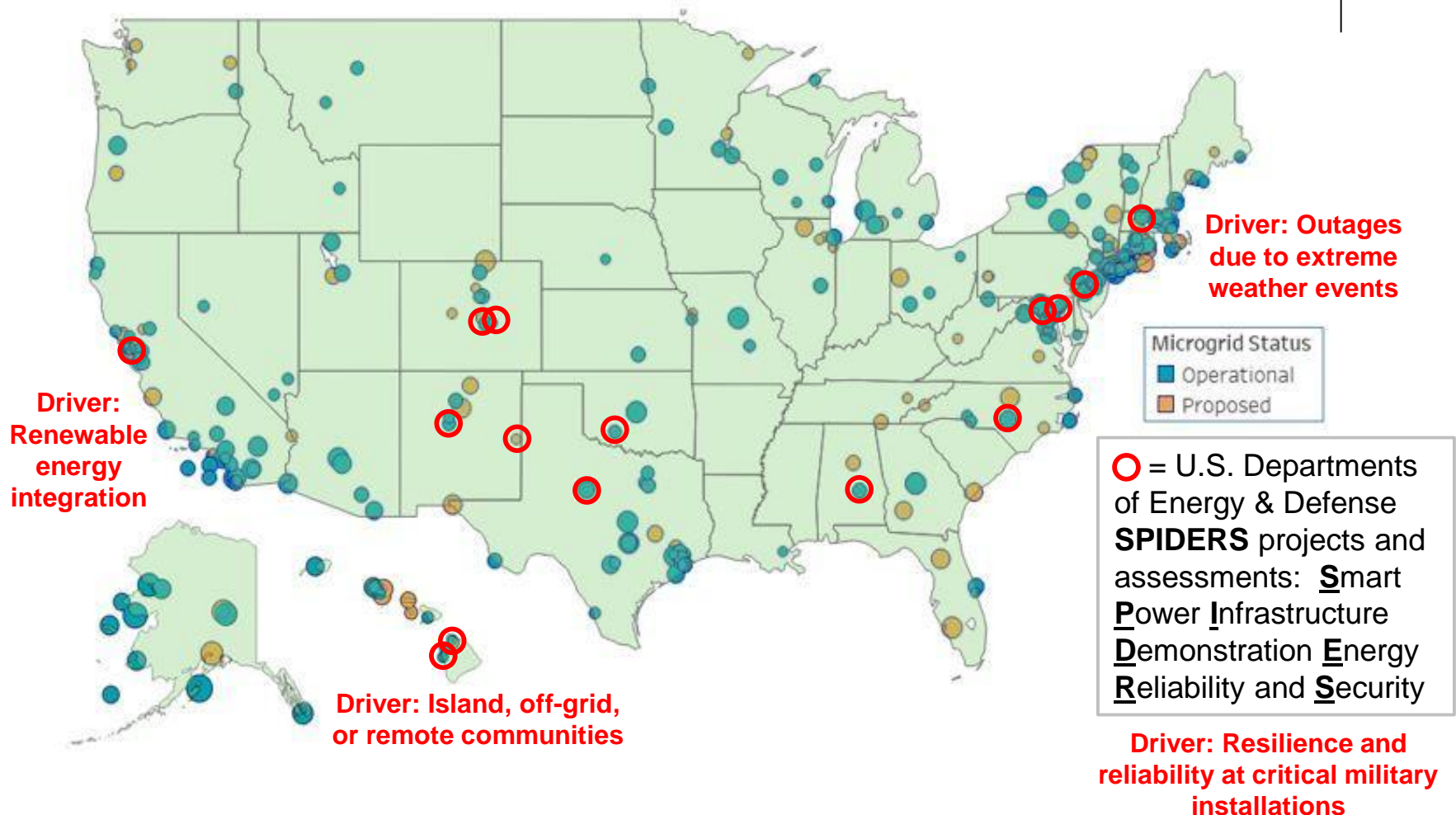
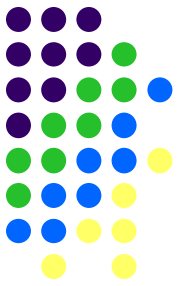
This map denotes the approximate location for each of the 14 separate billion-dollar weather and climate disasters that impacted the United States during 2018.

Source: NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2019).

<https://www.ncdc.noaa.gov/billions/>

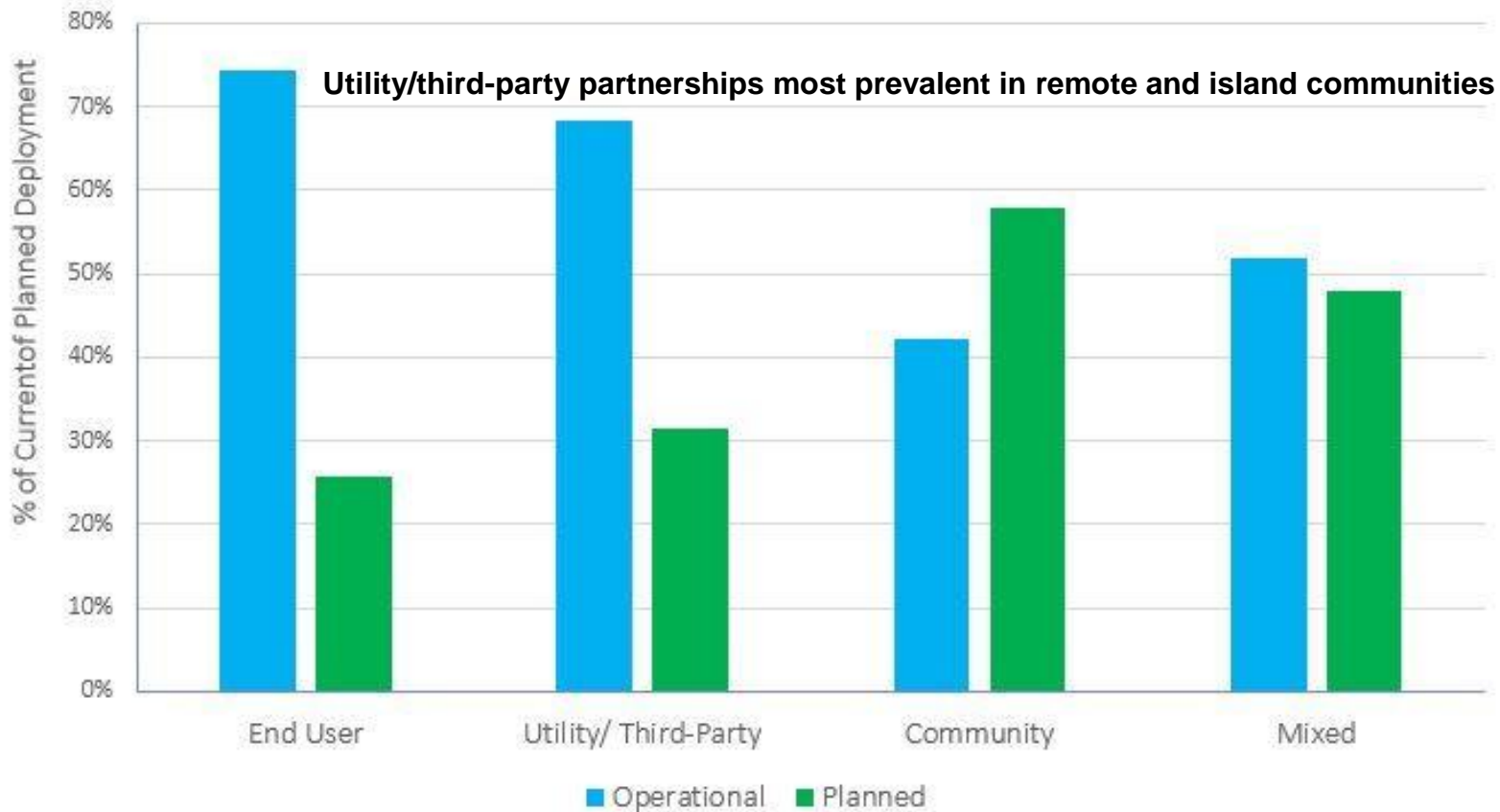
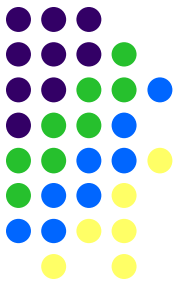
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Regional Microgrid Siting Motivated by Different Factors



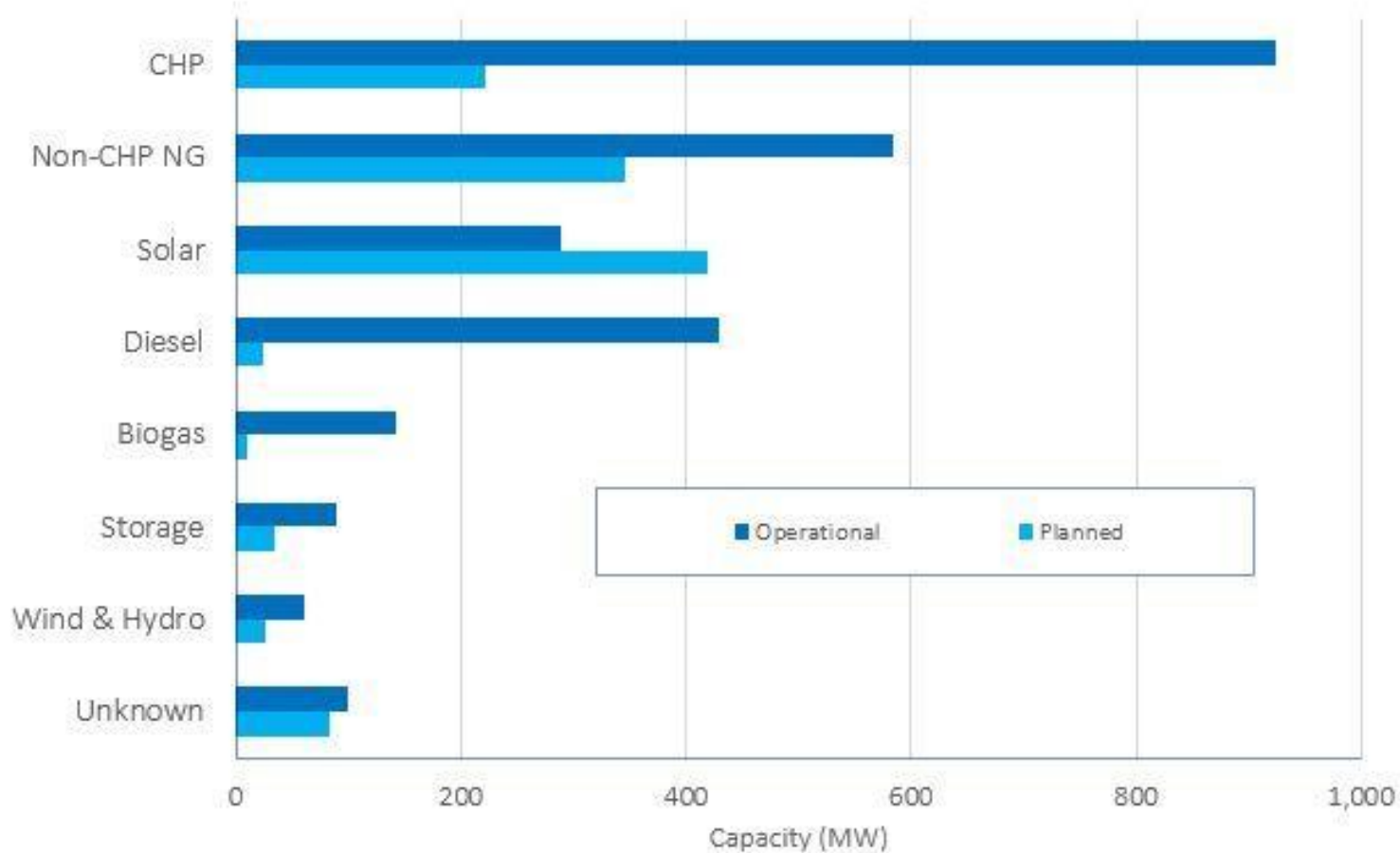
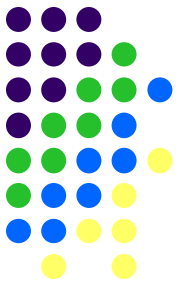
Source: ICF, 10/17/18, *Four Trends Driving the Future of Microgrids*, <https://www.icf.com/blog/energy/microgrid-database>; U.S. Department of Energy, *Microgrid Portfolio of Activities*, <https://www.energy.gov/oe/services/technology-development/smart-grid/role-microgrids-helping-advance-nation-s-energy-syst-0>.

U.S. Microgrids: 3.85 GW Operational, 1.55 GW Planned



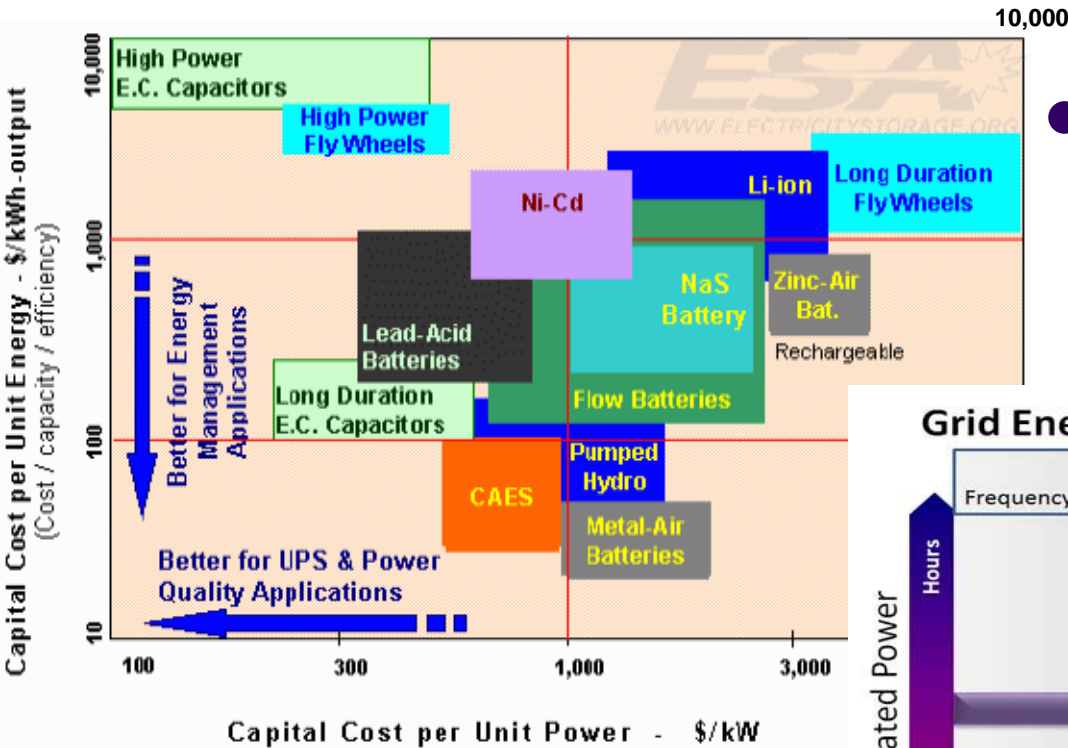
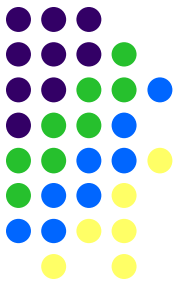
Source: ICF, 10/17/18, *Four Trends Driving the Future of Microgrids*, <https://www.icf.com/blog/energy/microgrid-database>.

CHP dominates in existing systems; solar leads in planned



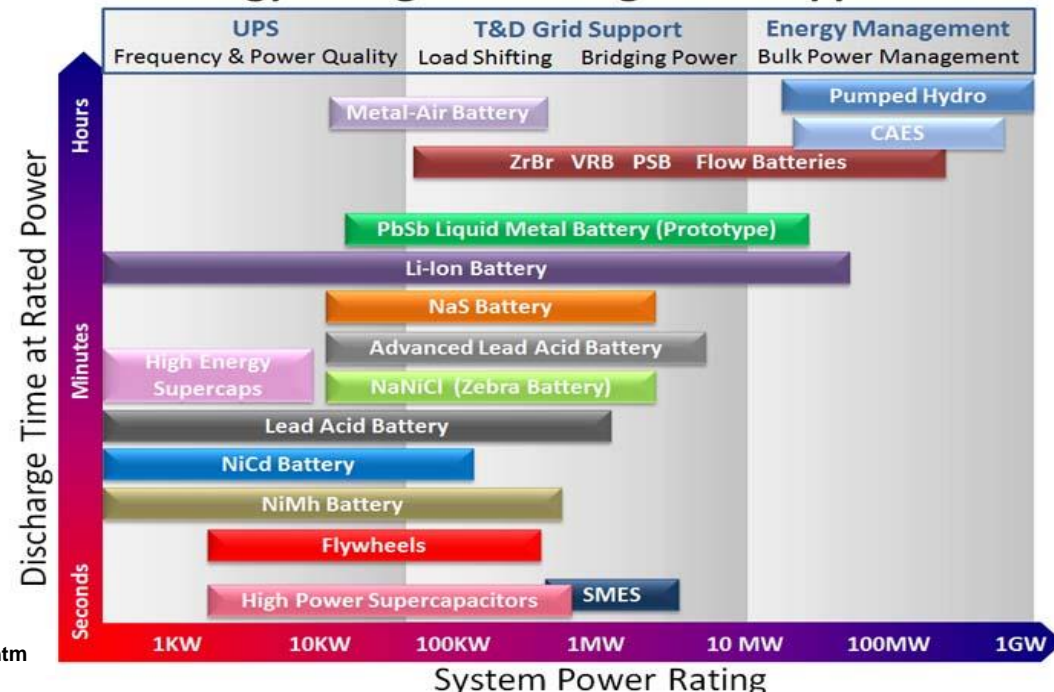
Source: ICF, 10/17/18, *Four Trends Driving the Future of Microgrids*, <https://www.icf.com/blog/energy/microgrid-database>.

Increased Solar Points to Increased Demand for Storage



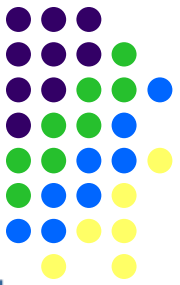
- Best storage type depends on microgrid equipment portfolio.

Grid Energy Storage Technologies and Applications



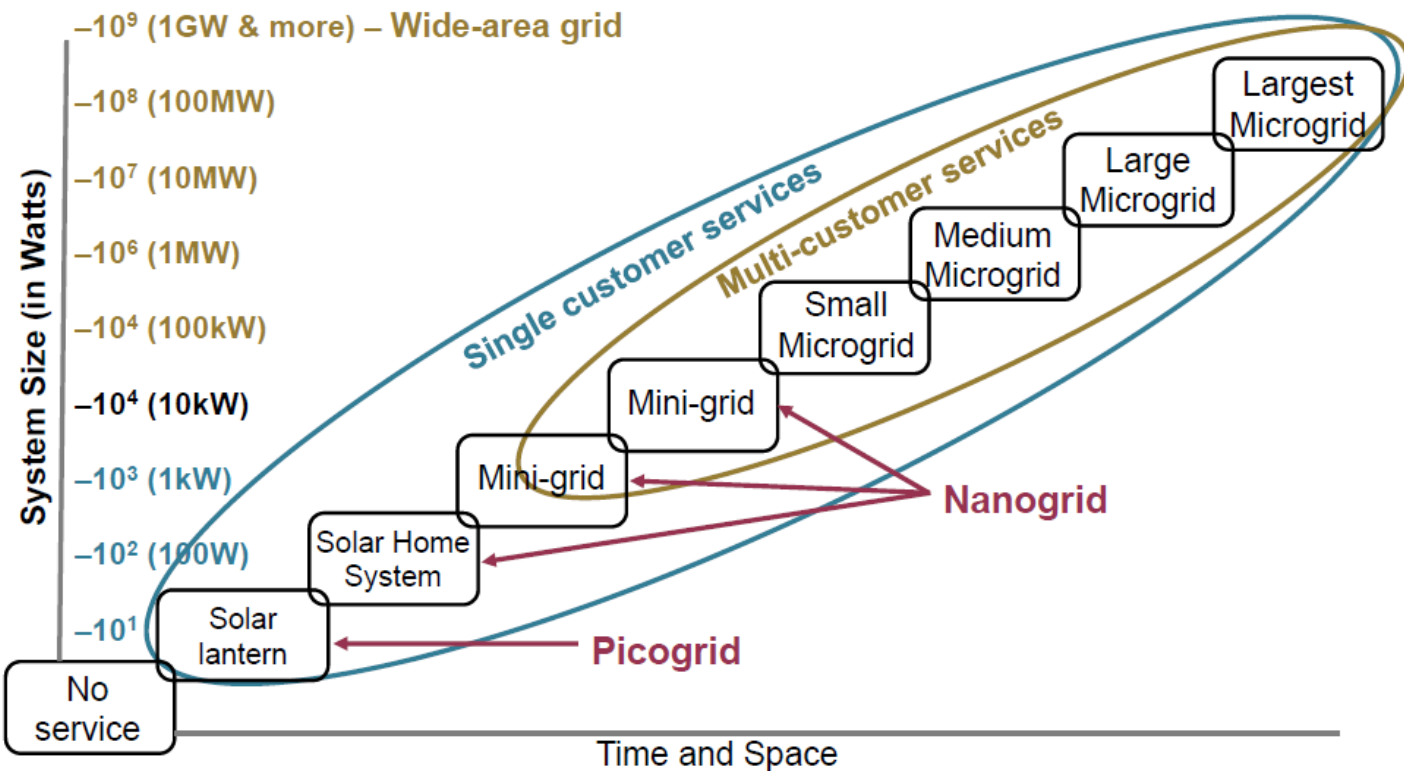
- Power vs. Energy
- Capacity vs. Flow

Microgrids Relevant at ALL Scales, for Multiple Purposes



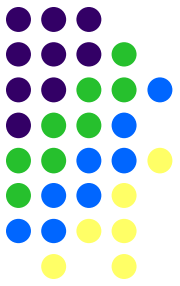
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Heading up or down the energy ladder...
Possible steps to an energizing future



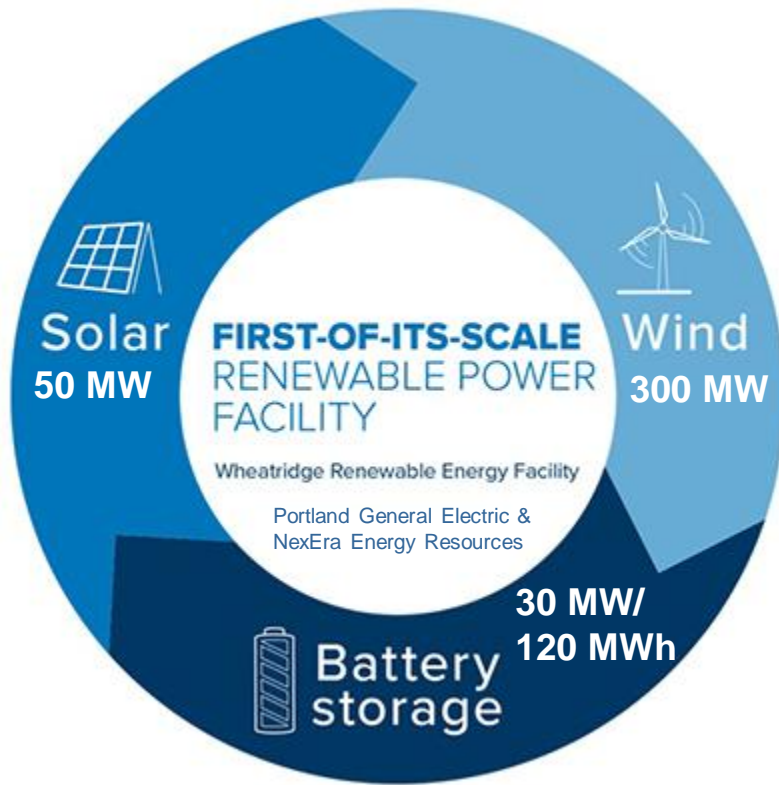
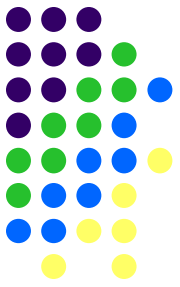
Source: National Regulatory Research Institute, 7/11/18, *Products, Services, and Regulations Up and Down the "Energy Ladder,"* <http://nrri.org/wp-content/uploads/sites/13/2018/07/Tom-Stanton-Energy-Ladder-All-Slides-PDF.pdf>.

Clean Coalition's Large-Scale Community Microgrids



- 8 configurations over an entire grid substation area, in different combinations of 4 factors:
 - DC and AC solar + storage couplings
 - Behind-the-meter (BTM) and wholesale distributed generation (WDG) proximities to the customer meter
 - Net energy metering (NEM) and Feed-In Tariff (FIT) rate tariffs
 - Rule 21 and wholesale distribution tariff (WDT) interconnection tariffs.

Wind + Solar + Batteries: *Grid-Scale "Microgrid"*

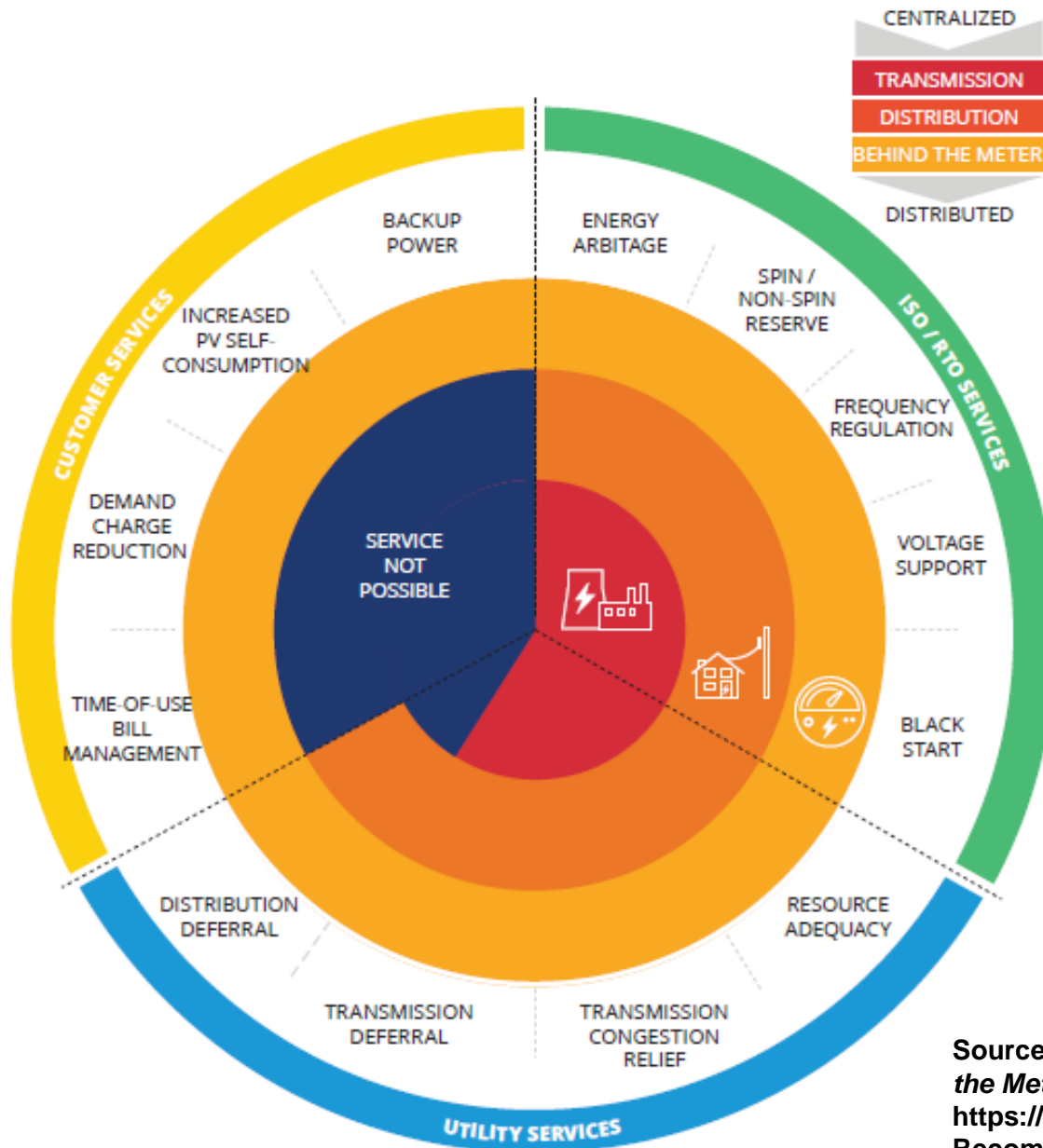
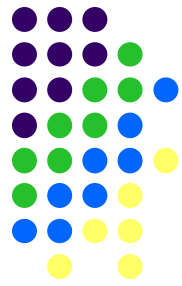


- Increased renewables, reduced emissions, added reliability, single operator
- Partial replacement by 2021 for 550-MW coal plant retirement
- Ideal geography, access to power lines
- Operated under NextEra Energy Resources PPAs

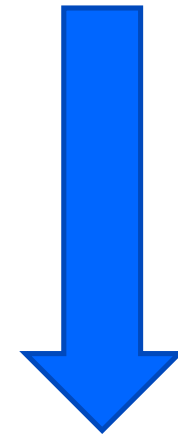
Source: Portland General Electric, *Wheatridge Renewable Energy Facility*, accessed on 2/20/2019.

<https://www.portlandgeneral.com/our-company/energy-strategy/resource-planning/wheatridge-renewable-energy-facility>

Grid Modernization Requires...

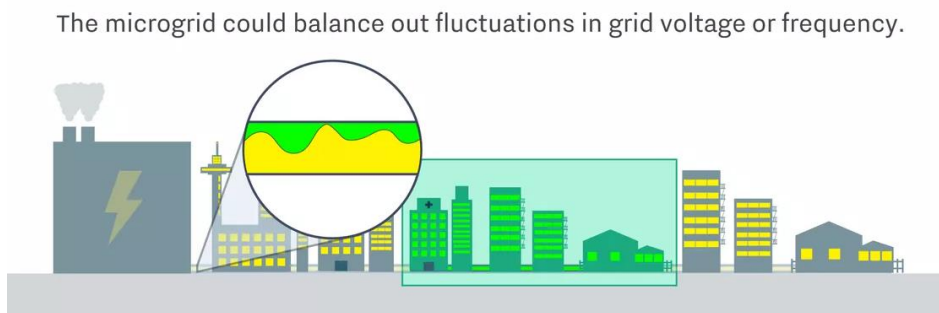
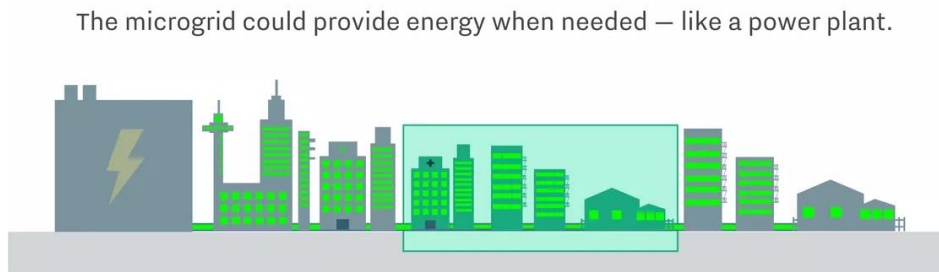
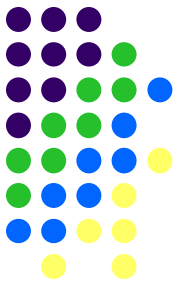
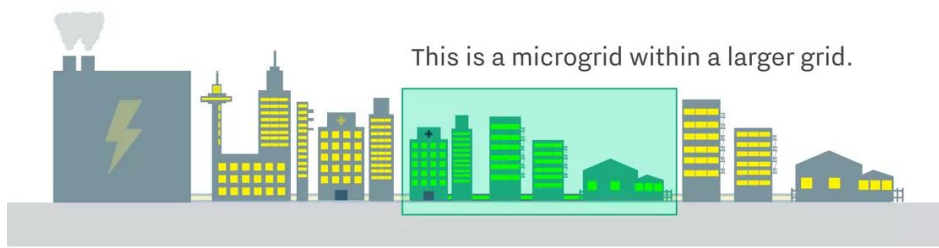


- Change of focus:
“Resources”

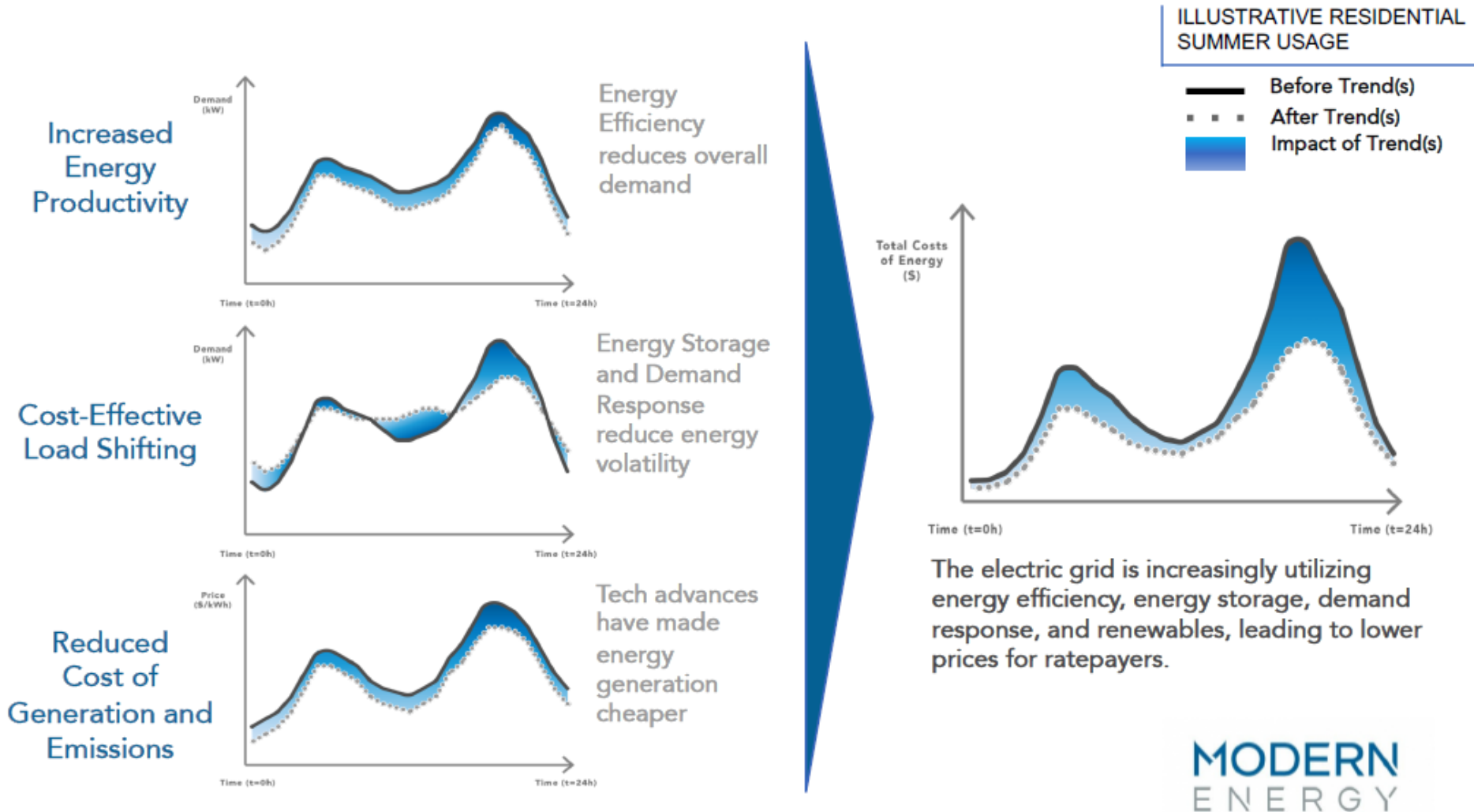


“Services”

Source: Smart Electric Power Alliance, June 2017, *Beyond the Meter: Recommended Reading for a Modern Grid*.
https://info.aee.net/hubfs/PDF/SEPA_AEE_RMI_BTMR-Recommended.pdf

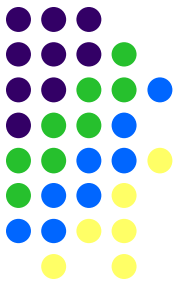


Three trends have the potential to transform the global energy system



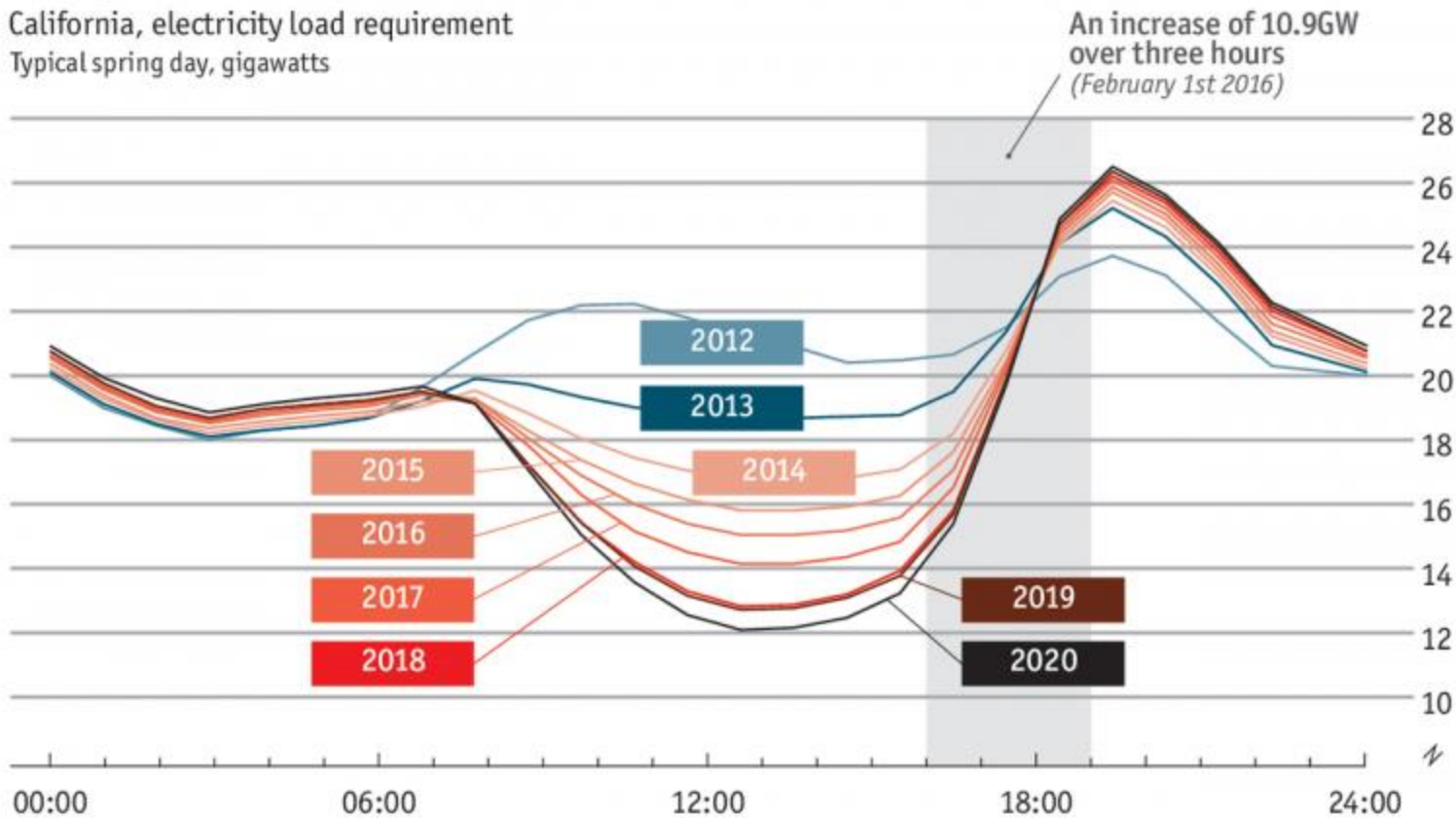
Source: Advanced Energy Economy, 2/27/2019, *Breaking Down Barriers to Advanced Energy in Wholesale Markets*.
<https://info.aee.net/barriers-to-adv-wholesale-markets-archive?submissionGuid=3da2372e-b440-42e2-be26-1ef28d24c496>

“Duck Curve” Requires Fewer Consecutive Peak Hours



Who gets the bill?

California, electricity load requirement
Typical spring day, gigawatts

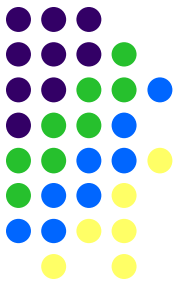


Source: California ISO

Source: The Economist, 3/28/2018, *What a ten-year-old duck can teach us about electricity demand.*

<https://www.economist.com/graphic-detail/2018/03/28/what-a-ten-year-old-duck-can-teach-us-about-electricity-demand>

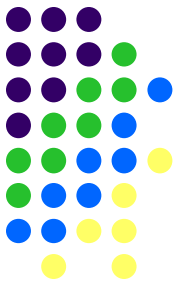
Regulatory Change Is Difficult and Slow



- Existing regulations and grid were designed for centralized generation and one-way flows
 - Risk-averse, invested incumbents
 - High expectations of reliability
- Ability of behind-the-meter DERs to participate fully in wholesale energy markets is limited
- Services provided by energy limited resources (ELRs) vs. specific technologies
 - Demand side vs. supply side impact
 - Energy vs. capacity impact

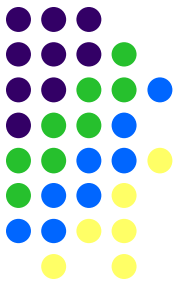


20 MW of ISO-NE Capacity from *Home Solar + Batteries*



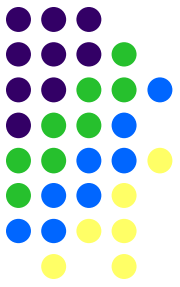
- ISO-New England's 13th Forward Capacity Auction, for 2022-23 delivery year
 - To supply capacity to wholesale power market, typically provided from centralized power plants
- Capacity from a virtual power plant (VPP)
 - VPP to be made up of ~5,000 of Sunrun's BrightBox home solar and battery systems
 - Sunrun CEO Lynn Jurich: "This is a breakthrough moment...This new energy services model is a win-win for everyone."
- Sunrun has partnership with National Grid.

Blockchain: Technology Greases the Microgrid Skids



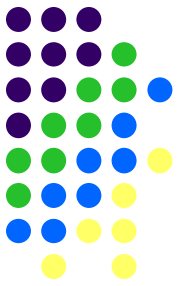
- Peer-to-Peer (“P2P”) real-time transactions
 - Instantaneous transactions/trades at any scale
 - “Smart contracts” reduce performance risk
- Secure encrypted computer algorithms
 - Transparent, immutable public ledger of activity
- Optimizing *physical* DERs can *financially* benefit producers, prosumers & consumers
 - Enables concept of “Virtual Power Plant”
- Best application is for fungible commodities.

Artificial Intelligence (AI): Scalability Critical for Growth



- Computational power, access to big data, algorithms key to AI growth and success
- Robust data analytics required to analyze trends in large (and growing) amounts of data
 - Increasingly important as systems get more complicated; “squiggly line problem”
 - Data quickly becomes too complicated for non-machine interpretation
- AI trains itself over time to avoid false positives.

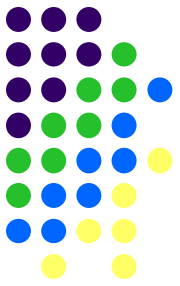
Cybersecurity: Microgrids As Easy Backdoor to Larger Grid?



- NY IOUs are seeking PSC requirement for:
 - Cyber Insurance
 - Data Security Agreement
 - Details each utility's cybersecurity requirements
 - Vendor-specific cybersecurity questionnaire
- Issues: Cybersecurity, cybersecurity incident costs (\$17 MM each in 2017), cost-shifting
- Naysayers argue against significant new requirements not currently in PSC rules.

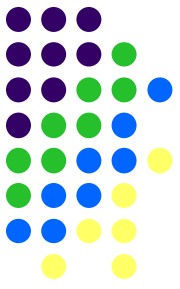


Green New Deal: Microgrids Arguably Get a Federal Boost



- House Resolution 109, 116th U.S. Congress
- Green New Deal goals to be accomplished through 10-year national mobilization, including:
 - Meeting 100% of the power demand in the U.S. through clean, renewable, and zero-emission energy sources
 - Building or upgrading to energy-efficient, distributed, and “smart” power grids, and ensuring affordable access to electricity.

Lessons and Observations Relevant for Microgrids



- Technology and controls absolutely critical
 - Both operationally and for ongoing economics
- “Services” more important than “resources”
 - Off-setting resources enable services optimization
- Regulations are lagging industry changes, potentially undervaluing services of DERs
- Multiple resources complicate “valuation”
 - Economic quantification vs. more qualitative assessment of resiliency and reliability services
 - Resiliency and reliability arguably still economic!

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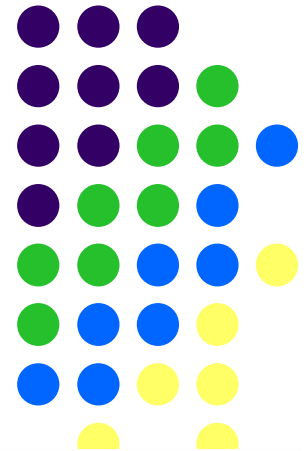


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QUESTIONS?

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