KEY INSIGHTS FOR EXPANDING MICROGRID DEVELOPMENT

C2ES SOLUTIONS FORUM

C2ES held a half-day Solutions Forum in March 2017 in Washington, D.C., focusing on the benefits of microgrids and examining what is standing in the way of accelerating their deployment. Two panels, comprising business and city leaders, shared their first-hand experience in the small, but rapidly developing microgrid industry. Discussion focused on what developers are learning from successful microgrid projects and overcoming obstacles to deployment. About 100 people, including policymakers, entrepreneurs, and academics, attended the forum at The George Washington University School of Law and 200 watched online.

Watch video of the event: http://bit.ly/MicrogridsMarch17

Learn more about the C2ES Solutions Forum: http://www.c2es.org/initiatives/solutions-forum

MICROGRIDS' MOMENT

When Hurricane Sandy cut off power to millions of homes and businesses in the Northeast, a few areas, mostly parts of universities, kept the lights on using their own power generation systems. This ability to sustain electricity service during widespread natural disasters is one reason for the growing interest in microgrids. But they offer other important benefits as well. By increasing efficiency, integrating renewables, and helping man-age energy supply and demand, microgrids can reduce greenhouse gas emissions and save energy. For utilities, microgrids can ensure power reliability in remote service areas. Microgrids also appeal to parties looking for self-sufficiency and independence.

A microgrid is defined as a relatively small, controllable power system composed of one or more generation units connected to nearby load that can be operated with, or independently from, the local distribution and bulk (i.e. high-volt-age) transmission system.

Microgrids currently provide a tiny fraction of U.S. electricity (about 1.6 gigawatts of installed microgrid capacity, or less than 0.2 percent), but their capacity is expected to more than double in the next three years.

PRACTICAL ADVICE FOR MICROGRID DEVELOPERS

Microgrids are unique undertakings that can be developed in remote, suburban, or urban settings for diverse customers using diverse power supplies. A decade ago, Shalom Flank currently with Urban Ingenuity, became the nation's first microgrid architect. Dr. Flank offered three key strategies for designers, particularly for microgrids in urban settings:

1. *Maximize solar, but don't depend on it.* Buildings are too tall, even in a moderate density setting, to get much of more than 5-10 percent of power from solar in urban areas.
2. *Remember thermal.* In most places, 40 percent of building energy consumption is used for heat-

ing, air conditioning, and hot water. If you're not using the heat generated by the microgrid, you won't achieve the desired financial returns and emissions reductions.

3. *Go for scale*. Fixed costs, including upfront design, are expensive no matter what size microgrid is being designed. Look for ways to pay back fixed costs by maximizing the scale of the project, e.g., multi-megawatts over millions of square feet.

Dr. Flank identified five categories of microgrids – three are economically viable frameworks, while the other two are not.

1. The classic success model, considering primarily the urban situation, is the "*combined heat and power (CHP) plus solar*" microgrid. These work downtown, on campus, or at a large facility like a hospital. With improvements in modern electronics and controller technologies, these projects can earn even greater revenues (e.g. providing grid services).
2. *"Thermal only"* microgrids pay for themselves. These involve creating a condenser water loop across multiple buildings with heat sources and sinks. They are highly efficient for serving heating and cooling loads. There is no resilience benefit in this instance, but emissions savings are excellent.
3. *"Solar saturation"* microgrids are viable. The current grid can't accommodate an entire neighborhood where all homes have solar without a microgrid. This kind of project provides emissions and resilience benefits.
4. The "*backup power"* microgrid is an unsuccessful strategy. Projects that only turn on when the grid goes down leave valuable assets idle too often. The owner is not receiving any financial return on the assets or realizing an emissions benefit because, most of the time, the microgrid is not operating. There may be a resilience benefit; however, since the project is not operating regularly, it's unclear that the microgrid will function correctly when it is called upon.
5. "*Firehouse plus library*" is another model that tends to fail. These are small projects with very low thermal loads, so they are not realizing any significant thermal benefits. Also, there is insufficient scale for meaningful emissions reduction. There is a resilience/public purpose benefit, but little else.

Each microgrid's unique combination of power source, customer, geography, and market can make financing these projects a challenge. Financial feasibility studies, simulation modeling, and public-private partnerships all could play a growing role in overcoming financial hurdles. Additionally, Sudipta Lahiri, a senior consultant with DNV GL, noted that companies can collaborate with developers to help smooth the financing process. Companies can work with microgrid developers, reviewing their processes and preparing reports for investors. They understand the language of the technologists and the financiers and can successfully navigate between the two worlds, increasing the likelihood of financial support.

Joel Langill, cybersecurity expert at engineering design firm AECOM focused on the importance of microgrid security. Planning to protect against manmade (e.g., cyber) and natural (e.g., weather-related) threats should be factored into the earliest stages of project design. Developers should perform threat vulnerability and risk assessments for infrastructure projects, and consider their options to address them. For example, some microgrids (e.g., defense) are particularly attractive targets for malicious attacks. The benefits of microgrids are enormous, but If security standards and expenses are high, profitability can become challenging.

LESSONS LEARNED FROM MICROGRID DEPLOYMENTS

Company and city leaders shared what they've learned and continue to learn from microgrid projects now operating. Here are four key lessons learned:

1. Several business models have been attempted over the years, but long-term public-private ownership microgrids are gaining popularity because they allow for flexible sharing of project risks and management. These long-term collaborations between the private sector and the government make it easier to create viable or "bankable" projects, structured such that cash flow is capable of meeting debt and equity investor return requirements. Mixed ownership microgrid projects, which could include money from public institutions, utilities,

and private entities, have increased from nearly zero in 2013, to a projected 38 percent of the market in 2016. Kevin Self, a senior vice president with Schneider Electric North America, cited a recent example in Maryland, where Schneider Electric, Duke Energy, and the Montgomery County government are collaborating on two microgrids to power county facilities. Ratepayers won't have to foot the bill, and the government will get more resilient and affordable power with environmental benefits.

2. Microgrids provide benefits to owners and consumers in several ways. Kyle Haas with the DC Department of Energy and Environment used the Food and Drug Administration (FDA) Federal Research Center microgrid in White Oak, Maryland, as an example of the multiple benefits. The 55 MW project has an inherent resilience value to the FDA; there is a tangible monetary loss if scientific experiments are ruined due to loss of power and climate control. While surrounding areas went dark during the 2011 earthquake, the 2012 Derecho event, Hurricanes Irene and Sandy, and numerous other storms, the FDA center's microgrid remained online. Additionally, the project prevents about 72,000 metric tons of carbon dioxide equivalent emissions per year. It helps support the existing macrogrid by providing ancillary services; a source of additional revenue for the microgrid.

3. For remote locations unconnected or poorly connected to the macrogrid, microgrids may be the only solution to provide reliable electric service. Tom Fenimore, technology development manager at Duke Energy, discussed the small, but noteworthy microgrid that will provide crucial emergency communications for Great Smoky Mountains National Park. The solar-plus-battery installation will remove the need for an existing overhead power line. Once the project is implemented, the line can be removed and 13 acres of park can be restored.

4. Many large U.S. companies are committed to working on their own and in partnership with governments to mobilize the technology, investment, and innovation needed to transition to a sustainable low-carbon economy. Pete Fuller, a vice president at NRG Energy, one of the country's largest independent power producers, underscored his company's goal to reduce its emissions by 90 percent from 2014 levels by 2050. Among NRG's many clean-energy initiatives, it has turned its Princeton, New Jersey, headquarters into a fully-islandable microgrid demonstration project laboratory where NRG can test and refine ideas for real-world applications. Additionally, NRG collaborates with grid operator PJM to explore how microgrids can enhance macrogrid operations.

CONCLUSION

Microgrids are an exciting resilience and reliability technology, offering environmental benefits and cost-saving opportunities. They are one of a handful of technologies that can both improve resilience and achieve some mitigation results. With the right planning approach, they can be successful enterprises. The C2ES event highlighted many of the positive aspects and some of the pitfalls microgrids have faced.

Additionally, panelists noted hurdles that microgrids face, including financing challenges due to project complexity and the need for a clearer legal framework to define and set forth the rights and obligations of the microgrid owner with respect to its customers and the macrogrid operator. Also, franchise rights granted to utilities may limit microgrid developers' access to customers. Addressing these and other barriers is essential to the wider deployment of microgrids.

C2ES will continue to work with stakeholders to help businesses, states, and cities collaborate on future microgrid deployments, focused on capturing the benefits and working through the barriers.

CENTER FOR CLIMATE AND ENERGY SOLUTIONS

The Center for Climate and Energy Solutions (C2ES) is an independent, nonprofit, nonpartisan organization promoting strong policy and action to address our climate and energy challenges. The C2ES Solutions Forum brings together businesses, states, and cities to expand clean energy, reduce greenhouse gas emissions, and strengthen resilience to climate change.

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