



MICROGRID KNOWLEDGE

Healthcare Microgrids

The path to more reliable, clean, lower cost
energy in hospitals



brought to you by **HITACHI**
Inspire the Next

CONTENTS

CHAPTER 1		CHAPTER 5	
Overview: The Value of Healthcare Microgrids	2	The No Money Down Healthcare Microgrid	10
Proton beam therapy	2	U.S. Electricity Prices for the Commercial	
Invisible energy loss	3	Sector 2017	11
What is a microgrid?	4	Achieving a wedge of savings with healthcare	
CHAPTER 2		microgrids	11
Why Healthcare Microgrids are Important to		Bringing intelligence to the right resources	12
Communities.	4	CHAPTER 6	
How microgrids work in a crisis.	5	Profiles of Real World Healthcare Microgrids	13
Microgrids during normal operations	6	Dell Children’s Medical Center in Austin, Texas	13
Common resources within a healthcare microgrid	6	Longwood Medical Area of Boston	14
CHAPTER 3		Utica Healthcare Migrogrid.	14
More than Back-up Power: The Genius of the		Princeton Healthcare System.	14
Healthcare Microgrid	7	Tampa General Hospital	14
Infusing genius into generators	8	Shands Cancer Hospital at the University	
CHAPTER 4		of Florida.	15
What Makes Healthcare Microgrids Efficient		Huntington Hospital, NY	15
and Green?	9	Buffalo Niagara Medical Campus	15
Energy efficiency as a hallmark of sustainability.	9	About Hitachi America Microgrids	15
What is combined heat and power?	9		

Chapter 1

Overview: The Value of Healthcare Microgrids

The senior population is on a path to double in the U.S, and even triple in Europe, [according to the U.S. Census Bureau](#). This creates pressure to expand hospitals, healthcare networks, assisted living facilities, adult day care and nursing homes.

Add advances in medical technology, which result in new equipment that needs to be housed, and it’s easy to see why so many hospitals are adding new wings, buildings and satellites. [A survey](#) of 3,125 hospital executives last year found that 70 percent had projects under construction or planned in the next three years.

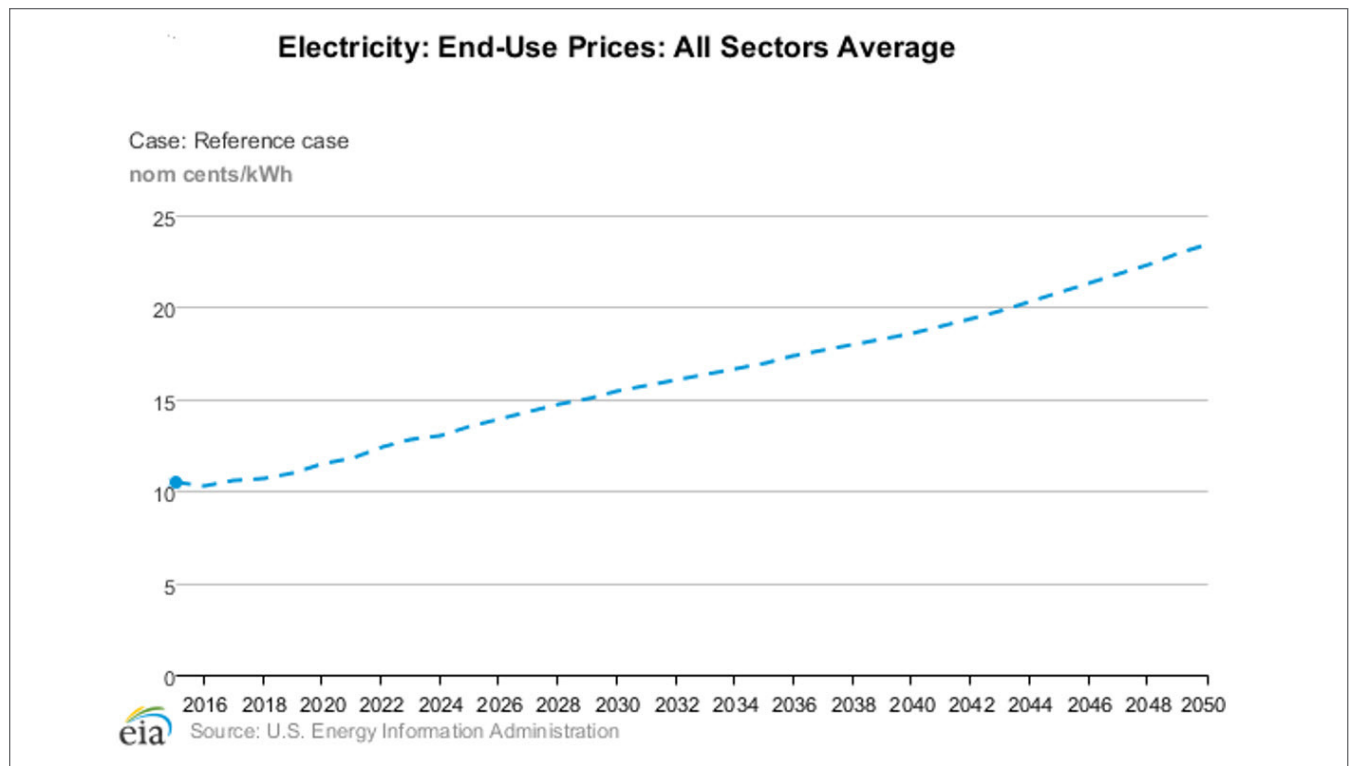
All of this expansion means a greater need for energy — in a sector that is already highly energy intensive.

A survey of 3,125 hospital executives last year found that 70 percent had projects under construction or planned in the next three years.

Hospitals use [2.5 times](#) as much energy as commercial buildings of the same size. This isn’t surprising given that hospitals must care for patients 24/7, which creates greater demand for lights, heat and cooling, as well as large amounts of hot water and steam for equipment sterilization, and refrigeration for temperature sensitive medications.

Proton beam therapy

Proton beam therapy, which uses protons in a highly targeted way to destroy cancer cells, and usually requires a medical building itself, is one example of a technology spurring building in healthcare. The number of regional proton centers in the U.S. has expanded about five-fold over the last decade, with nearly another dozen in planning, according to the [National Association of Proton Planning](#).



For all of these reasons, energy use is a top concern for healthcare executives, especially when they look at electricity price projections that show rates rising in the coming years. The U.S. Energy Information Administration forecasts that average electricity prices will increase from 10.6 cents/kWh in 2017 to 23.5 cents/kWh in 2050.

Invisible energy loss

So what's the best step forward, as hospitals expand, energy costs rise, and administrators feel pressure to focus more keenly on energy management?

One way is to take a careful look at existing energy infrastructure. How old is it? Often upgrades to boilers, generators, piping, metering and other equipment get put off as more pressing core needs consume a hospital's capital budget. Aging equipment is often inefficient, adding a premium to energy costs.

A second consideration is: How well do the hospital's energy systems work together? Are they integrated to achieve maximum efficiency? Or were they installed ad hoc as the hospital expanded its square footage? And was consideration given to how one system might influence another? Too often hospitals lack a long-term energy site plan. Often, hospital sites have added buildings and facilities as needed over the years to support growth of

programs and services, resulting in an inefficient site energy picture.

Both of these situations can lend themselves to invisible energy inefficiencies. It may not become apparent how much money has been wasted until the hospital adds newer, more intelligent equipment, and sees the difference in usage.

"If you're looking at physical expansion of your hospital today, you need to get your arms around energy planning," said Steve Pullins, vice president of energy solutions at Hitachi America. "Take a look at on-site generation resources, like microgrids. You will be surprised at how valuable this proves to be."

In this paper, we will explain how healthcare microgrids bring intelligence and efficiency to a hospital's energy planning. A microgrid employs a highly advanced software controller, a 'brain,' to optimize and synchronize the various pieces of energy equipment. Microgrids also contain more than one form of energy—often some combination of solar, energy storage and combined heat and power (CHP). The microgrid controller can determine which combination of energy resources to employ at any given time, based on hospital management goals. For example, it may optimize its energy resources to help the hospital meet budget goals, sustainability targets or other metrics.

Perhaps most important, a microgrid ensures that a hospital keeps the lights on during power outages. By now everyone has heard the dramatic stories from Superstorm Sandy—the medical personnel in darkened staircases feeling their way out to exits, trying to transport critical patients to safety. Hospitals with microgrids were spared this trauma, and in fact acted as a refuge for patients evacuated from hospitals that were not so lucky.

This report will explain why hospitals are increasingly installing microgrids. We will describe a healthcare microgrid model that delivers reliable, lower cost, sustainable energy under a more predictable long-term schedule than utility power, freeing up capital so that hospitals can focus on core services. And last we will provide some real-world examples of healthcare microgrids in action.

What is a microgrid?

A microgrid contains distributed energy resources (DERs) that directly serve one or more customers. The DERs are often solar, combined heat and power, energy storage, or other forms of energy generation located near the customers they serve. Most U.S. microgrids can operate connected to the central grid or independently (in ‘island’ mode). Intelligent control software manages the resources and their relationship to the central grid. The controller typically is programmed so that the customer receives the most efficient and economic energy at any given time. When a power outage occurs on the grid, the microgrid islands itself for protection and continues serving its customer, sparing them loss of electricity.

Chapter 2

Why Healthcare Microgrids are Important to Communities

Society has grown increasingly aware of the electric grid’s vulnerabilities. And with that awareness has come investigation into technologies that can protect our critical infrastructure when widespread power outages occur. Microgrids are part of the ‘new wave’ among these resilient technologies.

Sensitive to the threat of severe weather and cyberattacks on the electric grid, several states have funded programs to build what are known as community or resiliency microgrids.

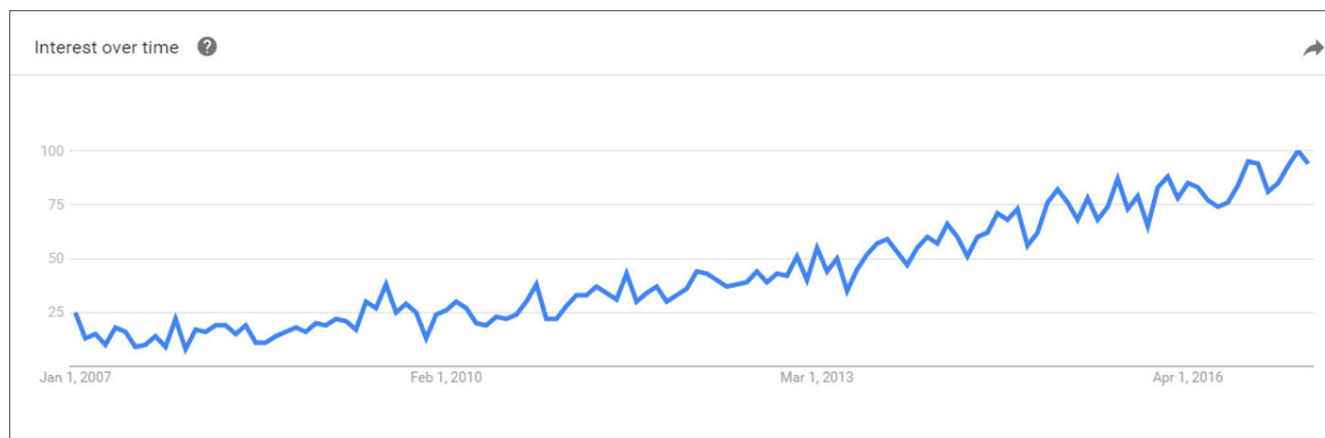
Power outages caused by severe weather cost the US economy between \$18 billion to \$33 billion annually, according to a federal report that studied the years 2003 to 2012.

Sensitive to the threat of severe weather and cyberattacks on the electric grid, several states have funded programs to build what are known as community or resiliency microgrids. Often funding for these microgrids is contingent upon them

servicing hospitals, police stations, water treatment facilities, telecommunication towers and other crucial infrastructure.

Considered a microgrid leader, New York state offers a good example. The state’s clean energy division—the New York State Energy and Research Development Authority—is offering a substantial amount of money to encourage development of microgrids for critical facilities. Called NY Prize, the program is granting \$40 million to communities to evaluate and build microgrids.

The NY Prize is divided into three stages. Stage 1 ended in 2015 with 83 communities winning \$1 million each to conduct microgrid feasibility studies. Then in March 2017, the NY Prize program allotted \$11 million in grants to 11 communities to move forward with detailed microgrid design. It’s important to note that more than half of the chosen communities—Albany, Syracuse, Rockville Centre, the East Bronx, Brooklyn, and Buffalo—included hospitals, nursing homes and other medical facilities in their microgrid plans. For Stage 3, New York will divide \$20 million in grants among yet-to-be announced communities, and offer each financing of as much as \$50 million for microgrid construction.



Source Google Trends: Chart indicates rising interest in microgrids based on Google searches on the term.

Microgrids can be found at universities, factories, data centers, stores, telecommunication centers, apartments, military bases, and a range of other operations.

Microgrids have clear societal benefits. At the same time, there is a great deal of confusion about what they are, how they work, their cost-benefit value, and what happens to the customer/utility relationship after the customer installs a microgrid.

There is no one size-fits-all microgrid, and hospitals are by no means the only type of institution or business to install them. They can be found at universities, factories, data centers, stores, telecommunication centers, apartments, military bases, and a range of other operations.

So what then is a healthcare microgrid, in particular?

A healthcare microgrid focuses on solving energy problems that are common to hospitals and their satellites. Hospitals benefit from these microgrids because of their:

a. Essential need for reliable power

Safety regulations already require some form of back-up generation for hospitals. However, these diesel generator backups are expensive to run and rarely power the entire facility. Presence of a microgrid allows a hospital to cost effectively install and leverage more cost effective power that can run all year and handle a much larger load when the grid goes down.

b. Cost pressures

As a major energy user, hospitals need to devote major financial resources to their energy budget. When cost savings are found, the organization can redirect those funds toward improving patient care.

c. Use of steam and heat

As major users of steam heat, hospitals can take maximum advantage of combined heat and power systems that allow the reuse of waste heat from energy generation — maximizing the efficiency of the system.

The microgrid uses software to direct its own on-site power, often solar panels, energy storage, and CHP.

How microgrids work in a crisis

Sometimes called ‘local energy,’ a microgrid gives buildings or communities the ability to produce their own electric power — seamlessly — when the central grid fails. Microgrids keep the power flowing by separating or ‘islanding’ from the central utility grid. The transition from grid power to microgrid power occurs without any human interface or disruption.

The microgrid uses software to direct its own on-site power, often solar panels, energy storage, and CHP. Together, this portfolio of resources creates exceptional flexibility for powering the hospital through all sorts of challenges.

It’s important to note what microgrids are *not*. They are not back-up diesel generators, equipment often installed by hospitals for energy crisis management. Microgrids are superior to mere back-up generation in several ways.



First, microgrids offer greater resistance to failure, since they typically use several different forms of on-site energy. Should one fail, another is ready for service. This is important in light of reports about hospitals going dark during Superstorm Sandy because their generators did not start, flooded, broke down, or ran out of fuel.

Second, microgrids are not ‘stranded financial assets,’ as back-up generators can be. A back-up generator sits idle except in emergencies. Microgrids, on the other hand, serve the hospital 24/7/365.

Microgrids during normal operations

While it’s true that microgrids give hospitals more control over their energy supply, their relationship with the utility does not end. The hospital remains connected to the local utility. This allows the hospital microgrid to leverage the cost of its own generation against that of the local utility. Its intelligent software will determine at any given time whether it is best for the hospital to buy power from the utility or use its own resources. This happens automatically with no action required by the hospital.

Such price leveraging is important to hospitals because they are large users of energy. Healthcare accounts for less than one percent of all U.S. commercial buildings, and two percent of all commercial floor space, yet is responsible for 5.5% of commercial building energy consumption. Hospitals, then, can little afford rising energy costs; it can affect patient care. In Ontario, Canada, area hospitals were forced to cut staffing, including nurses, to accommodate rising electric bills. Some have increased by as much as 45 percent over a four year period.¹

In the next chapter, we will take a deep dive look at the intelligence within a microgrid.

Common resources within a healthcare microgrid

Combined heat and power (CHP)

Highly efficient generating units that produce both electricity and heat from a single fuel, reducing the need for separate hospital boilers.

Solar Photovoltaics (PV)

Solar panels consisting of crystalline silicon or flexible thin-film cells that produce direct current electricity from sunlight. PV installations are typically ground or rooftop mounted. This form of energy is particularly well-suited for hospitals because they often have large expanses of roof space—such as atop of parking garages—that are excellent locations for solar panels.

Energy Storage

Predominantly batteries that serve multiple microgrid functions. Batteries store and conserve excess electricity produced by other assets, such as wind or solar. They then release electricity when other generators cannot be deployed or when economic conditions warrant. In addition, energy storage provide multiple ways to improve the quality of the power on-site.

Microgrid Controller

The sophisticated brains of the microgrid system. In essence, this software determines how a microgrid can achieve best economics, most reliability, and lowest emissions by deploying any combination of microgrid assets at any given time based on need or market conditions.

¹ <http://www.ontariopc.com/News/Details/Hospitals-cutting-staff-to-pay-for-Kathleen-Wynne%E2%80%99s-hydro-mistakes>
<http://www.thesudburystar.com/2017/03/22/sudburys-hospital-hydro-bill-up-1m-ndp>

Chapter 3

More than Back-up Power: The Genius of the Healthcare Microgrid

Thinking holistically about energy for healthcare

During the Northeast blackout of 2003 half of New York City's 58 hospitals suffered failures in their back-up power generators, according to the U.S. Environmental Protection Agency. When hospital back-up power fails, as happened again in some Northeast hospitals in 2012 during Superstorm Sandy, patients must be evacuated to other facilities, creating a chain-of-care nightmare for the patients, their families and caregivers at all facilities. And this comes at a time when people are seeking care from injuries, some very serious, caused by the storm.

Consider the overwhelming pressure put on one hospital during Superstorm Sandy. Flooding and generator failures "led to the unprecedented evacuation and closure of all hospitals in the lower half of Manhattan except for Beth Israel Medical Center," according to a [study published by Frontiers in Public Health](#). The only hospital to withstand the storm, Beth Israel saw ambulance arrivals spike by 64 percent in the four weeks following the storm. Emergency room visits jumped from an average 300 per day to 500 per day in the first



Installing a microgrid at the main hospital may not be enough to ensure stable patient care in a crisis. Communities need to look at their entire healthcare chain.

week. The hospital set up satellites and even opened beds in a detox center for patients. But it still could not accommodate the overwhelming need. Lines formed out the door, and the hospital saw a three-fold increase of ambulance patients "left without being seen," said the study.²

The pressure on hospitals during storms gets worse as other kinds of medical facilities lose power. The hospital becomes the health services fallback, creating an added burden at a tough time. Hospitals with working power become inundated. Patients arrive not only from neighboring hospitals, but also from other care facilities — satellites, walk-in medical clinics, nursing homes, retirement care facilities — that have lost power. The flood of patients can overwhelm the hospital's resources.

"If the satellite facilities are not resilient, they put their medical and healthcare load back on the hospital. In a major storm, the healthcare system can be crushed under its own weight," Pullins said.

That is why it's important for healthcare professionals and community leaders to think holistically about their power supply. Installing a microgrid at the main hospital may not be enough to ensure stable patient care in a crisis. Communities need to look at their entire healthcare chain.

² Frontiers in Public Health, "Hurricane Sandy: How Did We Do? Assessing a Manhattan Hospital's Response," Christina Ngoc Tram Tran, Michael Heller, Abraham Berger, Joseph Habboushe, 2014.

Infusing genius into generators

Government has tightened regulations for hospitals over the years in an attempt to avoid the power outage nightmares exemplified in New York in 2003 and 2012.

In the U.S., back-up generators must be tested on a regular schedule, generally monthly, annually and then every three years for four hours, depending on circumstances. But back-up generators still have clear limitations. Because they infrequently use the generators, hospitals may be unaware that they no longer work until they need the generators in a sudden crisis.

“A healthcare microgrid is truly a new energy business model for your hospital, one that encompasses your electric utility, your back-up generators, and your new on-site supply, all configured with a dynamic software intelligence. The microgrid tends to your energy needs and energy budget while you tend to your core business.”

– Steve Pullins, vice president of energy solutions at Hitachi America

The condition of a microgrid, however, is transparent since it's always in operation. So it can complement back-up generators by adding additional redundancy of supply. When a hospital installs a microgrid, it goes from having one form of backup, likely a diesel or natural gas generator, to multiple kinds of backup, solar, energy storage, CHP etc.

In fact, as Hitachi's Pullins points out, healthcare microgrids really shouldn't be thought of as back-up generation at all, but as a highly advanced complement to both back-up generators and utility services.

“Microgrids are a replacement for certain utility services at certain times, not a replacement for the back-up generator,” he said. “A healthcare microgrid is truly a new energy business model for your hospital, one that encompasses your electric utility, your back-up generators, and your new on-site supply, all configured with a dynamic software intelligence. The microgrid tends to your energy needs and energy budget while you tend to your core business.”

This intelligence arises from the microgrid controller, ‘the brain’ of the microgrid. The controller transforms what would otherwise be ‘dumb’ generation—the straightforward production of megawatts—into a dynamic configuration of resources. The controller can leverage multiple technologies for multiple purposes with no human intervention, and all at lightning fast speed.

For example, the controller can:

- ▶ Serve a facility on a standalone basis or configure with the central utility grid
- ▶ Seamlessly switch the facility from grid power to the microgrid and back again
- ▶ Determine which resources to use at any point in time based on building load and electricity prices
- ▶ Plan into the future, taking into account factors such as weather, which is important for wind and solar energy, as well as understanding if the weather trend may challenge the local grid
- ▶ Leverage the hospital's electric and heat loads for best pricing
- ▶ Sell services to the central grid, creating a revenue stream for the healthcare facility
- ▶ Manage the variable output of renewable resources. For example, the microgrid controller can ensure that the energy storage system or CHP seamlessly takes over when wind power or solar energy production ebbs
- ▶ Manage resources toward achieving hospital sustainability goals

Microgrid controllers—and the genius that they infuse into generation—allow hospitals to pursue energy planning in a new and sophisticated way. The result is an energy system that enhances energy reliability, efficiency and budget. Microgrids also assist hospitals in their pursuit of sustainability goals, as we explain in the next chapter.

Chapter 4

What Makes Healthcare Microgrids Efficient and Green?

Hospitals have been ahead of the curve when it comes to sustainability planning. As early as 2013, nearly 90 percent of hospitals said they were incorporating sustainability into their decision-making and operations, according to a [Johnson & Johnson survey](#).

While hospital sustainability plans tend to focus on issues surrounding disposal of hazardous waste or green product purchases, the importance of energy planning is coming into focus. Over one-third of those surveyed cited energy as their primary concern. And a more recent 2017 [Sustainability Benchmark Report](#) found that the percentage of hospitals with climate mitigation plans has almost doubled.

The Natural Marketing Institute surveyed 53,000 Americans in 2016 and found that 58 percent were more likely to do business with those that employ sustainable practices.

What is driving hospitals to engage in more earth-friendly energy practices? Economics is one factor. Renewable energy is becoming more affordable. Solar energy prices have fallen more than [60 percent](#) over the last decade.

Hospitals also pursue sustainability because they want to be good community citizens. Indeed, their constituents increasingly demand such behavior. The Natural Marketing Institute surveyed 53,000 Americans in 2016 and found that 58 percent were more likely to do business with those that employ sustainable practices.

“An interesting hallmark of the clean energy movement in general, and microgrids in particular, is the extent to which consumer demand drives growth,” Pullins said. “The consumer has an affinity for local and clean energy. They see sustainability as a good business or public service practice.”

Energy efficiency as a hallmark of sustainability

Installing renewables is one way hospitals can green their energy supply. Another is through energy efficiency practices. Energy efficiency is viewed as a smart economic pursuit since every dollar invested can net as much as [\\$2 to \\$4 in benefits](#).

The nature of hospital facilities makes them particularly good candidates for CHP, one of the most unsung,

What is combined heat and power?

Healthcare microgrids often have combined heat and power (CHP) plants, which provides the highly efficient steam, heat, hot water, and in some cases cooling, necessary to keep patients and workers comfortable, sterilize equipment, operate food services, and store medications safely. Conventional power generators waste up to two-thirds of the heat they produce when they make electricity. A CHP system instead reuses the waste heat to provide steam, hot and chilled water, space heating and air conditioning. CHP is highly efficient because from one source of fuel—often natural gas—it creates two forms of energy, heat and power.

yet highly effective and proven energy efficiency technologies.

CHP makes sense for hospitals because it provides not only electricity, but also thermal energy needed by hospitals in large quantities to heat and cool buildings, sterilize equipment, clean, provide food services and preserve temperature-sensitive equipment and medications. Instead of purchasing electricity from the distribution grid and separately burning fuel in a furnace or boiler to produce thermal energy, a hospital gets both from this one on-site plant.

This clean energy solution offers three main benefits:

1. Reduced energy operating costs
2. Increased energy efficiency
3. Reduced greenhouse gases and other harmful emissions by producing heat and electricity with less fuel than is required using conventional means

Not only do CHP plants use fuel in a highly efficient way, but they also typically employ relatively clean feedstocks. Often the fuel source is natural gas, the cleanest burning of the fossil fuels, or biomass, a renewable fuel typically derived from plants, municipal and industrial wastes or landfill fumes.

Moreover, the microgrid controller is able to optimize these various resources into configurations that maximize environmental performance. For example, a healthcare microgrid can be programmed to operate its generation resources to achieve greatest possible greenhouse gas reductions.

Using emission free sources and highly efficient CHP, healthcare microgrids improve a hospital's emissions profile. This not only boosts the hospital's sustainability effort, but also can contribute to city and state environmental goals.

And because a microgrid is built onsite, it averts energy waste caused by line loss. This is the dissipation of electricity as it travels long distances over transmission and distribution lines from power plants to consumers. The U.S. Energy Information Administration estimates that more than [five percent](#) of the electricity produced

Because a microgrid is built onsite, it averts energy waste caused by line loss. This is the dissipation of electricity as it travels long distances over transmission and distribution lines from power plants to consumers.

in the nation simply vanishes this way. A healthcare microgrid, however, is built at or near the hospital so the power has little distance to travel between where it is produced and where it is used.

So there are many reasons why a healthcare microgrid enhances a hospital's sustainability efforts and its standing as a good community member. At the same time, microgrid intelligence can optimize resources to supply energy at the lowest possible cost, as we'll explain in the next chapter.

Chapter 5

The No Money Down Healthcare Microgrid

Given today's uncertainties about healthcare policy in the United States, hospitals are [understandably wary](#) of making large capital investments. And those that do are likely to focus on projects that directly address their core mission – serving patients.

Upgrades to energy facilities tend to take a back seat. This is unfortunate because older, inefficient energy systems use more energy than is necessary, so hospital energy bills are higher than they should be.

Relying on inefficient energy equipment is a bit like putting your savings in a bank where interest rates are low. You could be making more money in a higher, yet guaranteed, yield investment fund. The longer you keep your money in the low-yield account, the greater your lost earnings over time.

Similarly, the longer a hospital puts off energy infrastructure upgrades, the larger the gap grows between what it should spend and what it does spend on energy – at least if electricity prices continue to rise as they have historically. The added operating expense reflects poorly on the hospital management when its performance is benchmarked against hospitals that have achieved more favorable budgeting through energy savings.

Most unfortunate, too many hospitals are unaware that they do not need to dive into their capital to install

a healthcare microgrid. A practical alternative exists known as a [no-money down microgrid](#).

This is achieved through use of a power purchase agreement (PPA), a contract structure used successfully for decades in various kinds of energy transactions. Under a healthcare microgrid PPA, the developer finances the risk and provides the upfront costs, and also operates and maintains the microgrid and its generators, so that the hospital can focus on its core work.

The energy developer and hospital share the savings achieved by the microgrid over the lifetime of the equipment, typically about 20 years. Meanwhile, the hospital pays only for the energy it uses, which is billed at regular intervals, much the same way a utility invoices the hospital.

Most importantly, the contract is structured so the hospital energy cost stays low over time.

“If your hospital is located in an area of the country where energy prices are high – such as the Northeast and California – and you structure the microgrid agreement right, you can achieve an immediate return on investment and larger return over time,” Pullins said.

But, he added that favorable microgrid economics are not confined to these regions. “Bankability can occur wherever electricity prices for commercial customers exceed the national average.”

U.S. Electricity Prices for the Commercial Sector 2017 (cents/kWh)					
STATE	JAN 2017	STATE	JAN 2017	STATE	JAN 2017
New England	15.02	South Atlantic	9.41	Mountain	8.96
Connecticut	15.60	Delaware	9.78	Arizona	9.66
Maine	12.37	District of Columbia	11.76	Colorado	9.17
Massachusetts	15.29	Florida	9.48	Idaho	7.43
New Hampshire	14.32	Georgia	9.80	Montana	9.89
Rhode Island	15.58	Maryland	11.17	Nevada	7.77
Vermont	14.34	North Carolina	8.41	New Mexico	9.39
Middle Atlantic	12.03	South Carolina	10.14	Utah	8.07
New Jersey	11.96	Virginia	8.02	Wyoming	9.19
New York	13.87	West Virginia	9.57	Pacific Contiguous	12.23
Pennsylvania	9.00	East South Central	10.44	California	13.99
East North Central	9.73	Alabama	11.50	Oregon	8.72
Illinois	8.30	Kentucky	9.48	Washington	8.37
Indiana	10.10	Mississippi	10.12	Pacific Noncontiguous	22.15
Michigan	10.84	Tennessee	10.42	Alaska	18.33
Ohio	9.67	West South Central	7.91	Hawaii	26.35
Wisconsin	10.73	Arkansas	8.01		
West North Central	8.86	Louisiana	7.64		
Iowa	8.67	Oklahoma	7.82		
Kansas	9.74	Texas	7.96		
Minnesota	9.57				
Missouri	8.10				
Nebraska	8.40				
North Dakota	8.76				
South Dakota	8.94				
U.S. TOTAL					10.19

Credit: Energy Information Administration, Electric Power Monthly, March 24, 2017

Achieving a wedge of savings with healthcare microgrids

Instead of experiencing growing losses, the hospital can achieve savings that expand over time. As Pullins explains, microgrids offer the opportunity for the hospital to achieve a “wedge of savings” that widens as years pass. This wedge develops based on both long and short-term financial strategies employed by the microgrid’s software and analytics.

Over the long term, the wedge grows as utility electricity prices rise and microgrid costs remain relatively stable. Electricity rates tend to go up as utilities upgrade and

expand their infrastructure, particularly their power plants and vast transmission and distribution systems. Utilities also must assimilate any increases in fuel costs for their power plants. The microgrid is designed — via the generation resources it contains — to beat these price increases over the long term.

Over the short term, a microgrid can achieve cost advantage as electricity prices fluctuate throughout the day. The healthcare microgrid does this by using its own on-site energy, instead of relying on grid power, during the times of day when utility power is most expensive.

In fact, if the microgrid curtails its use of energy on the day and time when grid power is most expensive for the year, the hospital can achieve significant savings. This is because the utility determines what's known as a hospital's 'demand charge' for the year based on the price of power at that one point in time. The demand charge can represent a significant portion of a hospital's annual energy bill, so it's important to focus on reducing it.

A microgrid can also lower a hospital's energy bills by incorporating solar energy, which requires no fuel. If the microgrid includes energy storage (often batteries), it stores the free solar energy and uses it to power the hospital when grid prices are high.

No two microgrids are alike; each is customized based on how the hospital uses energy, what energy resources are available, and other factors. Strategies for savings may also vary depending on the size and experience of the hospital's energy partner. For example, because of its reach and scale Hitachi is able to negotiate lower prices for large volume use of natural gas for CHP. Pullins explains that this offers yet another cost-savings opportunity, a way to undercut fluctuating natural gas prices over time.

For every moment of the day, every day of the week, and every week of the year the controller fine-tunes resource use to achieve savings.

Bringing intelligence to the right resources

The sophistication of the microgrid controller also is likely to influence savings. An advanced controller can forecast immediate pricing and estimate long-term pricing, which allows it to activate the best combination of resources. The advanced microgrid controller optimizes its resources and leverages those assets against electricity grid prices at any given time. For every moment of the day, every day of the week, and every week of the year the controller fine-tunes resource use to achieve savings.

It's important to note that it is through combined use of resources — solar, storage, CHP, utility power — that the microgrid achieves savings. Configured together correctly to respond to market conditions, demand charges, and weather changes, the resources can achieve greater savings.

By using solar, fuel management, demand charge reduction, and other optimization techniques, the microgrid can grow a hospital's savings as utility rates rise. "So you may have five percent year one savings on your energy bill. But then out there at year 10 it is 10 or 15 percent. And at year 20 it is 25 percent. So you get a wedge of savings over time."

– Steve Pullins, vice president of energy solutions at Hitachi America

Using CHP alone will not achieve this end, Pullins says, because CHP plants are not designed for what's known as load-following — the ability to increase or decrease energy production quickly as hospital energy use fluctuates. CHP plants cannot be quickly slowed or stopped without creating wear and tear that reduces life-time operating capabilities. So in a healthcare microgrid, solar and energy storage together act as a quick ramping resource, while the CHP plant provides 'baseload' — energy always on to power the majority of hospital systems.

Adding solar and storage to the mix allows the CHP plant to run when it can achieve its lowest cost per megawatt, lowest emissions level, and lowest maintenance requirement, Pullins says. The solar-fed energy storage system is the fastest, most flexible, load-following resource.

"If we've built our algorithm properly, we are eking out everything that we can, and we are doing that on a moment by moment basis," he says.

Utility rates have historically risen over time, and forecasters predict they will continue to do so. By using solar, fuel management, demand charge reduction, and other optimization techniques, the microgrid can grow a hospital's savings as utility rates rise. "So you may have five percent year one savings on your energy bill. But then out there at year 10 it is 10 or 15 percent. And at year 20 it is 25 percent. So you get a wedge of savings over time," Pullins says.

The bottom line for your healthcare facility — and society as a whole — is a dollar saved on energy is a dollar available for patient care.

Chapter 6

Profiles of Real World Healthcare Microgrids

When a storm knocks out your neighborhood power, you can hunker down and ride out the loss without too much stress. You can also borrow some ‘bread and milk’ from a neighbor if the local convenience store is closed.

But what do you do if you are several city hospitals and your power goes out for an extended period of time?

Patients and staff at New York City hospitals found out the hard way during Superstorm Sandy and its aftermath. Four hospitals were closed to patients for at least three weeks after the storm. NYU Langone Medical Center on Manhattan decided to evacuate patients at the height of Superstorm Sandy. At another East Side hospital, Bellevue Hospital Center, the National Guard was called in to help evacuate more than 700 patients. The Manhattan VA Medical Center and Coney Island Hospital also had to close because of the storm.

In the aftermath of Sandy, hospitals are looking at ways to increase the reliability and resiliency of the power generation resources. A clearly emerging best practice is building a diverse range of generating assets and putting them under the direction of a microgrid.

Two of the hospitals were either partially or completely closed three weeks after the storm, limiting quality of care and putting a huge stress on other hospitals in the city. The hospitals had to close for [many reasons](#), primarily flooding and power loss, even of their emergency back-up generation units.

In the aftermath of Sandy, hospitals are looking at ways to increase the reliability and resiliency of the power generation resources. A clearly emerging best practice is building a diverse range of generating assets and putting them under the direction of a microgrid. For example, more than half of the 11 finalists in the NY Prize microgrid competition proposed to include hospitals in their projects.

Here we detail several existing hospital microgrids and two proposed by communities with hospitals hard hit by Superstorm Sandy.



Dell Children’s Medical Center in Austin, Texas

The Seton Healthcare Family of Austin chose to power its new medical facility with a gas turbine microgrid. If there is an outage or an interruption in grid electrical service, the Dell Children’s Medical Center microgrid can continue to run, providing all of the hospital’s needs for power, steam and cooling, an important consideration in July and August in Austin.

Designed, owned and operated by local municipal utility Austin Energy, the CHP microgrid provides power and thermal energy for the hospital.

The ability of its electrical service to island or separate from the central grid was an important consideration for Seton. According to one study, the probability of failure for a traditional hospital grid-plus-backup system is 67 percent. Having the microgrid flips that equation for Seton. The microgrid allows the hospital to continue to operate if there is a grid failure. During a disaster, then, the hospital can also become a place of refuge and a center for medical care.

The microgrid exports excess electricity back to Austin Energy’s grid; excess chilled water provides air conditioning to a half-dozen other nearby facilities.

Longwood Medical Area of Boston

In Boston, the 213-acre Longwood Medical and Academic Area (LMA) includes five Harvard Medical School—affiliated hospitals that provide care to more than 100,000 inpatients and 2.4 million outpatients each year. The campus also encompasses medical research centers and teaching institutions.

To meet the area's critical energy needs, the LMA Medical Area Total Energy Plant (MATEP) generates electricity and useful thermal energy from natural gas CHP. The steam and chilled water travels via underground pipes to individual buildings for heating, hot water, sterilization and air conditioning.

The microgrid can island from the main grid during power disruptions and supply reliable service to the facilities. By operating independently from the main grid, the microgrid creates resilience for the healthcare operation, as well as the surrounding community. The system also is extremely efficient. According to U.S. Department of Energy estimates, MATEP's 47.5 MW CHP system has reduced total site fuel consumption by 24 percent.

Utica Healthcare Migrogrid

Utica College and Faxton-St. Luke's Healthcare have operated a 3.4 MW microgrid since 2009. The system relies on four small CHP generators to supply the bulk of the energy needs for the campus and hospital and 50 percent of a nursing home's energy needs. If the grid loses power, the microgrid can island and operate independently. It typically operates parallel to the grid, able to sell excess power back to the grid.

Princeton Healthcare System

Because of stringent patient-care needs, hospitals traditionally use at least two energy sources: their local utility, which acts as the primary power source; and their emergency generators, which can deliver a limited power supply in the event of an unexpected grid failure.

But when the Princeton Healthcare System first envisioned building a new 630,000-square-foot acute-care hospital with 237 single-patient rooms in Plainsboro, New Jersey, it considered a third level of redundancy offered by a non-traditional energy-efficient microgrid.

The result was a microgrid with electricity provided from a 4.6 MW gas turbine-powered CHP that also acts as the hospital's primary energy resource, meeting 100 percent of its heating, cooling and sterilization needs. This microgrid plant is backed up by 6 MW diesel-fired generators that can be supplemented by an interconnection to the local utility's power grid, if the need arises.

The system also uses electricity from a one million-gallon chilled water thermal-energy storage tank—literally a thermal 'battery' that can be charged during off-peak hours and discharged during peak-demand periods—plus a 200 kW solar array with panels distributed over the parking lot.

The integrated nature of this solution dramatically reduces the facility's monthly electric bills. And it provides the institution with the flexibility to export power to the local grid (creating a revenue stream back to the health system) when rates are high or quickly draw power from the grid when rates are low (or if additional energy is needed).

Tampa General Hospital

Florida hospitals are no strangers to hurricanes. More storms hit Florida than any other U.S. state. Since 2000 several hurricanes have touched down in the state, including Hurricane Matthew in 2016. This severe storm caused major damage along the eastern coast and central Florida. Add to this list 63 tropical or subtropical cyclones and Florida hospitals must be prepared for [destructive weather](#).

This keeps the microgrid managers at [Tampa General Hospital](#) (TGH) on constant alert, watching the weather and islanding the system routinely to protect the hospital's patients and staff. The 1,011-bed nonprofit hospital has a medical staff of 1,312. It serves a dozen counties for a patient population of more than 4 million.

The hospital and its large comprehensive service Level 1 trauma center are part of an [11 MW medical campus](#). The campus draws power from the main grid, with microgrid power provided by diesel-fueled generators. Natural gas-fired cogeneration units are being reviewed for the future.

Shands Cancer Hospital at the University of Florida

The South Energy Center microgrid on this Florida hospital campus was built and is run and maintained by Gainesville Regional Utilities (GRU). The center provides all of the campus' power needs, including steam, normal and emergency power, chilled water and medical gasses.

The microgrid includes both a CHP combustion turbine generator and a diesel generator. The CHP unit captures waste heat to generate the steam required by the hospital. GRU exports excess power from this system to their grid for consumption by other customers. Although the CHP system could have been installed without a microgrid, Shands wanted the reliability the microgrid, because it was important that the hospital be fully operational 24/7/365 even during storms, especially with its trauma center.

Because of its islanding capability, the CHP can operate in parallel to the utility or seamlessly direct its resources to the microgrid for campus use only when needed during storms and main power is lost. System resilience is further ensured because its energy distribution system is underground and thus shielded from lightning strikes or falling trees. The system effortlessly transfers back to grid mode when the storm passes.

The microgrid has another feature that adds both financial and environmental benefits to the campus. When standard emergency generators need to be tested, they are connected to "resistive load banks" which turn the generator's output directly into waste heat but do no useful work. As a microgrid asset, however, the generators can be tested with [no energy loss](#) to the system or to the utility.

Huntington Hospital, NY

Besieged by storm-related outages, the Town of Huntington plans to develop a microgrid project powered by multiple assets in several locations including the Huntington Hospital.

The Huntington project is one of 11 that won Stage 2 feasibility funding from NY Prize, a competition of the New York Energy and Research Development Authority (NYSERDA) to spur community microgrids. Final Stage three winners, expected to be announced next year, will receive development assistance for their projects.

The town microgrid would provide electric and thermal energy to its customers, as well as environmental

benefits for the community because of its use of solar and a near zero emissions fuel cell. In addition to the hospital, those to be served include: town hall, Huntington Wastewater Treatment Plant, Huntington YMCA, and Flanagan Senior Center. Other microgrid customers may be added.

As part of the microgrid, the Huntington Hospital would receive a 2.8 MW fuel cell operating as a CHP system and a 2.0 MW/2.0 MWh energy storage battery/inverter system with 1.0 MW load bank (used to provide load when necessary for fuel cell during transition to/from island mode).

Buffalo Niagara Medical Campus

The Buffalo-Niagara Medical Campus (BNMC) microgrid plan is another one of the 11 NY Prize projects statewide to win Stage 2 NY Prize funding.

BNMC serves as the umbrella organization of 13 individual medical services organizations that make up its 120-acre campus. The organization fosters conversation and collaboration among its member institutions, partners and the community. Its aim is to address critical issues, such as energy, entrepreneurship, access and transportation, workforce and procurement, neighborhoods and healthy communities.

The BNMC microgrid proposal includes a range of resources — existing diesel generators, expansion of a water-driven thermal energy loop, a new CHP system and rooftop solar power on-site and in an adjacent neighborhood.

Installation of battery storage units could help support the microgrid during island mode by handling transient PV generation and load, as well as the transition between island and full grid modes. The independent microgrid will also help reduce strain on the region's power grid during times of peak demand because of this islanding capability.

About Hitachi America Microgrids

Hitachi America offers end-to-end capabilities for microgrid feasibility, design, engineering, construction, finance, operations and maintenance.

We have decades of experience and a longstanding commitment to creative and collaborative environmental and energy solutions. From assessments through post-installation support and reporting, Hitachi America can help your hospital achieve its resource-saving goals.