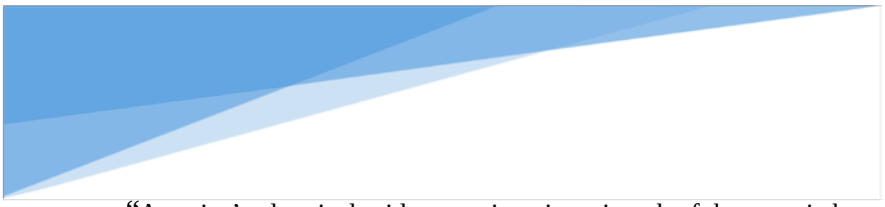
BEYOND COMPLIANCE: Healthcare, Climate Change, Technology and the Climate Leadership and Community Protection Act

Mather Hospital | Northwell Health Demonstration Case, in partnership with the Advanced Energy Research and Technology Center and Genesys Engineering

Abstract

The New York State Climate Leadership and Community Protection Act (CLCPA) calls for an 85% reduction of greenhouse gas emissions (GHG) by 2050 and 70% renewable energy by 2030. By examining a Long Island hospital, this white paper will demonstrate effective strategies to support the CLCPA while utilizing a unique and achievable model for hybrid energy solutions, including Distributed Energy Resources (DER), electrification, and hydrogen production.



The Problem

> "America's electrical grid, an engineering triumph of the twentieth century, is turning out to be a poor fit for the present. It's not just that the grid has grown old and is now in dire need of basic repair. Today, as we invest great hope in new energy sources–-solar, wind, and other alternatives—the grid is what stands most firmly in the way of a brighter energy future. If we hope to realize this future, we need to reimagine the grid."
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> (The Grid: The Fraying Wires Between Americans and Our Energy Future, Gretchen Bakke, Ph.D. 2016)

This hybrid energy solution is intended to reduce greenhouse gas emissions in alignment with the intent of the CLCPA, serving as a replicable, scalable model. A significant challenge to the CLCPA will be balancing load sources and load centers. By maximizing on-site efficiencies, removing load from the grid with DER, and reducing emissions we will successfully demonstrate how a facility can perform beyond compliance, using existing technologies, while still ensuring cost certainty and fiscal responsibility.

The grid restructuring that New York is embarking on is an unprecedented effort. The grid evolution, which started a century ago, was extremely disorganized - individual residences, trolley car companies, municipalities; each had their own fossil fuel burning power source. After the Great Depression, the Rural Electrification Act connected multiple disparate local entities into a nationwide structure – the grid. Subsequently, the grid continued to evolve, as individual

monopolies, into its present configuration. The grid will need to adapt to meet the current goals of the New York State's CLCPA.

One of the most significant challenges the grid transformation faces is the variability of load, a problem compounded with large scale adoption of renewables. Further, the day/night and summer/winter load cycles increase complexity. "Clean energy policies, such as the Climate Leadership and Community Protection Act (CLCPA) are reshaping the grid in unprecedented ways. New York's electricity industry is transforming from a grid that is powered by traditional synchronous, controllable generation to more non-emitting, weather-dependent intermittent resources and distributed generation. The increase in the intermittent and distributed generation, along with the related penetration of inverter-based technology, creates new challenges." (North American Electric Reliability Corporation. 2020 Long-Term Reliability Assessment December 2020.) Northwell Health cannot dictate state policy nor the operations of the grid, but we can increase our resiliency and reliability, while reducing our greenhouse gas emissions by clean generation in a microgrid, in addition to efficiency and beneficial electrification. Through hybrid advanced energy solutions we are developing viable opportunities for GHG reduction and load balancing in a cost effective and strategic manner.

After a decade of diligent effort initiating energy conservation projects at Northwell Health, many of the rapid payback, low complexity projects have been completed. As project complexity increases, expense increases and capital becomes more difficult to justify. Compounding the financial payback problem are barriers to implementation. Utility policies often preclude successful energy projects, with favorable electricity rates for certain programs. The unintended consequence is that energy conservation projects now have poor returns on investment, an inherent disincentive. An additional obstacle to efficiency enhancements is the current utility tariff or rate structure. Well over 90% of the operating expenses of a utility power plant are fixed. With fuel as the major variable expense, tariffs/rate structures could be enhanced for night time production of storable energy at the incremental fuel expense, perhaps $0.04/kWh (average Northwell Health rate at $0.16/kWh). That base rate would allow for the nascent hydrogen industry to develop, in advance of the forthcoming large scale renewable projects.

Tropical Storm Isaias is our most recent reminder of the effects of extreme weather, which is being magnified by climate change. Hospitals, more than any other building type, require emergency generation to back up the utility grid. During utility grid outages, hospitals cannot perform many activities, most notably patient operations. Microgrids offer considerable benefits to healthcare facilities, yet utility, PSEG-LI and LIPA, cooperation is required for facilities to interconnect with the grid.

Existing Conditions & Technology

Mather Hospital in Port Jefferson, NY has been a leader in innovation with an energy efficiency rating well above most hospitals nationally. Since energy efficiency and conservation efforts are a continuum, facilities must remain diligent in efforts to identify and resolve deficiencies, research and incorporate new technologies, then cost effectively implement their strategies. Conservation is a behavioral mindset. Hospitals face unique regulatory and operational requirements that create considerable challenges when it comes to reducing energy usage and emissions.

J. T. Mather Hospital | Northwell Health

John Titus Mather was a successful shipbuilder in Port Jefferson in the early part of the 20th century. When he died in 1928, his will outlined his wishes for the care of his family and loved ones and instructed his executor to 'Incorporate under the laws of the State of New York a non-sectarian charitable hospital, to be located in said village of Port Jefferson … so designed and constructed as to permit future enlargement, assuming that future needs may justify such action … It is my sincere hope that the citizens of Port Jefferson and vicinity will give their liberal and devoted support to said institution and endeavor to make it a success and a credit to the community." (matherhospital.org)

Mather has achieved a top 10% Energy Star efficiency rating (Energy Usage Index ~ 180 kBtu/sf, with the national average @ ~ 320 kBtu/sf) through diligent action across numerous energy conservation measures, most notably:

- **Thermal Energy Storage (TES)**
  - TES is a technology that stores thermal energy via a storage medium (i.e. water/ice) so that the stored energy can be used at a later time for cooling applications. In 2018, Mather received $1M rebate from PSEG-LI (the highest rebate ever awarded by the utility) to install this technology. TES is effective at flattening the building's energy consumption curve by shifting load from day to night, with savings of $180-200k/year.

This is extremely significant because the entire grid is constructed for peak load, typically late summer afternoons. By flattening the individual building load, we are improving the efficiency of the entire grid.

- **Solar Power System – 50 kW Array**
  - One of the main goals of the CLCPA is the installation of solar power. Mather has been a pioneer, among hospitals, with this installation generating approximately 674,520 kWh over the past eleven years.

- **Building Management System (BMS) Optimization**
  - The ability to gain centralized control of multiple systems and zones in a building is made possible with a BMS. This saves time and makes operating a building easier and more efficient. It also makes remote management and service easier, which improves response times and lowers overall costs. A BMS also facilitates the integration of Distributed Energy Resources (DER).

- **LED Lighting Replacements**
  - As an early adopter, Mather is almost 100% LED lighting. In addition to an average 5% total energy savings, LEDs generate little heat, therefore less air conditioning demand. Further, with additional controls, LED light color is controllable allowing for potential health benefits.

- **EV Charging Stations**
  - NYPA and NYSERDA Install More Than 70 Electric Vehicle Dual Port Charging Stations at ReCharge NY Customers throughout New York**.** Northwell Health, has installed 24 EV chargers across its health system facilities, including four at Mather Hospital. "*Northwell Health is committed to promoting a culture that values sustainability, which is why giving our employees access to charging stations for electric vehicles is an important step. We will continue to support the New York Power Authority in its effort to advance the adoption of electric vehicles through the installation of charging stations at our facilities.* (NYSERDA Website)

- **Geothermal Energy**
  - PW Grosser Consulting, Inc. is currently performing feasibility studies at Mather Hospital, along with other Northwell locations, for geothermal opportunities. Glen Cove Hospital, Northwell Health was an early adopter of this technology, with a geothermal cooling system in operation since 1967.

The Advanced Energy Research and Technology Center (AEC): Current Involvement, Supporting the Healthcare Industry

Overview

The Advanced Energy Research and Technology Center (AEC), a New York State Center of Excellence, is located in the Research & Development Park at Stony Brook University. It is a partnership of academic and research institutions, energy providers, industry, and government. The mission of the AEC is to increase the efficiency of current energy systems while promoting the adoption of alternative and renewable sources to reduce New York's carbon footprint. The AEC recognizes the valuable services provided by the healthcare industry and seeks to support their mandates to reduce GHG emissions and comply with the CLCPA. The unique challenges faced by the healthcare industry, as well as the unique transformation that the electric and gas grids face, to enable compliance with the CLCPA goals speaks to a leading role for the AEC.

The AEC conducts cutting edge research and development of new technologies to generate, transmit and distribute, store and manage energy. A critical component of the AEC mission is to work closely with industry and commercial enterprises. These are the customers that must deploy the latest technology to meet the goals of the CLCPA. Accordingly, the AEC will be active and engaged in collaboration with Northwell Health, and the proposed demonstration project at Mather Hospital. The AEC has facilities that can perform validation and verification, as needed, prior to actual installation of advanced technology at customer facilities.

The AEC recognizes that the conversion to hydrogen-based fuels and energy storage within the next few years has been identified as a national priority, and is active in hydrogen and alternative fuel production R&D. AEC coordinates research efforts among federally funded programs ongoing at SUNY Stony Brook, Farmingdale State College, and Brookhaven National Laboratory on biomass and micro-organism generation of hydrogen, nanostructured ion exchange membranes for hydrogen processing, high power density miniaturized fuel cells, biomimetic fuel cells, and self-assembled nanostructures for ultra-high capacity hydrogen storage.

Supporting the Healthcare Industry with Electrification and Fuel Based Solutions

The continued need for fuels and combustion in addition to electrification is envisioned as a bridge to the grid transformation. Renewable fuels, including green hydrogen, will be produced from renewable power supplies, creating a more efficient sustainability scenario. The healthcare industry can electrify when appropriate, utilize steam and hot water as required, and preserve options such as fuel cells for reliability as well as GHG reduction.

Hydrogen production will occur, both "behind the meter" as well as by utilities utilizing renewable power supplied from offshore wind, as envisioned by the National Offshore Wind Research & Development Consortium (NOWRDC), which is housed at the AEC. AEC is already assuming a leading role in the renewable electric arena. As part of the largest public investment in offshore wind workforce development by any state in the country, SUNY and NYSERDA have launched New York's Offshore Wind Training Institute (OWTI) to train 2,500 workers.

Through a partnership between Stony Brook University and Farmingdale State College, the $20 million investment in the new training institute, which is also housed within the AEC, will advance offshore wind training programs and the educational infrastructure needed to establish a skilled workforce that can support the emerging national offshore wind industry. This program could be enhanced to include training to service end-user equipment and appliances.

The AEC is mindful that customers, inclusive of hospitals, will require assistance and assurance that new technologies that rely on renewable electric and gas are commercially ready. Working with Northwell Health, the AEC will evaluate and test equipment to be deployed. Technologies in development include:

- Hydrogen & metal hydride hydrogen storage
- Boilers & burners
- Fuel cells & gas engines
- Gas heat pumps (Thermolift – developed at the AEC)
- Common gas appliances, such as stoves, fireplaces, clothes dryers, etc.
- Carbon capture technology, equipment, and systems

Additionally, AEC is working towards:

- Demonstrating a working Distributed Energy Storage System (DESS) involving renewable power supply, , hydrogen storage systems, methane/hydrogen blending systems, and microgrid controllers.
- Constructing a larger facility to test appliances and equipment on methane/hydrogen fuel blends and provide guidance to the gas utility as they move forward in transforming the gas grid to a renewable future.
- Conducting an evaluation of the value of hydrogen production byproducts, such as oxygen.
- Serving as a model for utility scale-up and promoting technology knowledge transfer to public and private enterprises, including start-up ventures that seek to advance the goals of the CLCPA.

Genesys Engineering P.C. - Partners in Excellence, a Willdan Company

Mission Statement

From project inception to the study, design, construction management, and commissioning of energy and utilities projects, Genesys Engineering seeks to be a 'client-centric' company, with a strong commitment to quality and innovation. By staying on top of the latest industry trends and new technologies we seek to provide the most creative approaches to our clients' most complex projects and their toughest problems.

Strategy for Compliance

While Mather Hospital is in the top decile of all hospitals, there is considerable work to be performed to comply with the New York State efforts to reduce carbon. ***The New York State Climate Action Council*** has developed a strategic pathway for energy reduction with:

Four Pillars to Deep Decarbonization:

- *Energy efficiency, conservation, and end-use electrification*
- *Switching to low-carbon fuels*
- *Decarbonizing the electricity supply*
- *Negative emissions measures and carbon capture technologies*

(New York State Decarbonization Pathways Analysis, Summary of Draft Findings, June 24, 2020, Energy + Environmental Economics)

The forward-looking Mather Hospital | Northwell Health energy strategy aligns with the four pillars:

1. ***Energy efficiency, conservation, and end-use electrification***

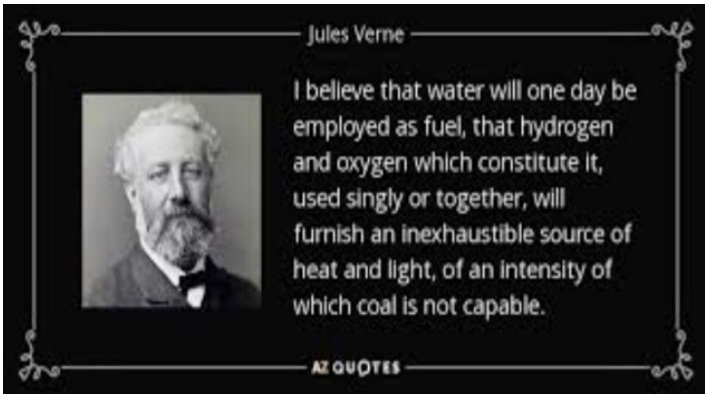
Foundational to any corporate energy project is the hardwiring of conservation and energy efficiency into our culture. An energy conservation culture instills the requisite ideals to minimize our collective carbon footprint while energy efficiency ensures that our systems are operating at their maximum potential. Northwell Health has numerous Business Employee Resource Groups (BERG), among them the GreenBERG has been developed with the following mission: *"GreenBERG members are focused on the environmental impact of Northwell's operations. They leverage sustainable and socially responsive initiatives in the workplace and in our communities, with a focus on recycling, transportation and energy efficiency."* (Northwell Health Website)

The bold, hybrid energy strategy at Mather Hospital will utilize a variety of technologies to comply with the vision of the CLCPA. *Beneficial electrification* of heating and process loads, such as cooking, dishwashing, and equipment sterilization, will reduce fossil fuel requirements and allow for a load balancing between natural gas and electricity. *The installation of a Cleaver Brooks electric boiler, the first electric boiler in a New York hospital, is in process.*

2. ***Switching to low-carbon fuels***

The road to full electrification will be long, convoluted and require innovative bridge technologies. A fuel cell operates on pure, carbonless hydrogen. Unfortunately, hydrogen production using existing technologies is energy intensive, and therefore currently cost prohibitive at scale. Green hydrogen, produced from renewable sources is the holy grail of energy production, but extreme levels of excess green energy is required.
As Mather Hospital has a solar energy farm, we intend to produce green hydrogen to fuel a Bloom Energy fuel cell. The green hydrogen will be created from water using an electrolyzer, with plans

currently in development with Bloom Energy. When large scale wind and solar power are more readily available, mid-decade, we will begin to recognize load imbalances from those intermittent resources and will require energy storage applications. For example, during a moderate evening with strong winds, there will be excess electricity production, which could be stored in batteries, or as hydrogen, possibly in the form of metal hydrides. Northwell Health, Genesys Engineering and GKN Powder Metallurgy are currently investigating energy storage opportunities and technologies. A primary benefit to hydrogen storage technology is the ability to balance day/night and summer/winter loads.



"Since hydrogen can be made from renewables and stored in a tank, it can be thought of as both a fuel and a storage solution. Think of it as energy from renewables that is stored in a tank for use at a later date, time and place. That is very different from the usual output of a wind turbine or a solar array, which must be transmitted and used immediately. Its flexibility as either a fuel or a storage medium is similar to petroleum, with none of the fossil fuel deficiencies. Long duration, even seasonal storage, has been the holy grail sought by the renewables industry. We have had it all along." (It's Time to Talk Hydrogen, Pat Sapinsley, Forbes, February 11, 2020)

Considering that multiple hybrid technologies will be required to enhance efficiencies and reduce carbon emissions, Northwell Health, the AEC, and Genesys Engineering are investigating advanced thermal efficiency opportunities:

- **ThermoLift Heat Pump**
  - *"ThermoLift is currently developing its Thermal Compression Heat Pump (TCHP™), a natural-gas driven air conditioner and cold-climate heat pump, which can provide space heating, water heating, and air conditioning simultaneously in a single device. The system has broad application as a combined heating, ventilation, and air-conditioning (HVAC) solution with the benefit of substantial energy, cost, and greenhouse gas (GHG) reductions."* (Performance Evaluation of the ThermoLift Natural Gas Fired Air Conditioner and ColdClimate Heat Pump Peter, et. al, Hofbauer, et. al., September 2019, Oak Ridge National Laboratory)

- **Heat Recovery Chillers**
  - High efficiency heat recovery chillers utilize the heat energy released from an air conditioning unit for alternate needs, such as humidity control or domestic water heating.

    "The advantage of heat recovery is that the heating energy is free. No need to pay for heat when you have a cooling load, and we lower our carbon footprint along with our negative effect on the environment. Imagine that we are able to save money and save the environment, this has to be a win, win situation." (Aermec website)

3. Decarbonizing the electricity supply

While Northwell Health cannot decarbonize the electricity supply, we can reduce our dependence on the utility grid and facilitate more resilient, reliable operations. Plans are in development with Bloom Energy to install fuel cell microgrids at multiple Northwell locations.

"Bloom Energy's mission is to make clean, reliable, and affordable energy for everyone in the world. Our solid oxide fuel cell product, the Bloom Energy Server, delivers highly reliable and resilient, 'Always On' clean electric power. Our Energy Servers generate electricity without combustion, utilizing natural gas, biogas, or hydrogen as fuel. At Bloom Energy, we work to contribute to the creation of sustainable communities by reducing carbon emissions and criteria air pollutants.

Our Energy Servers that run on hydrogen or biogas can produce carbon neutral power, and those fueled by natural gas produce carbon emissions. Our Energy Servers are however, among the most effective ways to displace less efficient centralized power plants with more efficient distributed generation, thereby achieving the combination of near-term emission reductions and increased resiliency. Power generation from our Energy Servers reduce carbon emissions and other air pollutants in the same manner as wind and solar generation — by displacing dirtier power plants. However, unlike wind and solar, our Energy Servers can do so around the clock."
(How Bloom Reduces Emissions, Technical Note, Bloom Energy Corporation)

Further, microgrids will enable Northwell to create energy on campus and minimize the disruptions and inefficiencies inherent in the conventional grid. Advantages include:

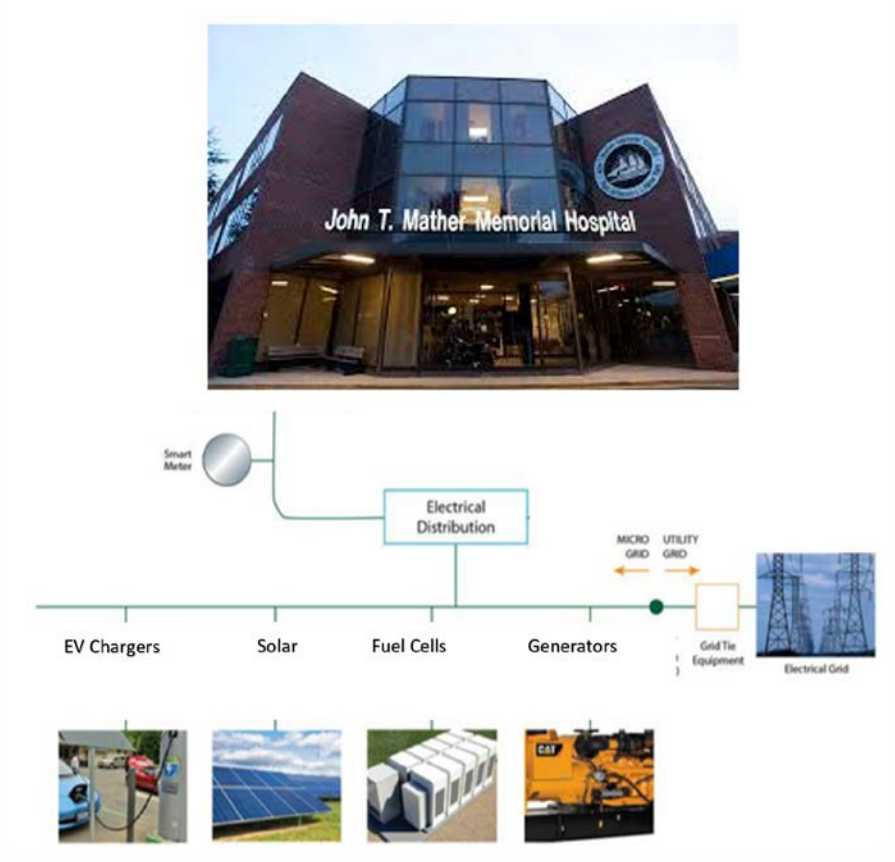
- ***Redundancy, Resiliency, & Reliability***: enhanced from multiple energy sources, as well as the ability to 'island' from the grid. The ability to 'island', which is to operate fully independently from the grid allows healthcare facilities to operate as normal during a utility outage, in particular ensuring operating room procedures can continue.

- ***Financial:*** reduced operating expenditures and the opportunity for grants to fund infrastructure improvements related to energy security.

- ***Economic:*** long term opportunity via hedging against energy increases and attenuating/avoiding business losses related to power outages.

- ***Sustainability:*** a reduced greenhouse gas footprint achieved through a mix of solar, fuel cells, thermal storage, & carbon sequestration.

- ***Corporate Social Responsibility***: as related to Sustainability, programs to reduce greenhouse gasses may be publicized to enhance the hospitals reputation in the community.



4. Negative emissions measures and carbon capture technologies

Decarbonization and hardening of the utility grid will be a multi-decade proposal. Multiple strategies are required to bridge that gap from fossil fuel to renewables. Northwell Health is developing plans with CarbonQuest, a cutting-edge technology, used to remove carbon from the exhaust stream of fossil fuel fired boilers. The retrieved carbon would then be utilized for numerous functions, creating a sustainable life cycle.

"The path for reducing CO2 emissions from natural gas however is challenging, especially in the short term. Carbon capture is an option today to reduce carbon emissions from natural gas usage." (CarbonQuest Website)

Conclusion - Beyond Compliance

"Achieving the ambitious goals of the CLCPA will mean transforming the way we generate and use electricity, the way we heat our homes, and the way we get to school and work. New Yorkers will tackle climate change and create new opportunities for our children and grandchildren. Through thoughtful planning, this effort will breathe life into our economy with well-paying clean energy jobs, new industries and business opportunities, and improved health and quality of life for New York families and communities" (NYS Climate Leadership and Community Protection Act, Climate Action Fact Sheet).

There is opportunity within the CLCPA framework to support transformation through hybrid energy systems by encouraging the following:

- Incentives for research and development at recognized research institutions to advance electrification and gas hybrid solutions.
- Incentives for utilities to implement renewable pipeline gas and natural gas / hydrogen fuel blends.
- Incentives for customers to implement hybrid solutions. NYSERDA PON 4164 ("Community Heat Pumps") is an example that stimulates electrification. Similar NYSERDA PONs for hybrid gas and electric solutions could be considered.
- Ratepayer funded incentives and tax credits including payments in lieu of taxes for non-profits.

Our society is poised for a grand transformation of the energy grid, through electrification, decentralization, and a reimagining of how we consume energy. Contrary to the haphazard events of a century ago we have strategic plans, technology, and innovation that are disrupting traditional models from generation through utilization. The vital importance of hospitals as institutions of public good is paramount to the maintenance and betterment of society. As detailed in this paper, healthcare institutions will require numerous, hybrid technologies to remain resilient and function for the public good through pandemics, public emergencies, and climactic events.

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