


# BUILDING A BETTER MICROGRID

*How utility Emera Technologies is creating the smart, resilient Microgrid of the future with Galvanically Isolated DC:DC Optimizers*

## Abstract

Microgrids – self-generating, self-consuming island energy - can solve several energy challenges: from building resilience in energy systems, to reducing carbon emissions to easing stress on the power distribution grid. In this case study, learn how one leading utility implemented unique ideas to make scaling the benefits Microgrids have to offer easier.

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# Building a Better Microgrid

## *How Emera Technologies is creating the smart, resilient Microgrid of the future with Galvanically Isolated DC:DC Optimizers*

"Adaptation is managing the unavoidable and mitigation is avoiding the unmanageable. A cybersecure, resilient Microgrid with on-site renewable generation is both."

**Deputy Assistant Secretary of Defense for Environment & Energy Resilience - Mr. Richard Kidd**

Microgrids, self-generating, self-consuming islands of energy with little to no reliance on power from a broader power distribution grid, offer solutions to so many of the challenges we read about in the headlines daily. These issues include power outages in Texas, wildfires and rolling black outs in California, the need to improve the cyber security of our bulk power system and the push to get more of our energy from clean, renewable sources.

To achieve the incredible potential of renewables based Microgrids, these systems need to be cyber secure, reliable, safe, cost effective, scalable, and structured in a way that they satisfy the needs of many stakeholders including power consumers, utilities, regulators and the power distribution grid itself. That is where Emera Technologies ("ETL"), a subsidiary of Emera Inc., an energy services company with $34 billion in assets, has stepped in. ETL has developed a scalable and easily repeatable and deployable microgrid topology based on cutting edge power electronics hardware and software that can be used to provide reliable, safe, and cost-effective renewable power to both consumers as well as public assets like military bases.

"ETL started looking at building DC microgrids because a majority of the assets of Emera are utilities that are in six countries – the United States, Canada and four Caribbean countries – that sit along the Eastern Seaboard of North America and Caribbean islands. We got tired of replacing poles and wires that blow down every time there's a tropical storm or hurricane," says Gary Oppedahl, Vice President, Emerging Technologies at ETL.

In 2019, in a period of just nine months, ETL's team went from breaking ground to commissioning the first of these microgrids based on its BlockEnergy™ Smart Platform at the Kirtland Airforce Base in Albuquerque, New Mexico. The BlockEnergy microgrid at Kirtland Airforce Base provides secure, clean power to a variety of loads at the country's fifth largest Airforce base through a unique DC distributed solar and storage system that is supplemented by BlockCentral, a centralized, DC coupled solar and battery installation that connects to the broader power distribution grid through a single point of interconnection. The solar at that centralized PV generation location is harvested and safely delivered at a fixed, standardized DC voltage by Alencon Systems' SPOT DC:DC optimizers.

In this case study, we explore just how ETL is leveraging the unique galvanic isolation of the SPOT to change the game in microgrids that are powered by solar and battery energy storage.

## How the System Works

According to Oppedahl, the quarter megawatt microgrid ETL has built at Kirtland Airforce Base, which is based on solar generation and battery energy storage, is a hybrid DC and AC microgrid.

"A lot of people make the distinction between DC and AC microgrids. Our microgrid uses both, to take advantage of the native [load] wherever possible. We use DC where it makes sense for safety and efficiencies, but it's an AC microgrid in that It delivers AC to each of the loads it powers."

"Our microgrid delivers split phase AC through an inverter from a localized battery into the loads. The microgrid has one point of common coupling with the bulk power AC grid. So we're AC on either at the grid and at the home, and we're DC in the middle to capitalize on DC efficiencies. We generate in DC from solar and store in DC, so to the extent possible, we also move power around in DC. That is the difference with traditional AC microgrids. The generation, if it is solar, is DC. The battery energy storage is DC. And by the way EVs, which are already upon us, are DC. So, why are we converting to AC just to convert back to DC? What I try to tell people is that we're a hybrid microgrid, using DC where appropriate for efficiency and safety. This also prepares our users for the eventuality of more DC loads in the future" explains Oppedahl.

At the heart of BlockEnergy microgrid system sits a centralized DC coupled solar and battery energy system connected via a DC distribution system to a variety of smaller loads, loads ETL refers to as nanogrids.

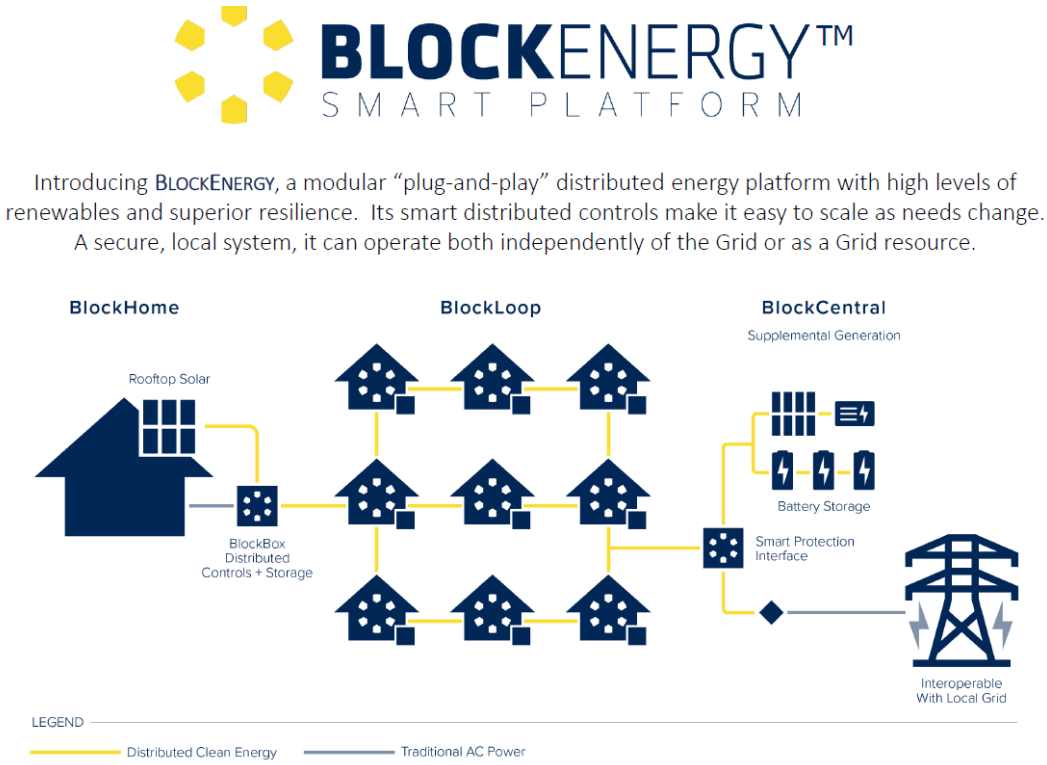


*Figure 1 Emera's BlockEnergy™ Smart Platform Microgrid topology is shown above. In the Emera "hybrid" Microgrid, a central DC coupled solar and battery storage system is connected to the grid and clean energy is distributed to individual loads via a DC distribution system. Each load (node) in the nano-grid has its own localized generation and storage infrastructure as well.*

"Instead of having the AC cables going to each one of the homes in the microgrid and then having transformers either for a single home or for a group of homes, we have a single point of interconnection to the AC grid and that interconnection point is going to be in a place where we create DC voltage and then we distribute it to the loads via DC voltage," explains Luis Zubieta, who leads the Product Innovation group at Emera Technologies.

"In our microgrid, we have what we call BlockCentral™ where the AC comes from a medium voltage interconnection to the distribution grid. DC voltage is the center of our system. All the loads inside the microgrid will interconnect via a DC bus from a battery at the Central Energy Park that is the balancing element in the system. The battery is the asset controlling the DC bus voltage. The grid interconnection, the solar and individual loads are just following the voltage that is adjusted or set by the battery's electronics," says Zubieta.

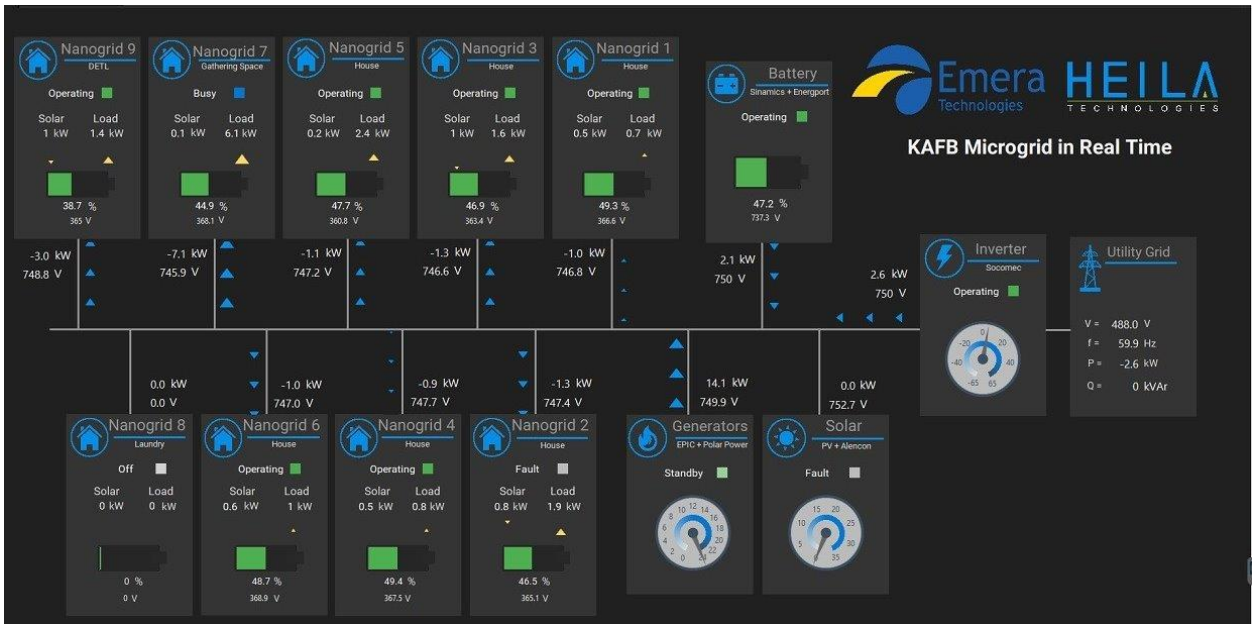


*Figure 2: The Emera Microgrid provides real time monitoring and control of all the loads and energy sources to which it is connected.*

## The Role of Galvanically Isolated DC:DC Converters

One of the critical pieces of equipment in the BlockEnergy microgrid is the Alencon SPOT. The Alencon SPOT is a galvanically isolated DC:DC converter that serves to harvest the maximum amount of power from the PV strings in BlockCentral in the BlockEnergy microgrid and deliver the needed fixed DC voltage output to the DC distribution system.

*Figure 3: The Alencon SPOTs serve to harvest power from the central PV arrays in ETL's BlockEnergy Microgrid and deliver a fixed voltage to the DC distribution bus that connects to each of the nano grids. The SPOT's galvanic isolation isolates the grounding of the PV arrays from the DC bus to enable ETL's protection scheme for the Microgrid to assure a high level of safety and resilience.*

The SPOT serves two main roles in ETL's system. On the input side, the SPOT performs maximum power point tracking at the PV string level to harvest maximum power from the solar panels. Since the SPOT is a string level device, it is particularly well suited to the Kirtland Microgrid because there are multiple PV arrays scattered around the base from which solar power is being generated. These distributed arrays can have different levels of irradiation exposure and are also comprised of different PV panels, so they can have different power generation characteristics. The SPOT manages those differences in a highly granular way to assure maximum power is always extracted from the PV arrays. The SPOT's output is dictated by the DC distribution system's fixed DC bus voltage.

In ETL's case, that DC bus voltage is 750 volts, comprised of a floating +/-375 volts. Being galvanically isolated means the SPOT can separate the grounding scheme of the input of the device – the solar array - from the grounding scheme of the output – the DC bus. This separation of grounding is critical for ETL because the floating DC bus voltage is the key to assuring the safe operation of the whole system based on some unique protection schemes it has devised. The galvanic isolation provided by the SPOTs offers the flexibility of picking any grounding scheme for the PV array while assuring faults that occur in the PV array do not propagate to the DC bus and shut down the rest of the system.

"One of the main targets of our system is reliability, so we want to have the system running all the time. However, an event could happen at any moment. In this case, the SPOT's galvanic isolation gives us the opportunity to keep the Microgrid running if there is a problem with the solar," explains Zubieta.

To achieve that high level of reliability, the SPOTs themselves must be highly reliable. Oppedahl notes that the SPOTs' track record for reliability and uptime has been top notch since commissioning the project in 2019.

"The other element of the SPOT's galvanic isolation that is important is related to the grounding scheme of the whole the system. Many people want to negatively ground a solar array, though in some cases customers may want to have a floating system. In our case. we have a specific grounding style for the distribution system that does not necessarily match the grounding of the solar, so we need to have isolation between the two different types of grounding. Such separation is only achievable with Alencon's galvanically isolated DC-DC converters," states Zubieta.

## A Microgrid That Pleases Many Stakeholders

While the technical implementation of the BlockEnergy microgrid is an achievement unto itself, this microgrid also represents a true "win – win - win" for a variety of stakeholders. Historically, one of the concerns utilities have had with Microgrids is that they promote "grid defection" – meaning they can provide a mechanism for the customer to stop buying power from the utility. The downside to that approach is that it made microgrids highly capital intensive, expensive affairs for the consumer to install and deploy. As an owner of utilities, Emera has flipped this script with its BlockEnergy Smart Platform Microgrid. In ETL's approach, the infrastructure of the entire microgrid is owned and serviced by the utility. This means no upfront costs for the end customer; they just need to purchase power. On the flip side, the customer gets the benefit of increased resilience while having the opportunity to consume clean, renewable energy at a very competitive, market price. At the same time, the grid wins because BlockEnergy eliminates several challenges typically associated with solar generation.

"Our microgrid reduces the burden on the AC grid regarding rooftop solar because we have energy storage everywhere so we can solve a lot of the problems that the good intentions of using more and more solar have brought into the AC grid. For example, if you have many customers with solar, the variability of different solutions and multiple connecting points is eliminated with the BlockEnergy microgrid. It integrates all the numerous roofs into a single point of integration. Individual roofs could have excess generation when the sun is out. Those customers do not care where the energy goes, so the grid becomes forced to take it and find a use for it or store it somewhere. When there is no sun the customer just says 'Give me back my energy.' The grid then has to find a way to deliver that energy. We are solving this problem by having local storage directly at the load," states Zubieta.

For the US Military, on-site generation is key to ensure that the energy required for mission assurance is there, even when the bulk power grid is not. That energy needs to be cyber secure and needs to be renewable and sustainable, so as not to depend on supply chains – such as diesel fuel – in critical situations.

By addressing the needs of all the stakeholders in the energy ecosystem through the implementation of advanced power electronics and controls technology, ETL is taking the Microgrid to a whole new level of applicability.