

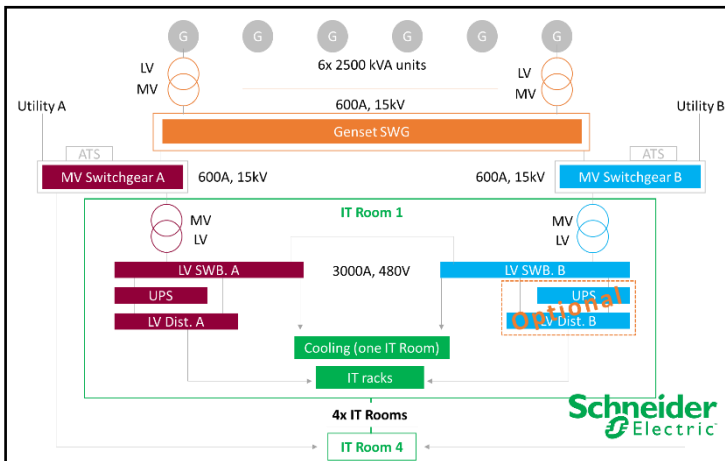
# NEXT GENERATION DATA CENTER BACKUP POWER SYSTEMS

## DATA CENTERS

Data centers are growing rapidly across the US and around the globe. They are the new industrial factory of the modern digital economy and require a massive amount of power to support their high-tech operations. Data centers are located in every state, but the largest hyperscale data centers are sited where power is the least expensive. However, low-cost power does not ensure highly reliable power, so the standard data center design includes backup power systems that can carry the facility computing and infrastructure loads without interruption during a power outage.

These backup power supplies are typically large arrays of diesel generators connected in parallel strings to create maximum resiliency when coupled with battery based uninterruptible power supplies (UPS). See diagram below from the Schneider Electric data center reference design library<sup>1</sup>. These generators sit idle most of the time, except for the periodic testing and occasional power disturbance. Still, they are an essential to mitigating operational risk in the data center.

Typical Layout for Data Centers



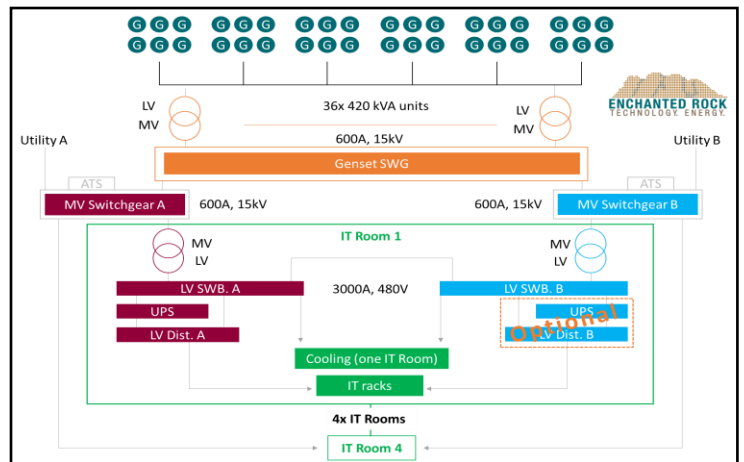
## More Reliable

Natural Gas Microgrids have the same or better reliability compared to diesel backup generators due to their standard modular design, their operating profile and a more robust fuel supply chain.

Diesel backup system designs are generally figured in parallel strings of low voltage generators that step up to medium voltage bus for connection through the site switchgear. When an outage occurs, the UPS carries load until the diesel generators can start and ramp up to full power. Losing one 3MW generator results in significant reduced capacity so the system is designed for n+1 redundancy.

The **Enchanted Rock** design is based on modular building blocks of ultra-clean, natural gas, 400 kw Continuous Backup Capacity that have a unique patent pending packaging design, enabling the same or smaller footprint than the typical 2500kVA diesel and significantly smaller than 2500kVA natural gas. Single gensets can be taken out of service for maintenance with a much smaller impact on reliability.

Enchanted Rock Layout for Data Centers



In a standard layout for data centers, losing one generator decreases the customer's reliability by 17%, however with the **Enchanted Rock** layout, a loss of one generator only decreases the customer's reliability by 3%.

Diesel generators require frequent maintenance including testing under load and conditioning the fuel to ensure reliable operation when called upon. But even strict maintenance programs leave the diesel generator vulnerable. Reciprocating engines need much more frequent operation under load to maintain their readiness, and monthly testing under load is not adequate.

## NATURAL GAS MICROGRIDS AND DATA CENTERS

An alternative approach to data center backup power utilizes Natural Gas Microgrids – a grid connected asset that operates in support of both on-site backup power needs and power grid capacity, energy and ancillary service opportunities. This dual duty mission provides increased data center reliability, reduces operating and capital costs, and provides clean power locally and for the broader grid when compared to typical diesel installations.

**Enchanted Rock** leads in this new approach, with over 350MW of installed distributed energy, and 100MW of natural gas customer sited microgrids operating.

<sup>1</sup> Schneider Electric, Reference Design 65, 5.2 MW, Pod-based build, Chilled Water, 85000 ft<sup>2</sup>

## More Cost Effective

Diesel generators that sit idle for most of the year and are not providing grid services become an expensive drag on both the balance sheet and income statement of the data center operator. But a natural gas generator can reduce or even eliminate that drag when operated in support of energy supply and grid support objectives.

Grid services can generate revenues for the owner of backup generators if they are compliant with performance requirements. These payments can be in capacity auctions, day ahead and hourly market energy sales, avoided demand changes, or interruptible tariff credits.

**Enchanted Rock's** team has achieved revenues ranging from \$75-\$130/kw-year, a significant offset to the cost of ownership of stand-by generators, all while increasing the generator reliability through increased run hours under load.

Procuring renewable energy is an increasing supply strategy for many data center operators. Google, Facebook, Microsoft, Apple, and Amazon have all secured or pledged 100% carbon free energy sourcing through the use of long term power purchase agreements for wind and solar assets. Since most of these contracts are financially settled, there is hedge value of having on-site generation that can provide fast response, cost effective capacity and energy that operates in conjunction with the owner's PPA portfolio.

**Enchanted Rock** has a unique expertise in the technology/electricity market interface, with significant experience in structuring and transacting complex, asset-based energy flexibility products.

Reliability as a service business models provide an alternative to direct ownership of the natural gas microgrid, which can reflect the above economic benefits of grid connected fast response natural gas assets in the form of lower capital contribution and reduced O&M.

The **Enchanted Rock** On Demand Electrical Reliability offering provides backup power as a service by matching investor interest in owning revenue producing infrastructure assets, like on-site natural gas microgrids, with the host need for cost effective backup power. Quite simply, the investor achieves a competitive return in assets and the host pays a fraction of the cost of purchasing a stranded under-utilized diesel backup generator system, while achieving ultra-high availability not attainable in the traditional model.

In summary, just as the data center industry has led in a clean and efficient energy operation, it can now take advantage of a new tool – ultra-clean natural gas microgrids – to increase reliability, improve cost effectiveness, and increase environmental performance.

Enchanted Rock, the leader in natural gas microgrids and innovative reliability as a service business models is the right choice for taking full advantage of these benefits across the US market.

The **Enchanted Rock** solution, based on design and operating principles of the US Nuclear Navy and NASA, runs its generators much more frequently than during power outages and testing. The generators are synchronously interconnected so they can provide grid support when local or regional conditions present opportunities for capacity and energy as well as ancillary services. In one wholesale market, the Enchanted Rock generators run an average 400-800 hours per year.

Normal refueling for a 50MW+ data center is a monumental task. 50 MW of generation consumes ~70 gallons/Mwh for a total of 3,500 gallons of fuel per hour, requiring a tanker every other hour and/or massive tank farms. Additionally, the diesel supply chain becomes very challenged during severe weather events, when refueling may be impossible due to insufficient on-road fuel tankers or impassible roads, as was the case during Hurricane Sandy, Harvey and Irma.

The **Enchanted Rock** natural gas microgrid uses underground pipeline infrastructures for its fuel supply, which are generally unaffected by weather events and even widespread power disturbances. Underground distribution is logistically more reliable than aboveground delivery, as it is protected from the hazards that can cause outages.

## Cleaner Power

When it comes to environmental performance, most data center operators are in a class by themselves. Their focus on improved energy efficiency inside the data center has achieved tremendous improvement in the last decade. And the decarbonizing of energy supplies is unsurpassed by any other industry.

The diesel generator fleet at most data centers runs counter to these achievements. Diesel fuel is high carbon emitting, high particulate emitting, and higher NOx emitting when compared to natural gas equivalent.

**Enchanted Rock's** system has significantly reduced emissions of air common pollutants and about ½ the carbon footprint compared to diesel. With NOx emissions of less than 1% of Standard Tier 2 diesel generation and less than 4% of Standard Tier 4 final diesel generation, Enchanted Rock generators are a much cleaner alternative than diesel.

Due to the quick-response nature of Enchanted Rock's resiliency microgrids when in grid synchronous mode, they are uniquely capable of cost-effectively providing ancillary services to grid operators for balancing intermittent renewables, thus enabling further integration of those renewable energy sources.