



# ENCHANTED ROCK

## The Power is On.

# Zero-Carbon Microgrid Technology to Ensure Full-Facility Operational Resiliency

Ohio Energy Management Conference

March 1, 2023

# WHO IS ENCHANTED ROCK?

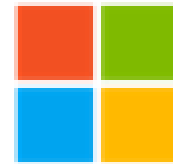
## Dual-Purpose Microgrids for Electrical Reliability Protection

- Lower cost, more sustainable and higher reliability
- Founded in 2006, developed 280+ microgrid sites and over 600MW, with 400MW+ under construction



CALIFORNIA DEPARTMENT OF  
**WATER RESOURCES**

**150MW** to support **CAISO Peak Load** shortfalls



**Microsoft**

**60MW** at San Jose Hyperscale **Data Center** Phase 1;  
36MW for Phase 2

**Walmart** 

**200MW** Portfolio  
113MW under construction



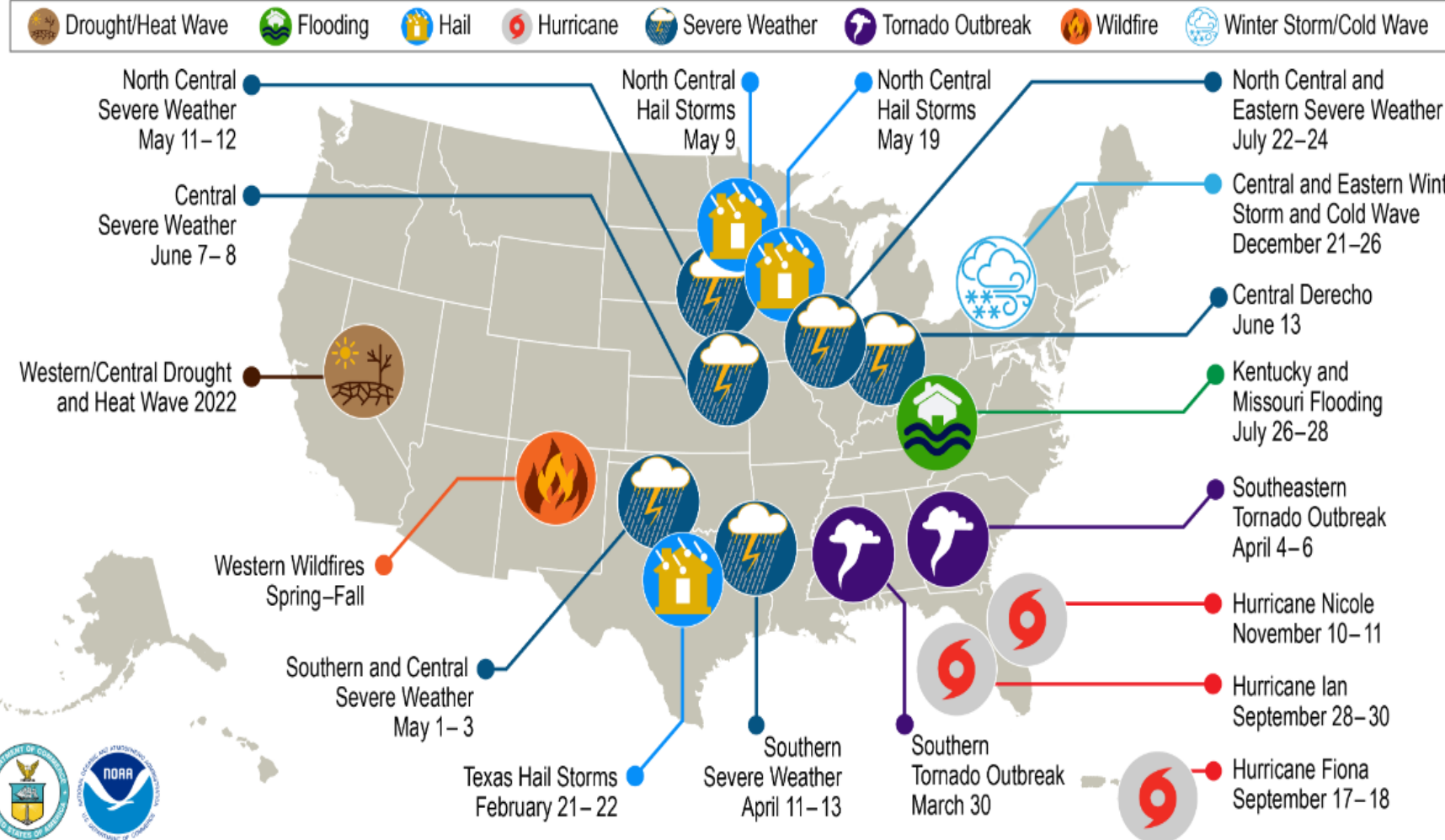
**33MW** City of Houston Water  
Purification Plant

**abbvie**

**7MW** Pharmaceutical  
Manufacturing Facility

# US power outage events from severe weather have doubled in 20 years - now average 100 outage events annually over the past five years

## U.S. 2022 Billion-Dollar Weather and Climate Disasters



This map denotes the approximate location for each of the 18 separate billion-dollar weather and climate disasters that impacted the United States in 2022.



### ADVANCED AGE

In many parts of the country, the U.S. electric grid is more than 50 years old—and in desperate need of an engineering overhaul.



### SEVERE WEATHER

More frequent heatwaves. More crippling cold snaps. More powerful storms. Climate change is placing unprecedented strain



### DIGITAL AND PHYSICAL THREATS

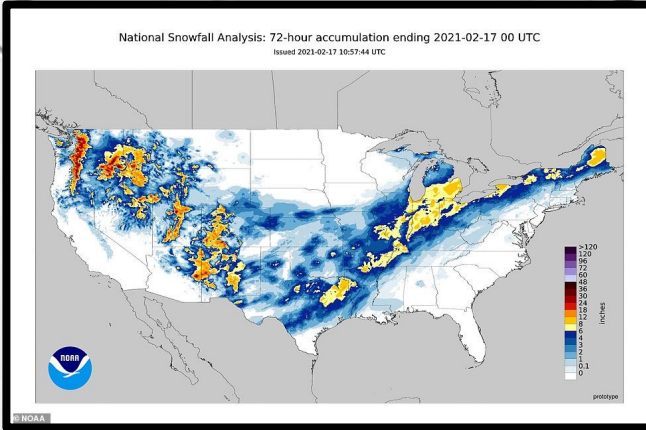
From ransomware assaults to cyberattacks to civil unrest, we've seen increased incursions on our country's vital infrastructure.



# WINTER STORM URI - FEB 2021

“Costs could top \$200 billion”

Perryman Group



Plants were offline for days

Raw materials wasted & finished products not shipped

Supply Chains interrupted

...it could have been WORSE....

Officials at the Electric Reliability Council of Texas (ERCOT):

- The grid was just 4 minutes and 37 seconds away from a **cascading** series of events that could have left Texas in the dark for weeks – if not longer.



# OHIO SUMMER 2022 OUTAGES



## June 13-19 2022 Summer Outage Events

- 606,000 total number of customers who experienced an outage
- Peak customers interrupted at one time 239,000



District	Total CI	Total CMI
Athens	27,374	18,201,835
Canton	80,503	99,264,808
Chillicothe	37,022	39,484,943
Columbus	351,463	195,958,792
Newark	86,562	113,490,220
Western Ohio	22,809	21,281,992
<b>Grand Total</b>	<b>605,733</b>	<b>487,682,590</b>

## Sequence of Events

- Severe storm damage to electric grid
- High temperatures followed
- Load Shed events for **'cascading'** grid protection

# GRID STABILITY ISSUES - NOT JUST THE WEATHER

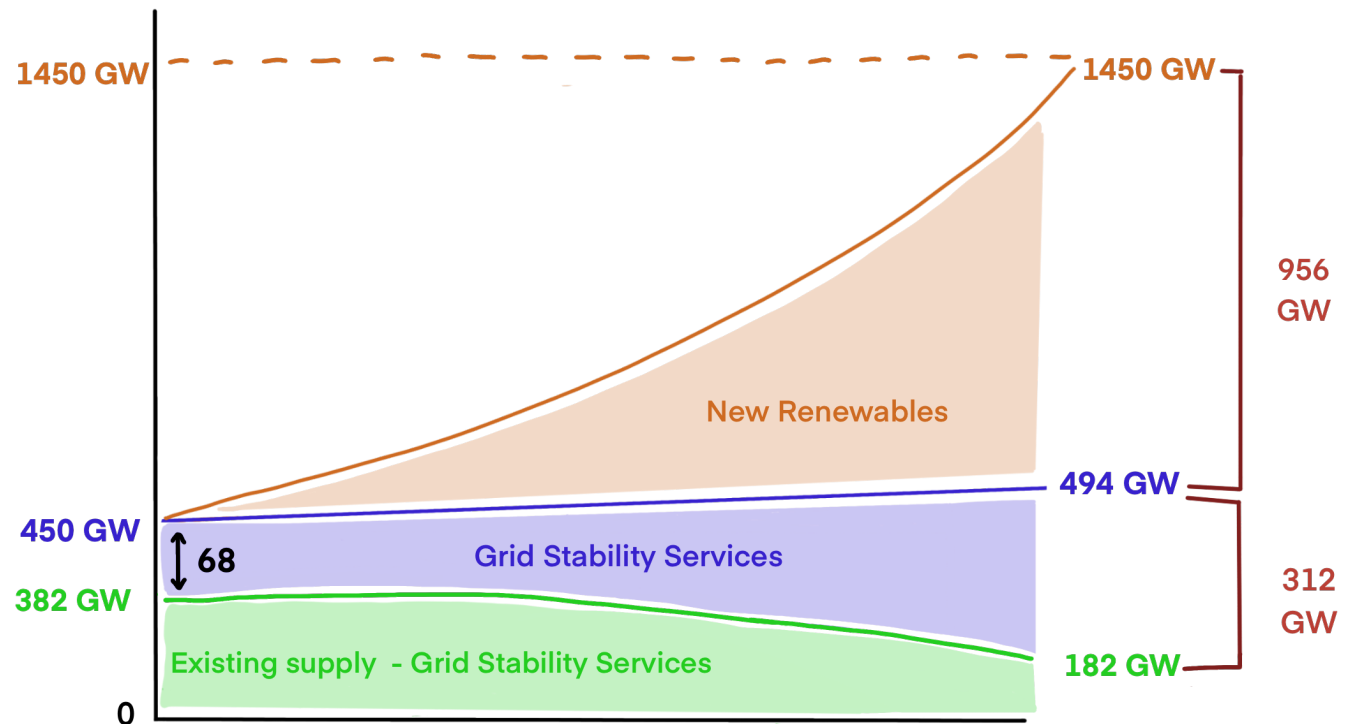
## DECARBONIZATION/ELECTRIFICATION

Total Grid Services **312GW** – Existing Grid Services **68GW** = New GW of Grid Services **244GW**

### Gap Between Supply and Demand is Widening

To electrify everything, we'll need more than three times the amount of electricity that we currently produce. Today, the U.S. grid delivers, on average, 450 GW of electricity. If we electrify nearly everything as we described in the last chapter, we'll need somewhere between 1500 GW and 1800 GW. That's a lot. If we use solar, it's more than we can fit on all of our rooftops, and more than we can erect over our parking spaces (See Figure 6.2). If we added wind turbines in all of the corn fields in America, that would supply about half of what we need.<sup>1</sup>

Excerpt from Rewiring America Handbook



Assumptions:

- 1) Grid Stability Services = 15% of peak load
- 2) Peak load = Avg. load/0.7
- 3) 200GW of fossil fuel power plant retirements
- 4) Demand growth from electrify everything is below the low end of the range from the excerpt to the left

# NERC - GRID RELIABILITY REPORT 2022



“We've been doing this for close to 30 years. This is probably one of the grimmest pictures we've painted in a while”  
- NERC



“Much of the U.S. could see power blackouts this summer”  
- NERC



“Emerging risks are coming at us faster and with more frequency than ever before”  
- NERC CEO

# ELECTRICAL RESILIENCY: CONSIDERATIONS & SOLUTIONS

Businesses can consider multiple solution variables when electing to install a back-up power solution:

## Considerations

- Performance
- Cost
- Emissions/ESG Goals
- Footprint
- Noise

## Solutions

- Diesel Generator
- Natural Gas Generator
- Solar + Storage
- Fuel Cell



# RESILIENCY SOLUTION TECHNOLOGY COMPARISON

## Standalone Technology Providers / Integrators






















Utility-Grade Power
Outage Duration
Emissions
Footprint
Cost

	Diesel	Traditional Natural Gas Genset	Fuel Cell	Solar + Storage
Utility-Grade Power	●	◐	◐	◐
Outage Duration	◐	●	●	◐
Emissions	◐	◐	◐	◐
Footprint	●	◐	◐	○
Cost	\$\$	\$\$\$	\$\$\$\$	\$\$\$\$\$



# RESILIENCY SOLUTION TECHNOLOGY COMPARISON

## Standalone Technology Providers / Integrators

	 <b>ENCHANTED ROCK</b>	Diesel	Traditional Natural Gas Genset	Fuel Cell	Solar + Storage
Utility-Grade Power					
Outage Duration					
Emissions					
Footprint					
Cost	\$	\$\$	\$\$\$	\$\$\$\$	\$\$\$\$\$

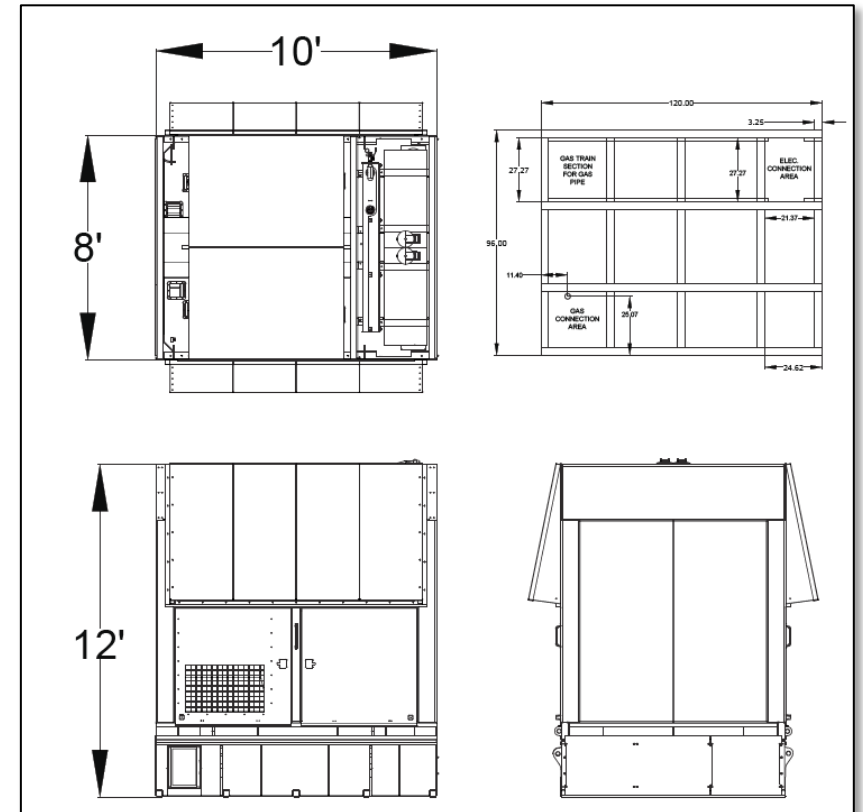


# NATURAL GAS GENSET WITH DIESEL-LIKE PERFORMANCE

## NG450kW Generator:

**Type:** 21.9L Natural gas reciprocating internal combustion rich burn engine dual purpose microgrid generator.

- Meets NFPA110 10-second cold start requirement
- Diesel-like transient response that meets G3 requirements per ISO 8528-5 standards
- Power density equal or better than diesel through a patented, compact packaging design
- Modular design:
  - Configured to meet tight or irregular space requirements
  - Results in higher reliability with reduced single shaft risk
- Solid three-way catalyst emissions controls achieve ultra-low emissions without SCR
- Meets CARB DG emissions limits with optional emissions package, the toughest emissions limits in the world
- Operating range of 5 to 120F. Modifications can be made to widen this range.
- Achieves sound levels ~4-5dBA less than diesel in the same footprint



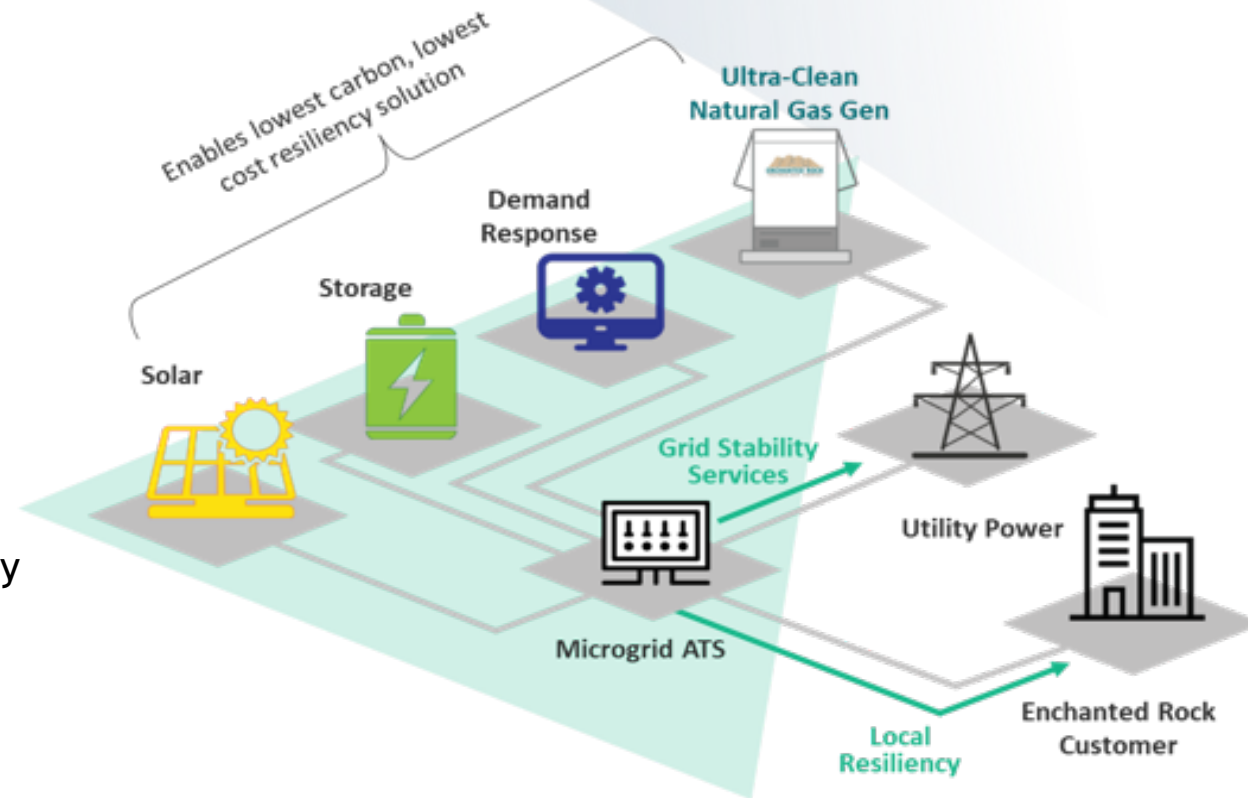
# DUAL-PURPOSE MICROGRID = LOWEST COST 'Resiliency-as-a-Service'

Enchanted Rock microgrids solve two issues:

1. **Electrical Resiliency:** Long-duration (>24 hrs.) power for customers during grid outages.
2. **Grid Stability:** Energy is sold back to the grid to balance grid, augment solar and wind-generated power, etc.

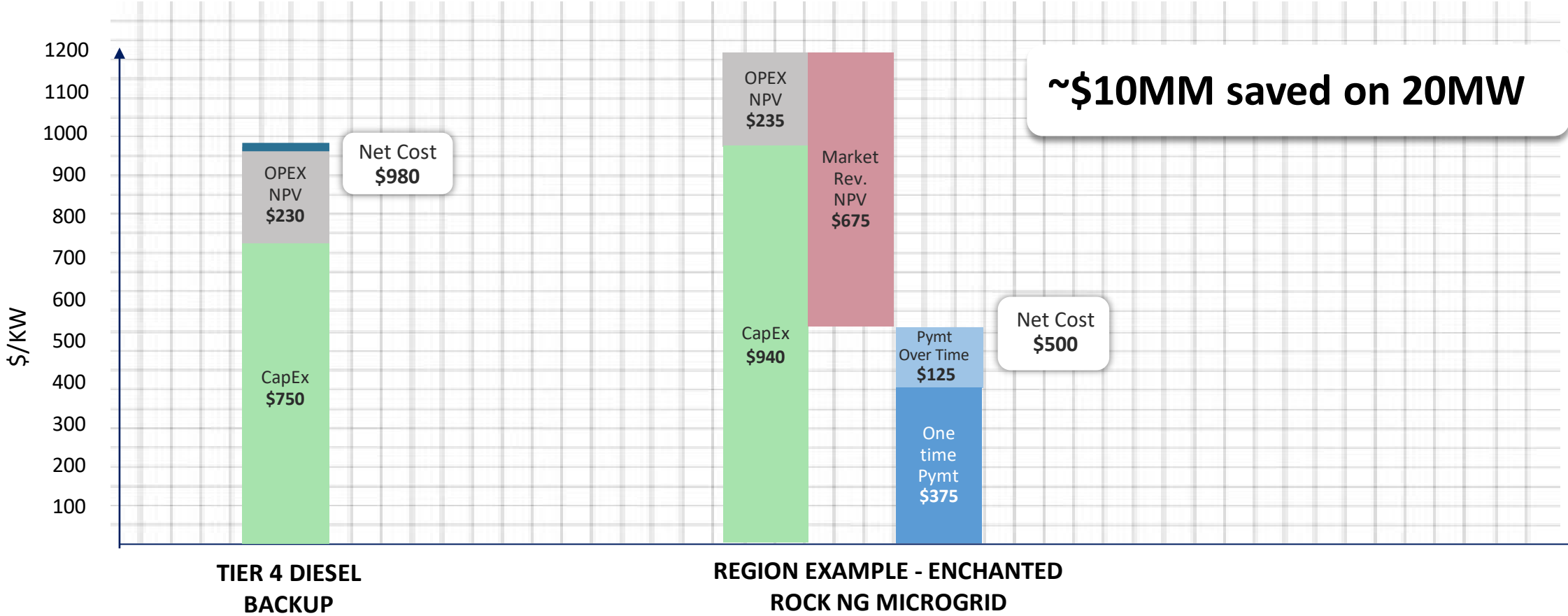
Our systems integrate renewables, demand response and battery storage to enable the **lowest cost and lowest carbon-footprint resiliency solution** in the industry.

Enchanted Rock microgrids also reduce emissions by 10-100x as compared to a traditional diesel-powered backup.



# WE'VE SIGNIFICANTLY REDUCED THE COST TO OUR RESILIENCY CUSTOMERS

20 Year Total Financial Cost (\$/KW-ESP)



\*\* OPEX NPV for Diesel is equivalent to O&M of \$1.00 and \$1.25kw-mo for Tier 2 and Tier 4 respectively. It also includes an estimated cost for testing diesel gens once every 2 weeks for 20 minutes at a cost of \$300/MWh. This cashflow is discounted at 6% for over 20 years with 2% annual inflation on the O&M.



# 60MW MICROGRID: HYPERSCALE DATA CENTER

## What Microsoft wanted:

Datacenter Resiliency solution that matched diesel technical performance but with full decarbonization (net-zero carbon)

## Enchanted Rock Solution

### Diesel Matched Performance

- In order to maintain the data center design, Enchanted Rock had to fit 3MW natural gas generator cells into each diesel generator footprint.
- Meets NFPA110 10-second cold start requirement; Meets G3 requirements per ISO 8528-5 standards; Power density equal or better than diesel; sound levels ~4-5dBA less per gen

### Cost lower than Diesel

- 'Resiliency-as-a-Service' microgrid will be lower cost than the original diesel
- Dual-Purpose microgrid will provide grid stability services back to PG&E and California ISO to reduce cost of system

### Net Zero Carbon

- Renewable Natural Gas (RNG) will be used to fully decarbonize the resiliency offering and grid stability services; Scope 1 & Scope 2 Reduction



## SAN JOSE DATA CENTER SITE

Deal Close: March 2022

Project Size: 60 MW

COD: 07/23 – 03/24

Microsoft has communicated that the San Jose Data Center is establishing a template for future fully decarbonized data center microgrid deals with Enchanted Rock

# ENCHANTED ROCK PERFORMANCE DURING URI

Performance during Winter Storm Uri's unprecedented one-week grid outage event:

- 143 customer sites covered
- 93 customer sites covered concurrently at one point
- 4,984 grid outage hours covered in single week
- ERCOT support provided all week as called via ERS program
- Reliable uninterrupted natural gas supply

Healthcare, Pharma



Industrial Manufacturing



Critical Infrastructure - Water Plant



Warehouse / Distribution/ Grocery



# NATIONAL GUARD HQ AT ENCHANTED ROCK POWERED BUC-EE'S



During Hurricane Harvey in 2017, Enchanted Rock powered three Buc-ee's locations for 100 consecutive hours—allowing them to **stay open** and provide critical services to the community.

One location served as headquarters for first-responders and the National Guard.

# NATIONAL SUPER RETAILER



## Ensure business continuity during power outages and energy market hedge

- Initially 5 locations pilot with success
- Expanded 30 additional stores: 36MW
- Expanded 123 additional stores: 145MW + 9MW distribution center
- Accelerated deployment
- Microgrid ATS at 60 stores  
*adds power capacity and breakers for future nodes, including EV charging, battery storage, and other distributed energy asset types*



Portfolio size: 196.8 MW  
Current COD: 83.6 MW  
Under Construction: 113.2MW  
Over the next 5 – 10 years, Enchanted Rock expects to install microgrids in all Walmart stores and distribution centers where natural gas is available and affordable. The new installations will have the microgrid ATS.

# NATIONAL GROCERY STORE CHAIN & DALLAS DISTRIBUTION CENTER



- ✓ Eliminate the frequent power outages from grid instability
- ✓ Ensure business continuity during severe weather and grid failures
  - Initially, 50MW of resiliency microgrids across the Houston region
    - Expanded to over 100MW across Texas
  - All HEB locations protected against unplanned outages
  - Experienced revenue growth due to continuous power protection
  - Millions in cost-savings from preventing lost/damaged inventory
  - 24/7/365 monitoring and optimization to detect problems, grid power quality thus preventing equipment damages and losses



Portfolio Size: 204 MW

Current COD: 183 MW

Under Construction: 21 MW

Enchanted Rock will install resiliency microgrids at all of HEB's Texas stores, totaling ~360 sites for ~400MW



# LARGEST US MICROGRID PROJECT AT WATER PLANT

## City of Houston Water Purification Plant Project:

- 33MW, 75 Gensets
- 15 rows of 5 450kW gens
- Weekend Install
- <https://youtu.be/n4M4VqrikDw>



# EMISSIONS COMPLIANCE

## LOW EMISSIONS BY DESIGN

A key design feature of the Enchanted Rock NG450 genset is low emissions. With the standard emissions package we regularly maintain fleet emissions below the achieved emissions levels show in the table below. The optional emissions package brings CO emissions even lower to meet strict [California Air Resources Board \(CARB\) Distributed Generation \(DG\) emissions levels](#). Tier 2 and 4f diesel emissions are shown for comparison; % reductions are shown relative to Tier 4f.

In-House Field Testing



Standard Unit

Optional Emissions Package

Air Pollutants lb/MWh	Standard Unit		Optional Emissions Package			
	Tier 2 Diesel	Tier 4 Diesel	NG450 Standard Emissions Pckg	% Reduction v. Tier 4	NG450 Optional Emissions Pckg	% Reduction v. Tier 4
NMHC	15.40	0.45	0.038	92%	0.020	96%
NOx		0.96	0.070	93%	0.070	93%
CO	8.34	8.34	3.200	62%	0.100	99%
PM	0.48	0.048	0.009	81%	0.009	81%

Note: Units of lb/MWh are net of generation and account for all transformation efficiencies and parasitic losses.

# RENEWABLE NATURAL GAS

*Enchanted Rock provides a Renewable Natural Gas offering that enables customers to achieve carbon neutral or carbon negative emissions.*

1. Use of RNG will cover both scope 1 and 2 emissions
  - a) Enchanted Rock documents entire chain of custody trail through regionally approved renewable energy tracking platform
2. Enchanted Rock procures RNG through long term fixed price contracts on a portfolio basis

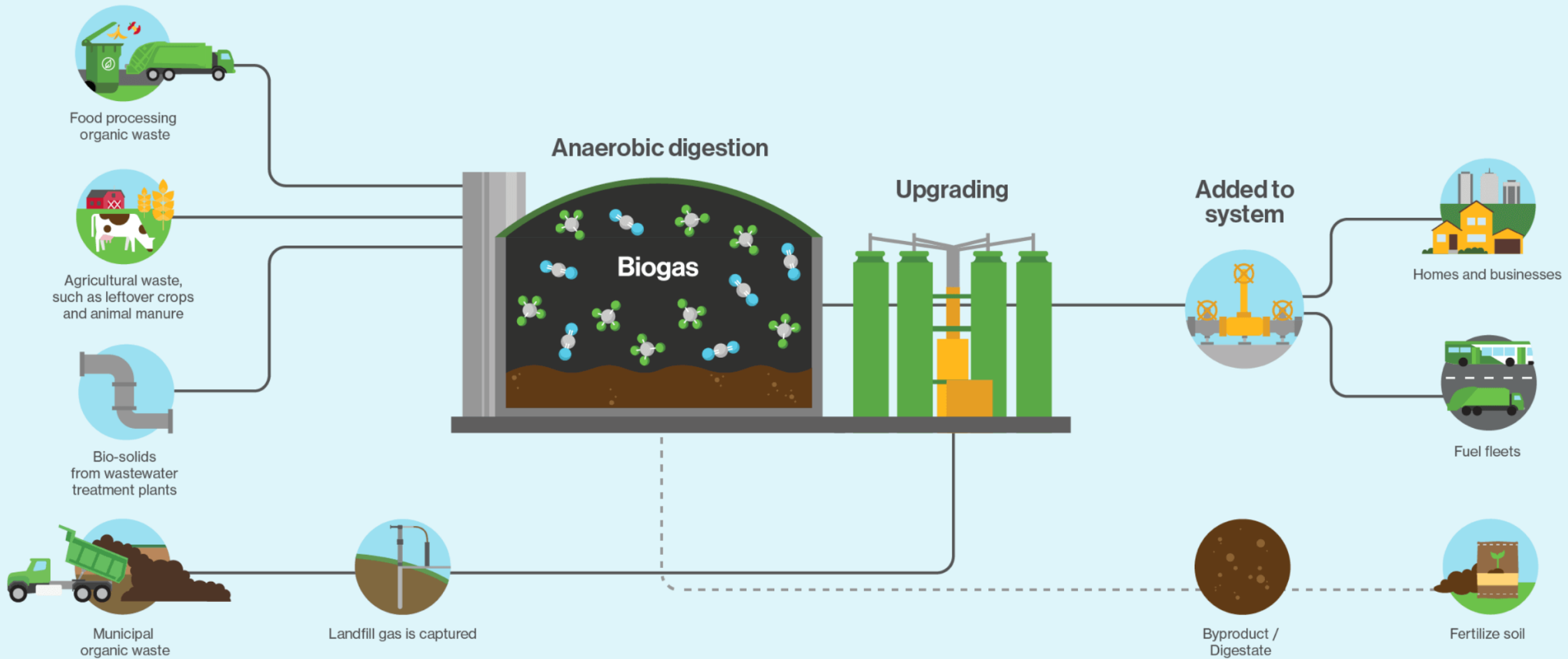
**Table 1. Carbon intensity of transportation fuels in California LCFS program**

Fuel type	Carbon Intensity (grams CO <sub>2</sub> e/Megajoule)
Diesel	102
Gasoline	100
Corn ethanol	34-75
Natural gas	68
Fuel cell (nonrenewable hydrogen)	39
Electric vehicles (CA power grid)	31
Biodiesel	9 to 50
Landfill biogas	11 to 40
Biogas from forest waste	14
Wastewater biogas (large facilities)	8 to 30
Biogas from diverted food and green waste	-15 to -100
Dairy biogas	-276 to -330

Source: California Air Resources Board



# RNG Lifecycle: How is it Made?



# WHAT ARE THE BENEFITS OF RNG OVER OTHER FUELS?

- RNG enables customers to achieve zero or negative carbon equivalent in their Scope 1 and Scope 2 emissions protocols. This cannot be achieved with renewable diesel or biodiesel, as these fuels will always have a positive CI score.
- As shown in the table on the bottom right, methane has more than 70 times the warming power of carbon dioxide over the first 20 years after it reaches the atmosphere.
- Utilizing RNG lowers emissions when methane is captured and repurposed as RNG, rather than being released directly into the atmosphere or flared.
- At COP26, the US and EU announced the [Global Methane Pledge](#), which is a major effort to reduce methane emissions in order to keep global warming at 1.5 degrees Celsius.
- Reducing methane through the utilization of RNG is the quickest way to slow the rate of global warming today.

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Source: California Air Resources Board

## Global Warming Potential of Short-Lived Climate Pollutants<sup>1</sup>

Pollutant	Lifetime (years)	20-year GWP
Carbon dioxide	~100 <sup>2</sup>	1
Methane	12	72
F-Gases (Hydrofluorocarbons)	1.4 – 52	437 – 6350
Black carbon	Days to weeks	3,200

<sup>1</sup>Short-Lived Climate Pollution Reduction Strategy. Global Warming Potential for SLCPs, Table 5, Page 44.

Available at: [https://ww2.arb.ca.gov/sites/default/files/2020-07/final\\_SLCP\\_strategy.pdf](https://ww2.arb.ca.gov/sites/default/files/2020-07/final_SLCP_strategy.pdf)

<sup>2</sup><https://www.biofuel-express.com/en/hvo100/>



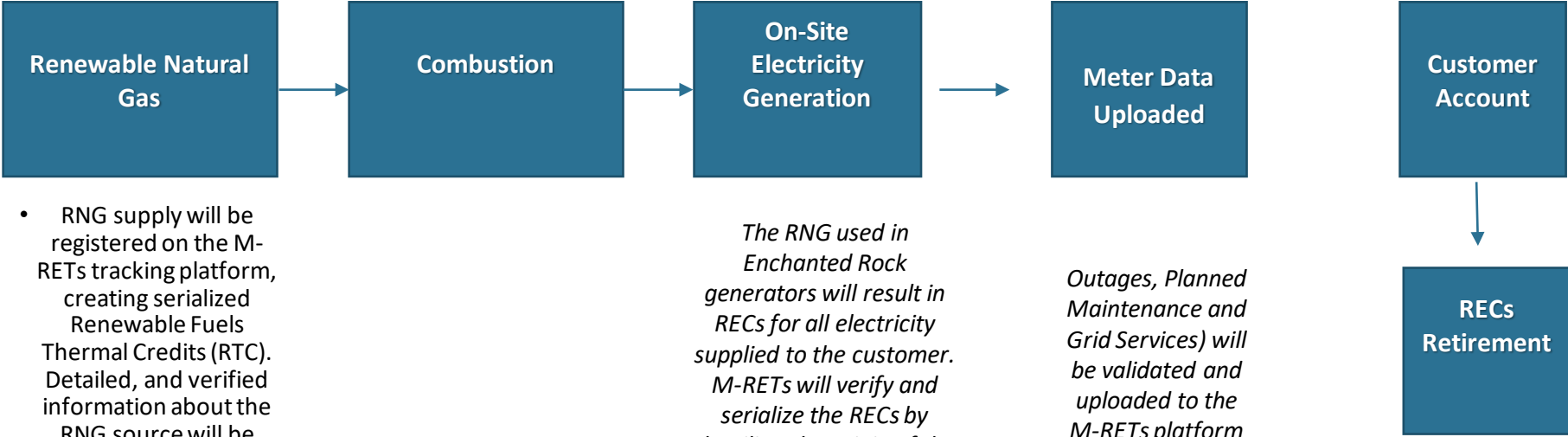
# Renewable Natural Gas (RNG) for Zero Carbon Resiliency

## Background



- M-RETS creates and tracks Renewable Thermal Certificates (RTCs) and Renewable Electricity Certificates (RECs) across North America.
- M-RETS RECs are able to contain hourly data information and peak/off-peak and RTC's may include verified carbon intensity data.
- M-RETS supports RTC and REC compliance and voluntary markets in one easy to use platform that utilizes the latest software.

- Mission:** M-RETS validates the environmental attributes of energy to serve as a trusted centralized gateway to environmental markets.



- RNG supply will be registered on the M-RETS tracking platform, creating serialized Renewable Fuels Thermal Credits (RTC). Detailed, and verified information about the RNG source will be included in the RTC record

*The RNG used in Enchanted Rock generators will result in RECs for all electricity supplied to the customer. M-RETS will verify and serialize the RECs by detailing the origin of the renewable natural gas used during generation*

*Outages, Planned Maintenance and Grid Services) will be validated and uploaded to the M-RETS platform every 30 days*

*RECs generated from MWh's supplied during DR load reduction, or sold back to the Grid during market runs will be banked for future sale into the secondary RECs market, and will not count towards the customers Scope 1 or 2 emissions reductions goals*

*REC's generated from the MWh's supplied during outages, and planned maintenance will be transferred to, or retired on the customers behalf to count towards their Scope 1 and 2 emissions reductions goals. All data is collected for both*

# EMISSIONS CONSIDERATIONS

Enchanted Rock is an industry leader in reducing natural gas emissions – we are the only reciprocating engine to meet CARB DG standards in California

## Enchanted Rock Microgrid



### Enchanted Rock Air Permit holder for criteria pollutant emissions such as:

- NO<sub>x</sub>, CO, VOCs, PM, and SO<sub>2</sub> along with HAPs
- These emissions are reported by the permit holder
- Permitting strategy defines approach and can help mitigate potential site issues.



### Customer Site Scope 1 & 2 Emissions

- GHG emissions for carbon accounting tracking
- Renewable Natural Gas REC's generated by ERock when used by Customer during outage backup and planned maintenance will be transferred to reduce Scope 1 and 2 emissions.
- 'Resiliency-as-a-Service' moves backup power emissions to Scope 2 to Zero with **RNG**

# NETWORK OPERATIONS CENTER(NOC) AND O&M

- GraniteEcosystem™ software platform to monitor, automate, analyze and control microgrid operations and immediately respond to grid conditions
- ✓ Monitor over 40 data points per generator on over 1,300 individual generators on a 24/7/365 basis and provide 99.999% historical reliability.
- ✓ Market dispatch and weather monitoring for pre-emptive islanding as needed to minimize customer interruptions
- ✓ Detects anomalies in real time genset operating data and with automated analytics, triggers routine program maintenance and any required component replacement or upgrades.
- ✓ Custom proprietary control software hosted on redundant servers at a Tier 3 Data center and in a secure internet cloud
- ✓ Independent network connection ensures that no single equipment failure will interrupt system monitoring and control.
- ✓ Enchanted Rock actively hires through the Nuclear Navy pipeline as these technicians bring valuable experience maintaining mission-critical systems at multi-billion-dollar defense assets.

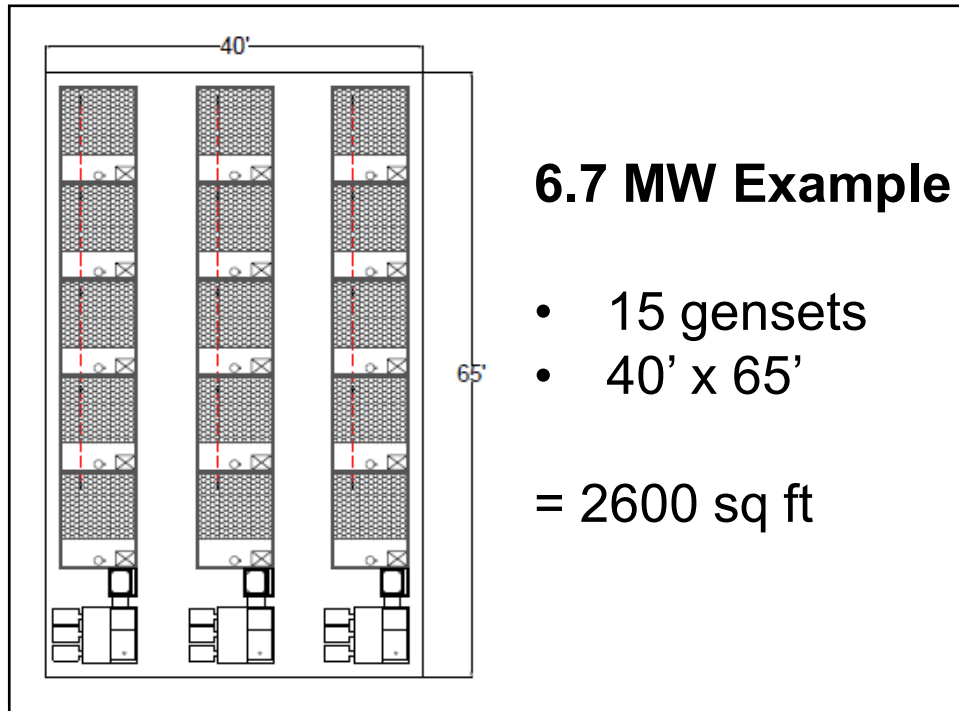


*Enchanted Rock Network Operations Center Houston, TX*

# FLEXIBLE ARCHITECTURES

## CENTRALLY LOCATED GENERATION PLANT

- Compact footprint on a MW/sqft basis
- Ease of installation with modular design
- Hyper-redundancy for reliability
- Simplified utility-like connection at MV



### Northeast Houston Water Purification Project:

- 33MW, 75 Gensets (15 rows of 5)
  - Weekend Installation
- = 260' x 65' = 16,900 sq ft (0.38 acre)

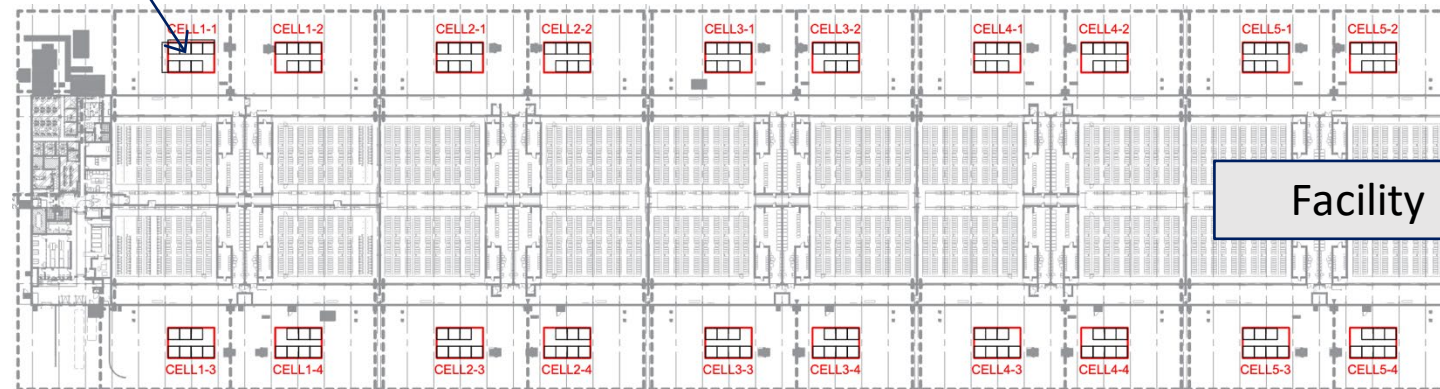


# FLEXIBLE ARCHITECTURES

## 3MW CELLS OPTIONALITY

- 480V direct connect to load eliminates transformation losses
- Reduced land use as gensets are nested between other facility equipment
- Eliminates recirculation issue of clustered large MW generation

3MW Cells, 60MW Total



Facility



# MICROGRID DESIGN & IMPLEMENTATION

Enchanted Rock's 'Resiliency-as-a-Service' offering is a full turnkey solution that includes the design, construction, commissioning, operations, maintenance and 24/7 monitoring of the microgrid.

## Enchanted Rock Standard Project Deliverables

1. Civil, mechanical, and electrical design of modular, scalable, high-availability microgrids
2. Grid revenue program availability, evaluation, and selection
3. Local permitting and management, including air permits
4. Gas and electric utility interconnection agreements and coordination
5. Utility and load electrical integration (including power and controls cables/conduits)
6. Plumbing integration and construction from gas meter to generation
7. Commodity equipment specification, sourcing, and supply, e.g. transformers, and switchgear
8. Microgrid equipment installation, assembly, and commissioning, and utility DG integration testing including third party witness

## Working with GCs and Sub Contractors

- Minimize possibility of scope overlap
- EC and GC expected to take the electrical and civil scope
- Enchanted Rock to provide issue for construction drawings
- Enchanted Rock to provide construction management or supervision support on site

Site electrical contractor is expected to provide:

- Low voltage cable, conduits, terminations, and labor
- Medium voltage cable, conduits, terminations, and labor

Site civil contractor is expected to provide:

- Civil materials and labor for duct/ boring for conduit lay
- Concrete pad or other level options for placement of generators

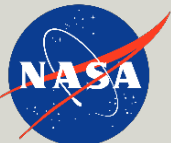
# FOUNDER AND CEO THOMAS MCANDREW

- ✓ Served in Navy on nuclear vessels
- ✓ Named by Texas PUC to the Texas Reliability Council

Enchanted Rock was founded based on Navy Nuc and NASA backgrounds



*Ships as original microgrid*



**2006**

**Enchanted Rock Founded**  
Intersection of tech and markets

**2011**

**City of Houston**  
Designed/developed 60MW for three Houston water plants

**2016**

**iROC**  
Launched natural gas microgrid service offering – integrated Reliability On Call

**2022+**

**284 Microgrid Sites**  
H<sub>2</sub> Blend Testing, Engine R&D

**2009**

**Hurricane Ike**  
Prompted launch of resiliency-as-a-service which was the first of its kind

**2013**

**Diesel Merchant Fleet**  
Built 170MW of diesel generation

**2021**

**Voluntary RNG Offering**  
CARB DG Emissions and Net-zero Resiliency with Renewable Natural Gas

# ENCHANTED ROCK BY THE NUMBERS



**284** Operational  
Microgrid Sites



**11,603** Hours of Utility  
Outages Covered



**621** MW  
Commissioned



**804,533** Unit  
Run Hours



**419** MW Under  
Construction



**99.9995%** Combined  
Reliability



# TRUSTED BY

## Grocery & Distribution



## Healthcare



## Critical Infrastructure



## Manufacturing



## Utilities



## Data Centers



## Education



## Automotive





# ‘Resiliency-as-a-Service’ Advantages

## Enchanted Rock owns and operates the equipment

1. ‘As-a-Service’ model **eliminates CAPEX** purchase – keep capital purchase off balance sheet, service fee only.
2. We have a vested interest in the performance of the backup system.
  - ✓ Contractual performance metrics and 5 9s historical reliability.
  - ✓ NOC 24/7 monitoring, 20-year warranty and O&M
3. Reduce **Scope 1 and Scope 2** emissions with Renewable Natural Gas
4. Higher performance and higher reliability with overall lower cost over 20 years.



# WRAP-UP & Questions

- Ever-changing grid is less reliable
- Enchanted Rock delivers 99.999% reliability
- Lower CAPEX / OPEX than other systems
- Renewable Natural Gas (RNG) is utilized to achieve carbon-neutral emissions
- Solutions meet CARB DG emissions standards—the most stringent limits in the world



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# ERock Contacts and Additional Resources



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## White Paper Resources:

[The Brattle Group Report: Decarbonized Resilience](#)

[Navigant Research Report: Resiliency Microgrids](#)

[Guidehouse Insights: Enhancing Resiliency for the Energy Transition](#)

## Webinars Resources:

[Recorded Webinar: Shedding Light on the California Electrical Grid Challenges](#)

[Recorded Webinar: How to Foster Resilience in Times of Crisis](#)

## BIOGRAPHICAL INFORMATION



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**Global Account Director – Manufacturing**  
**Enchanted Rock**  
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**[mmaiers@enchantedrock.com](mailto:mmaiers@enchantedrock.com)**

Matt Maiers is a Global Director with Enchanted Rock and is focused on helping companies in the manufacturing sector prevent downtime and financial loss due to grid failure events. Matt works closely with large manufacturers to evaluate solution fit for Enchanted Rock's 'Resiliency-as-a-Service' advanced microgrid technology which provides 'full-facility' electrical redundancy through utilization of a 'dual-purpose' microgrid which maximizes asset value and drives down customer sided costs. Enchanted Rock is one of the largest microgrid companies in the US and has developed over 270 microgrid sites and over 600MW since 2006.

Matt has over 20 years of experience in the manufacturing and energy sectors and has a passion for delivering complex, entrepreneurial solutions that provide economic and sustainably focused real world value. Matt has a diverse background having worked with leading companies such as Battelle and DNV, and is also experienced in the commercial sales, financial analysis, project development and technology commercialization of various energy and renewable energy technologies such as solar, wind, biogas, waste-to-energy, battery energy storage and distributed microgrid solutions. Matt has a Bachelor of Science and MBA degree from Oakland University in Michigan, and resides in Columbus, Ohio.