ENCHANTED ROCK
Managed Power Resiliency Solution
August 25, 2020

Challenge Statement
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Question One: Does your solution replace diesel generators by supplying power to all customers at a substation level?

Yes.

Secondary Question One: Does your solution replace diesel generators as a portable and deployable fleet of temporary generation, or is it a permanent installation at a specific substation?

Enchanted Rock proposes a stationary microgrid solution at specific substations.

Secondary Question Two: Can your solution sustain islanding for 48 and/or 96 hours? A single wind event will require an outage of 24-48 hours depending on weather and timing. Back-to-back events, while less likely, may require 96 hours of islanding capability.

Enchanted Rock's solution meets/exceeds the 96-hour islanding requirement. There are no runtime limitations due to continuous supply of pipeline fuel.

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Every item in the Challenge Statement has been addressed. Enchanted Rock concludes it has a viable solution for 2021.

Secondary Question 3: Can your solution be ready for commercial operation by 2021 and can you provide enough labor (to both construct and operate) and ancillary equipment (e.g. cabling, step up transformers, protection, etc.) to execute a full-scale deployment? If not, when can it be ready? Reference Appendix C below for more detail.

Yes. The construction timeline is 9 – 12 months from contract date, depending on the site. For stationary installations, no labor needed for set up and breakdown for each event.

Secondary Question 4: Given the constraints detailed above, how many MW can your solution reasonably cover in 2021? In future years? Under what conditions can your solution be reasonably deployed?

If contracts are signed by October 31, 2020, Enchanted Rock can deploy

- **225 MW by July 1, 2021**
- **350 MW by October 1, 2021**

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Enchanted Rock Portfolio

Proven resiliency microgrid solution that meets technical requirements ready for 2021 PSPS season

227 Diesel MW commissioned

203 NG MW commissioned

116 MW under construction

170 Sites with islanded operation

4,474 Hours of utility outages covered

- Please see the Appendix for a detailed portfolio of Enchanted Rock's medium voltage customers

Texas A&M RELLIS, 2017
10.5 MW Natural Gas

City of Houston, 2011
16 MW Diesel

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Patented Genset Design

High power density and modular design results in more compact footprint that allows for fitting in complex spaces

16 million operating hours in engine family

Diesel-like transient response

Standardized and modular for scalability

Advanced microgrid controls

Small footprint

Unique airflow

Three 448kW Genset Units

Ultra-clean natural gas

Carbon-negative biogas

Ultra-quiet

Infinite operation

Island or synchronous

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Alto Site Layout Example

High power density matches diesel space requirements with no on site fuel storage or deliveries needed. Low emissions and quiet operation is less than ambient noise

Peak Load	Load Factor
31.81	67.8%

Alto Substation, Mill Valley

85 gensets at 448 kW ESP

Gray area denotes approximate area cleared of trees earlier in 2020

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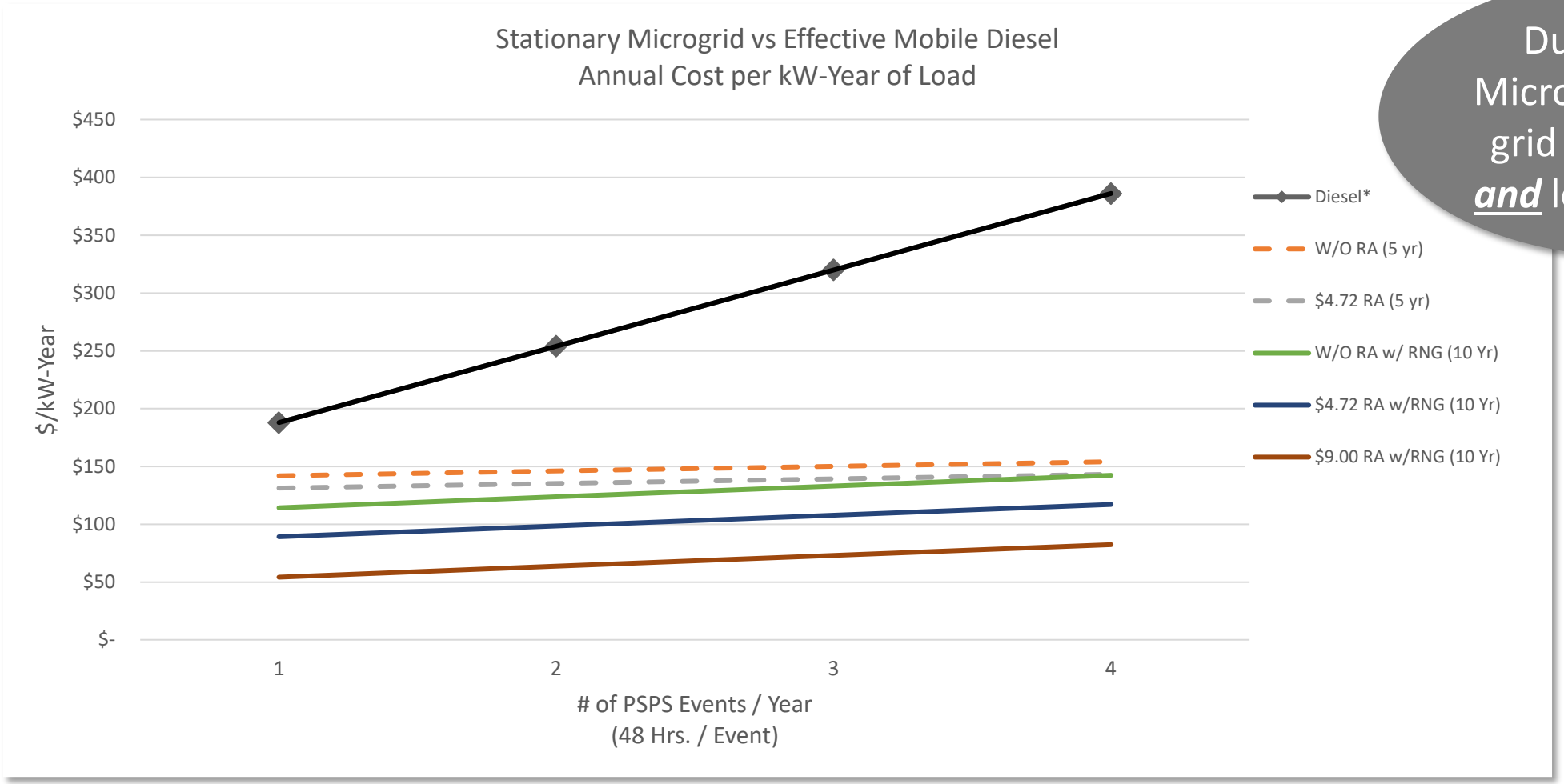
Annual Cost / kW

Stationary Microgrids can save ratepayers $150M - $2B due to avoided annual rental and costly deployment fees at 39 substations



Dual Purpose Microgrids support grid stability (RA) ***and*** local resiliency

**Diesel effective annual cost reflects the ratio of 350 MW of rental capacity serving 900 MW of load. For stationary installations, the ratio is 1.*

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Benefits of Stationary Microgrids

Stationary microgrids reduce risks and provide highest availability and immediate protection during changing conditions

Many of the risks that are associated with mobile generation can be mitigated with stationary installations. These risks include:

1. PSPS prediction must be accurate 48 hours in advance to enable mobilization
2. Movement of mobile assets and personnel from staging area to multiple substations is complex
3. Diesel refueling logistics for multi-day PSPS result in multiple refueling trips per day at each substation
4. Consecutive events or shifting fire risk conditions make timely movement more challenging
5. Safety risks increase with with DLA cables, fuel spills, crew fatigue, etc.
6. Over road transit of equipment results in vibration and less than 100% availability

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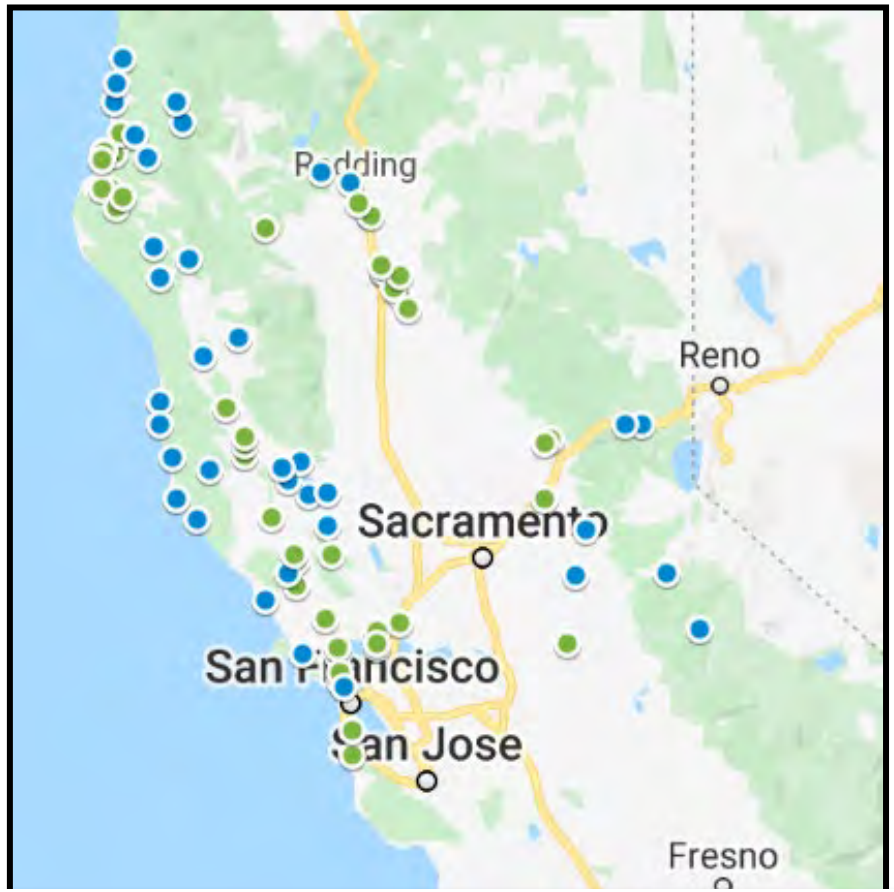
Applicable Substations

Analysis of 2019 PSPS affected substations shows 39[1] sites totaling approximately 650[2] MW are technically feasible

- Enchanted Rock's microgrid solution can be deployed at up to 39 substations with proximity to gas pipelines
- Enchanted Rock estimates the 39 substations require 20 MW or less per bank, with 2 exceptions[3]
- If a substation does not have adequate land, Enchanted Rock can install microgrids downstream from the substation near fuel supplies. Please see the Appendix for an example
- If gas capacity is not ready for 2021, mobile fueling can bridge until infrastructure arrives. Please see the Appendix for an example



● = substations with proximity to gas pipelines

● = substations not in close proximity to gas pipelines

1. The list of 39 substations excludes Humboldt because it will be served by the Humboldt Bay Generating Station and 2 substations in Tehama county because they will be served by local cogen
2. 650 MW excludes any partial substation opportunities due to non-transmission PSPS curtailments
3. Highway and San Rafael

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Microgrid Experience with Natural Disasters

Stationary microgrids perform well in multi-day resiliency operations and recent events show 100% load coverage for all locations

Enchanted Rock has significant experience running microgrids for multi-day periods during severe weather events. Total outage events exceed 670 and Enchanted Rock provided power for up to 49 consecutive days until utility power arrived.

	2017 Severe Weather Event	2020 Severe Weather Event
# of Islanded Microgrids	22	27
Average Run Time	105 hours	23.6 hours
Max Run Time	105 hours	54.4 hours
Total Customer Load Covered	100%	100%

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Rapid Field Installation

5-Week construction timeline reflects assembly of standardized modular equipment, rather than custom design and construction

Enchanted Rock's kitting approach to microgrid installation allows for quick deployment. The timeline constraints are from permitting and electrical and gas interconnect.

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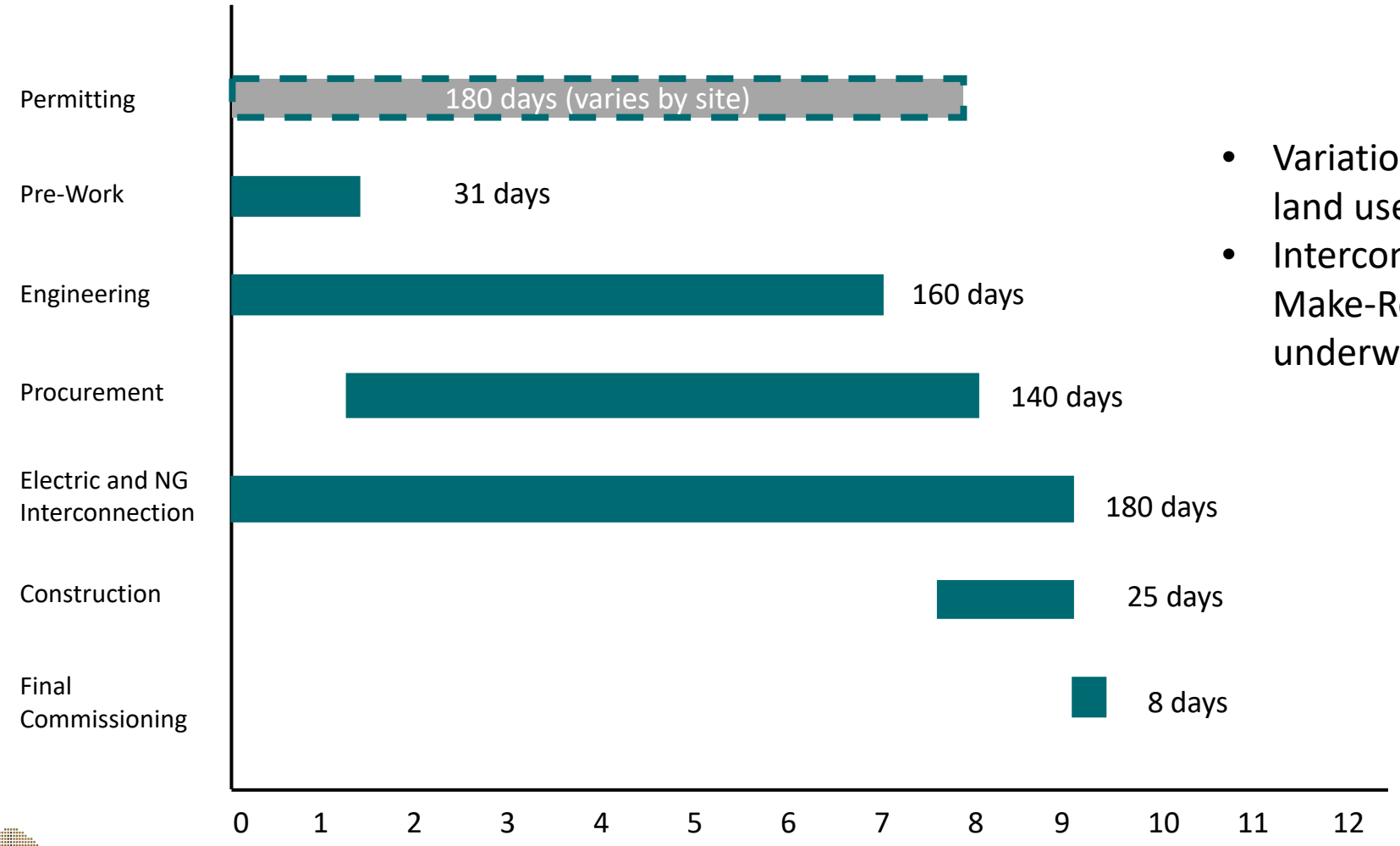
Substation Microgrid Project Schedule

9 – 12 month end-to-end construction schedule



- Variation in permitting is local land use approvals
- Interconnection assumes PG&E Make-Ready investments already underway

Note: Days = Business Days

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Timeline to COD and Scale for 2021

Significant reduction in diesel use starting in 2021 is possible if adequate time allowed for contracting and construction

If contracts are signed by October 31, 2020, Enchanted Rock can cover:

- 225 MW by July 1, 2021
- 350 MW by October 1, 2021

Enchanted Rock can support this volume through existing robust supply chain, dynamic project management, scalable construction enabled through pre-construction kit assembly

Enchanted Rock can complete the addressable market of 650 MW by 2022

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Appendix

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Enchanted Rock Performance Testing

Enchanted Rock passed 100% of prescribed performance tests conducted by PG&E on January 15, 2020

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Testing Requirements

Enchanted Rock's patented genset meets all performance standards, as tested by PG&E. Extensive operational data proves real-world emergency operations

- Generator performance testing
  - PG&E conducted prescribed performance testing of Enchanted Rock's gensets on January 15, 2020 to validate start, ramp, step load, frequency and voltage management. 100% of the tests were passed.
  - Enchanted Rock has an extensive operational record and currently manages nearly 700 individual generators in real time. Data points from each generator are routinely analyzed to improve generator performance and prevent problems before they become critical in nature

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Performance Requirements

Enchanted Rock meets all performance requirements outlined in Appendix B and D with the two exceptions below.

Synchronizing	The system shall use the Slip Frequency synchronization Method, set to 0.1 Hz slip. ~~have the ability to make small frequency adjustments for PG&E to passively~~ resynchronize the island back to the normal utility source grid.	Control systems in place to be able to make these required adjustments	This allows for the generation island to support real-time adjustment to meet power quality criteria for the islanded load. This also is required to ensure the island can be re- paralleled to the utility grid.	Enchanted Rock has successfully used this method to resynchronize the island back to utility at over 170 NG Microgrids, interconnected to 7 different electric utilities
Protection	Generators must have ability to generate short circuit fault duty for various fault types to allow traditional overcurrent protection to be used to successfully detect and clear utility primary faults. Generator must have ability to generate 3- phase short circuit of at least 250% of the nameplate ~~MVA~~ full load current rating. Generator must have ability to sustain 3-phase fault duty for 10 seconds, Line-Line (L-L) fault duty for 5 seconds and Line-Ground (L-G) fault duty for 2 seconds.	Generating sources meet the requirement defined	This is required to ensure fault detecting devices have the proper amount of system fault energy to be able to detect hazardous fault conditions	As verified by PG&E on February 13, 2020 during the DGEMS RFO process

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Emissions Comparison

Compound	EROCK Rich-Burn		Tier 2 Diesel	
	Engine Zero-Hour Emission Factor (lb/MW-hr)	Emission Factor Source	Engine Emission Factor (lb/MW-hr)	Emission Factor Source
VOC	0.001	NRTL Test Data [1,2]	14.11	NSPS IIII 5
NOx	0.0024	NRTL Test Data [1,3]		
CO	0.10	CARB DER SB1339	7.72	NSPS IIII[5]
PM/PM10/PM2.5	0.003	NRTL Test Data [1,4]	0.44	NSPS IIII[5]
SO2	0.007	AP-42 Table 3.2-3	0.016	AP-42 Table 3.4-1
CO2	1,381	NRTL Test Data [1]	1,555	AP-42 Table 3.4-1

1 Enchanted Rock ISO 8178 D1 weighted test cycle emissions results from a single engine at a Nationally Recognized Testing Laboratory. Actual field test results may vary due to site conditions, installation, fuel specifications, test procedures and engine to engine variability.
2. VOC emissions found to be below the minimum detection level of the equipment.
3. NOX and CO emissions data are the near-zero hour non-deteriorated emission rates which are not guaranteed emissions for the purposes of air permitting. These rates are typical for lower run hours which will increase with catalyst age.
4. PM emissions not expected to change with catalyst age, although differences in fuel quality could impact actual emissions.
5. NSPS IIII emission limit for electric generator rated between 560 kw and 900 kw.

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Emissions Comparison

Diesel Engine Emissions Compared to EROCK

Compound	Tier 2
VOC	4151x
NOx	
CO	77.2x
PM/PM10/PM2.5	176x
SO2	2.3x
*CO2**	1.1x

**Assumes using natural gas only. Genset is carbon negative when offset by Renewable Natural Gas.*

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Alto - Permitting

Substation Name	County	Air District	Permit Type or Approval	Document Type	Issuing Agency/Entity
ALTO	Marin	Bay Area Air Quality Management District (BAAQMD)	CEQA/NEPA Approval	Negative Declaration	Mill Valley Building Department
			CEC SPPE	N/A	N/A
			Endangered Species - USFWS Section 7 Consultation	Not Expected	USFWS
			Endangered Species - California DFW Consultation	Not Expected	CDFW
			Endangered Species - Incidental Take Permit	N/A	N/A
			Cultural Resources - Native American Stakeholder Consultation	Not Expected	tbd
			Cultural Resources - Section 106 Review	Not Expected	N/A
			Cultural Resources - Site Specific Required to be listed on State Register	Not Expected	N/A
			Additional Permits - Hazardous Materials and Waste	Spill Prevention Control and Countermeasure Plan	N/A
			Additional Permits - Water Quality and Supply	Construction General Permit (SWPPP)	California State Water Resources Control Board
			Additional Permits - Air Quality	Authority to Construct/Permit to Operate	BAAQMD
			Water Resources	Not applicable. Units do not require any water.	N/A

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Diesel Economic Assumptions

Effective Annual Diesel Gen Reservation Fee:

= (diesel gen reservation fee)(diesel gen reserved/load served by diesel gen)

= ($312)(350/900) = **$121/kW-Yr**

Diesel Per-Event Cost:

= (Nonprepared mobilization yearly total + prepared mobilization yearly total)/ # of events

= ($40,386,988 + $38,869,011)/4 = **$66/kW per event**

Estimated Diesel Cost:

$121/kW-Yr + ($66/kW)(# of events)

**Diesel effective annual cost reflects the ratio of 350 MW of rental capacity serving 900 MW of load. For stationary installations, the ratio is 1.*

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Annual Cost Savings Assumptions

Stationary Microgrids can save ratepayers up to $150M - $2B due to avoided annual rental and costly deployment fees

Low Savings Scenario: Diesel vs. ERock 5-Year PPA w/ no RA

Assumes 1 PSPS event

Estimated Diesel Cost (1 Events)	$	142.00	$/kW-Year
Estimated Stationary Microgrid Cost (1 Events)*	$	188.00	$/kW-Year
Savings/Year	$	(46)	$/kW-Year
Savings/Year (650 MW)	$	(29,900,000)	$'s/Year
Contract Term		5	Years
Total Estimated Savings over contract	$	(149,500,000)	$'s Total for 650 MW of Load

$150M in savings over 5 years

High Savings Scenario: Diesel vs. ERock 10-Year PPA w/ $9.00 RA

Assumes 4 PSPS events

Estimated Diesel Cost (4 Events)	$	386	$/kW-Year
Estimated Stationary Microgrid Cost (4 Events)*	$	82	$/kW-Year
Savings / Year	$	(304)	$/kW-Year
Savings / Year (650 MW)	$	(197,398,500)	$'s/Year
Contract Term		10	Years
Total Estimated Savings over contract	$	(1,973,985,000)	$'s Total for 650 MW of Load
*$9RA w/RNG (10yr)			

$2B in savings over 10 years

Stationary Microgrid Cost Assumes:
Assumes 2,500 feet from site at $1,500/ft (Alto)
Assumes make-ready investments already made and additional $340,000 for interconnect
Assumes $100/kW for deliverability study and upgrades to realize RA

Addressable Market

- Enchanted Rock analyzed the list of 86 substations in PG&E's Prepared Testimony from January 21,2020 that were deenergized due to transmission related outages but could have safely energized some or all customer meters served.
- 23 of the 86 substations were removed from Enchanted Rock's list of addressable substations because they will be served by the Humboldt Bay Generating Station and 2 substations in Tehama county were removed because they will be served by local cogen
- 24 of the remaining 63 substations were removed from the list because they were not in close proximity to gas
- 39 substations are within no more than 3 miles to gas transmission lines and are therefore addressable with Enchanted Rock's microgrid solution

Substation Name	Maximum Customer Meters Restorable 10/9/2019 or 10/26/2019	MW Test
SAN RAFAEL	15,968	68.6
HIGHWAY	14,773	57.6
MOLINO	12,791	33.9
ALTO	12,242	38.7
LAS GALLINAS A	10,339	33.8
IGNACIO	8,152	40.7
WILLITS	6,352	15.4
CARQUINEZ	6,305	13.3
GREENBRAE	6,206	24.8
WINDSOR	5,066	22.1
BRUNSWICK	4,571	61.1
UKIAH	4,117	17.8
CLOVERDALE	3,173	16.9
JESSUP	2,147	8.7
LOS MOLINOS	2,066	8.4
GERBER	1,740	7.1
CALISTOGA	1,591	6.5
CALPELLA	1,444	5.9
MIRABEL	1,387	5.6
FITCH MOUNTAIN	1,315	5.3
SAUSALITO	1,158	4.7
DAIRYVILLE	671	2.7
AUBURN	576	2.3
WILDWOOD	131	0.5
VINA	124	0.5
HALF MOON BAY	8,756	35.5
SOLEDAD	5,732	23.3
RED BLUFF	5,131	20.8
CORDELIA	3,888	15.8
GONZALES	3,059	12.4
SAN BRUNO	3,024	12.3
ANDERSON	1,848	7.5
MENDOCINO	1,784	7.2
PETALUMA A	1,229	5.0
VALLEJO C	799	3.2
CORRAL	428	1.7
GRASS VALLEY	340	1.4
GIRVAN	306	1.2
CAMPHORA	203	0.8
		651.4

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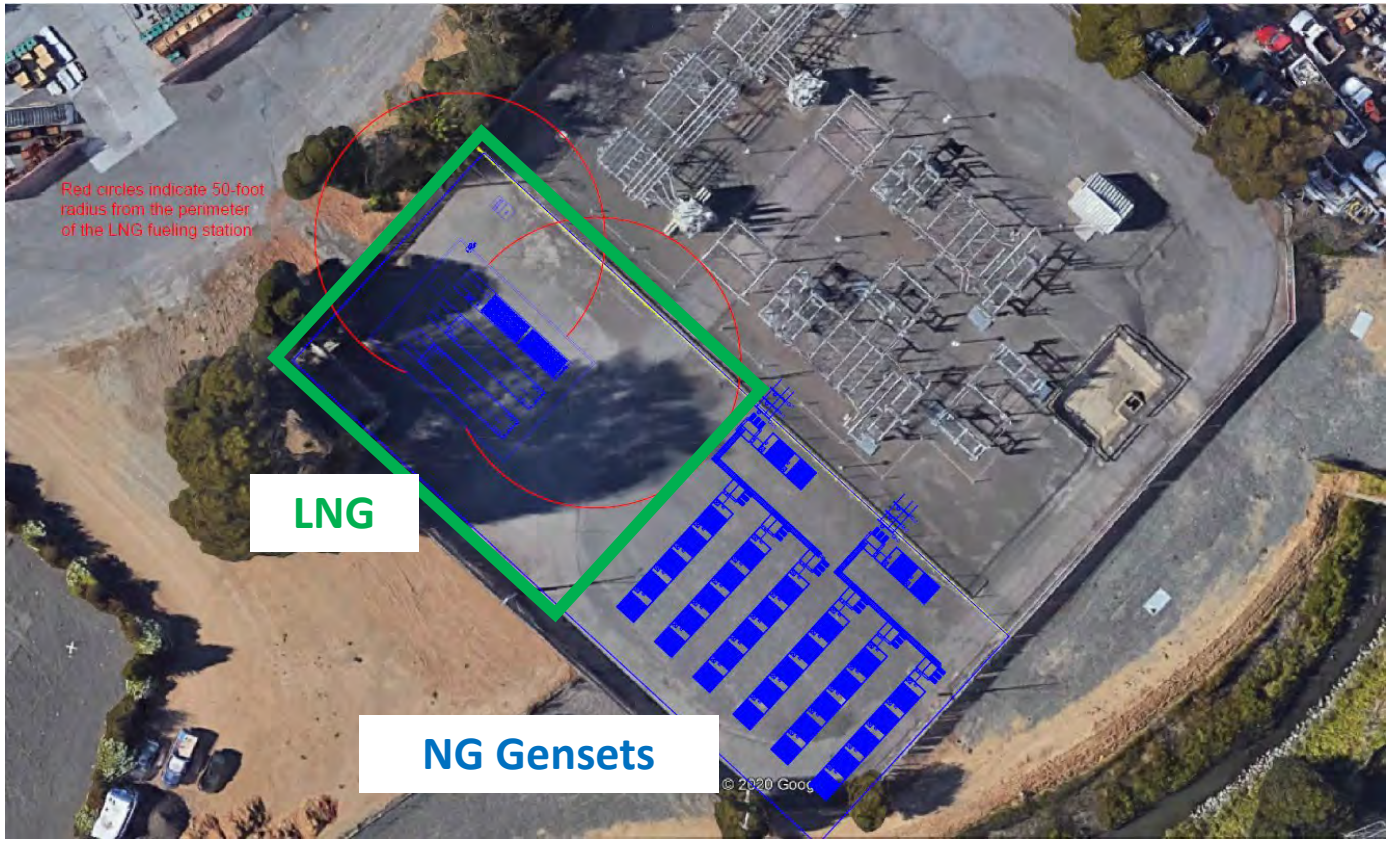
Layouts of Alternative Solutions

1) Stationary microgrids with temporary fuel until natural gas arrives to the site



Carquinez Substation – 14.9 MW
Vallejo, CA

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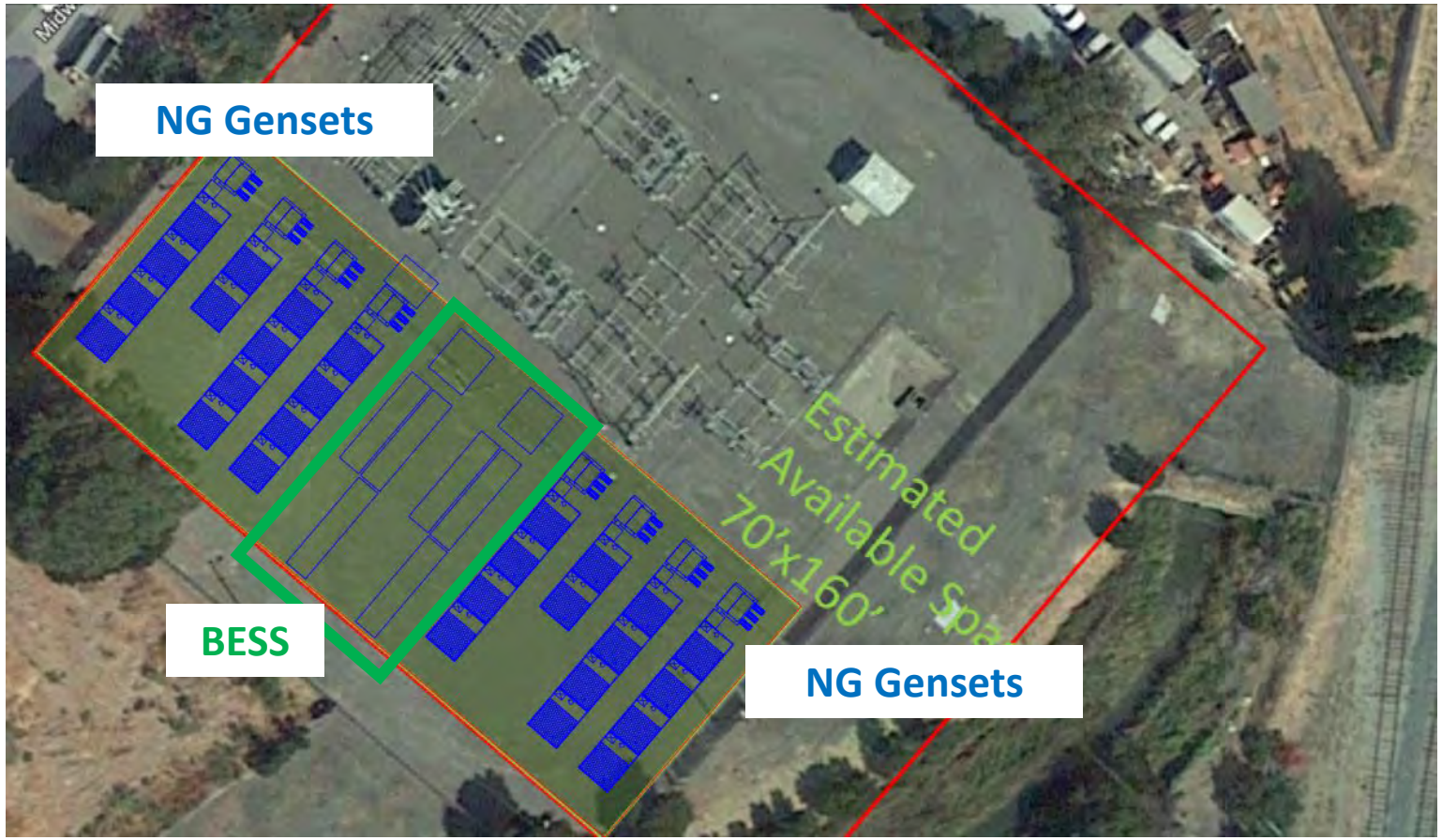
Layouts of Alternative Solutions

2) Stationary hybrid microgrid with reciprocating engine and battery storage



Carquinez Substation – 12.2 MW NG, 4.4 MW BESS
Vallejo, CA

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Layouts of Alternative Solutions

3) Down feeder installation when space is not available at the substation

Molino Substation – 39.33 MW
Sebastopol, CA

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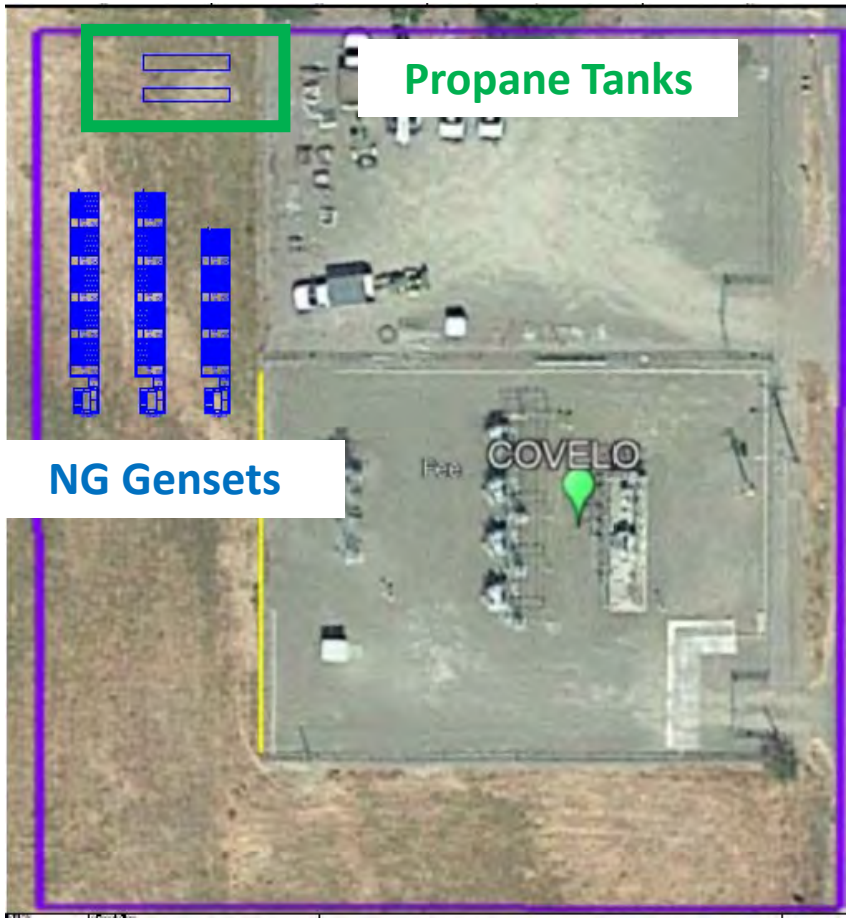
Representative Layout for Covelo

Alternative layout for Covelo substation where pipeline gas is not available



Covelo Substation – 4.3 MW with two 2,000-gallon propane tanks
Mendocino County

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Enchanted Rock Medium Voltage Sites

Customer portfolio in MW grid synchronous

Site	MW	Voltage	COD	Operator	Number of Sites
Reliability Only: Isochronous Only					
Coastal Water Authority - Trinity River Pumping Station	8.0	4160V	2011	NRG	1
Resiliency Microgrids: Both Synchronous and Isochronous Ops					
City of Houston - Northeast Water Plant	5.0	12.47kV	2012	NRG	1
City of Houston - Southeast Water Plant	5.0	12.47kV/7200V	2012	NRG	1
City of Houston - East Water Plant	16.0	4160V	2011	NRG	1
Coastal Water Authority – Lynchburg	15.0	4160V	2011	NRG	1
Gulf Coast Water Authority – Industrial Pumping Station	5.0	2400V	2013	ERock	1
Gulf Coast Water Authority – Municipal Water Plant	2.5	2400V	2014	ERock	1
HEB – Grocery Store Distribution Centers	22.4	Various	2017-2019	ERock	3
Texas A&M RELLIS Campus	9.6	13.8kV	2018	ERock	1
Citizens Medical Center	2.8	12.47kV	2020	ERock	1
North Fort Bend Water Authority	2.4	12.47kV	Construction	ERock	1
Fort Bend Lid 2	11.2	34.5kV	Construction	ERock	1
City of Houston North East Water Purification Plant	30	25kV	Construction	ERock	1
Raven Chemical Plant	3.2	34.5kV	Construction	ERock	1
Merchant Grid Synchronous DG					
FM 1967	9.4	12.47kV	2013	ERock	1
HWY 158	9.4	12.47kV	2013	ERock	1
N Mary Francis	9.4	12.47kV	2013	ERock	1
Tumbleweed	9.4	12.47kV	2013	ERock	1
US 385	9.4	12.47kV	2013	ERock	1
W 16th	9.4	12.47kV	2013	ERock	1
288	9.4	34.5kV	2013	ERock	1
Clara	9.4	34.5kV	2013	ERock	1
Cutten	9.4	34.5kV	2013	ERock	1
McKeever	9.4	34.5kV	2013	ERock	1
Stonegate	9.4	34.5kV	2013	ERock	1
E Porte Court	9.4	12.47kV	2013	ERock	1
FM 506	9.4	12.47kV	2013	ERock	1
FM 1732	9.4	12.47kV	2013	ERock	1
FM2221	9.4	12.47kV	2013	ERock	1
Ridge Road	9.4	12.47kV	2013	ERock	1
Vaquero	9.4	12.47kV	2013	ERock	1
Total	**298**				**33**

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