



IDEA2022

Building Connections

June 6-9 | Sheraton Centre Toronto Hotel | Toronto, ON



INTERNATIONAL
DISTRICT ENERGY
ASSOCIATION

Hybrid Microgrids

Using hybrid microgrids to enable more reliable, resilient and renewable power solutions

Speaker: Joseph Martorano, P.E.



***NORTHEAST – WESTERN™
ENERGY SYSTEMS*** →

Today's Discussion

- **An opportunity for our industry:** Hybrid microgrids and the 3Rs
- **Case study:** Pittsburgh International Airport
- **The path forward:** Moving from interest to installs

OUR COMPANY

Over 50 years in business ... Engine heritage

The logo for Northeast-Western Energy Systems, featuring the text "NORTHEAST - WESTERN" in a green, italicized sans-serif font, with "ENERGY SYSTEMS" below it in the same style. A green arrow points to the right, passing through the text.

NORTHEAST - WESTERN
ENERGY SYSTEMS

Distributed energy systems
including hybrid microgrids

The logo for Penn Power Systems, featuring the word "PENN" in a large, bold, red, italicized sans-serif font, followed by "POWER" and "SYSTEMS" in a smaller, bold, black, sans-serif font, stacked vertically. A yellow lightning bolt graphic is positioned behind the text. Below the main text, the phrase "Power and Industrial Solutions" is written in a smaller, black, sans-serif font.

PENN POWER
SYSTEMS
Power and Industrial Solutions

Standby diesel and
gas generator power
systems

The logo for Penn Power Group Fleet Services, featuring the word "PENN" in a large, bold, red, italicized sans-serif font, followed by "POWER" and "GROUP" in a smaller, bold, black, sans-serif font, stacked vertically. Below this, the words "FLEET SERVICES" are written in a bold, black, sans-serif font, flanked by two black wrench icons.

PENN POWER
GROUP
FLEET SERVICES

Truck Service Repair with
13 locations across PA, NJ
and NY

DEVELOP, INTEGRATE AND MAINTAIN RENEWABLE, RELIABLE & RESILIENT ENERGY SOLUTIONS



15+ years of integrating power products



200+ gas engines in our fleet



50%+ of our engines sold to repeat customers



Ability to do turnkey projects



Jenbacher North America Channel Partner of the Year

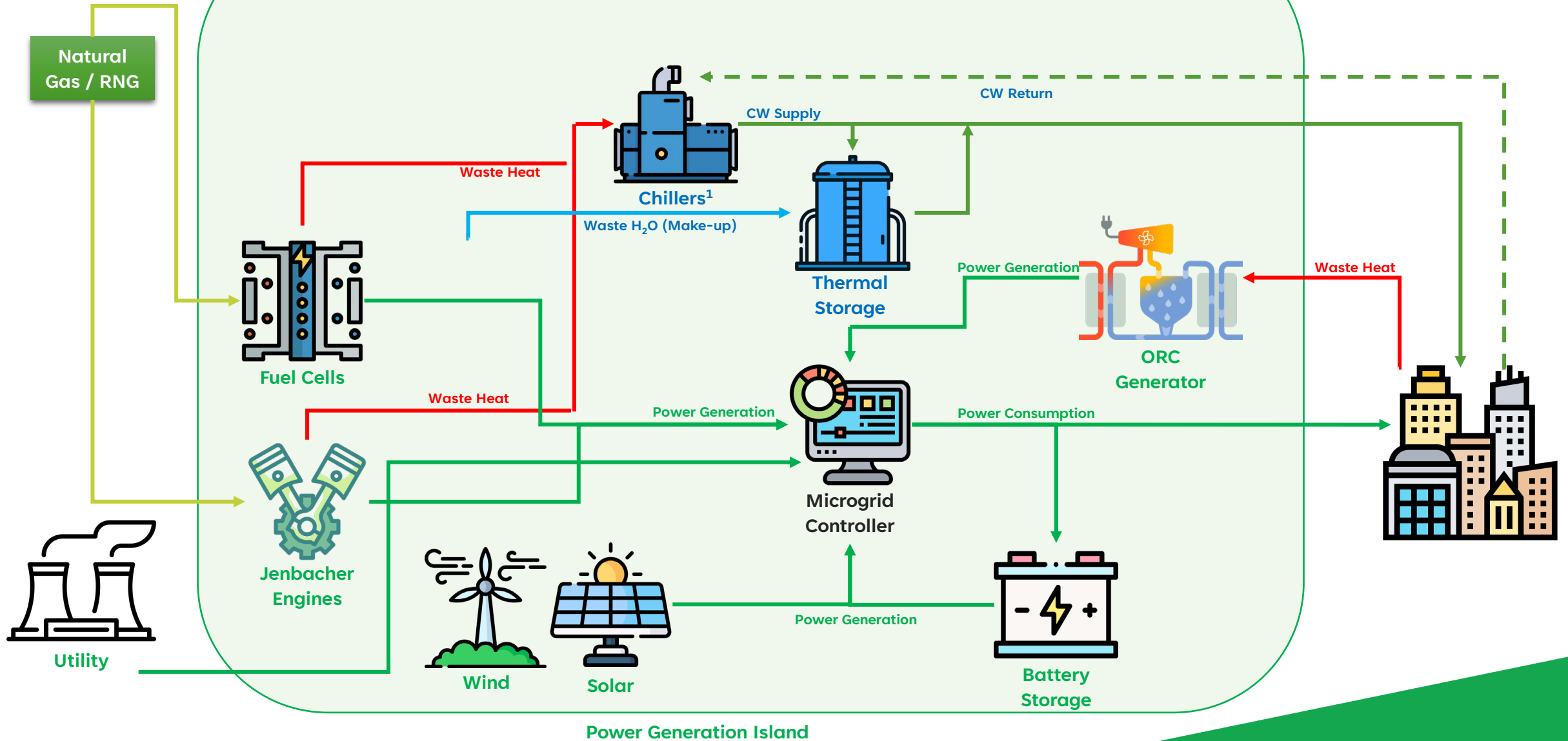


Integrated gensets with solar, storage & other technologies



NYU Coles, New York

HYBRID MICROGRID



MICROGRID PROJECTS IN ACTION

EVERY PROJECT WAS A TEAM EFFORT.



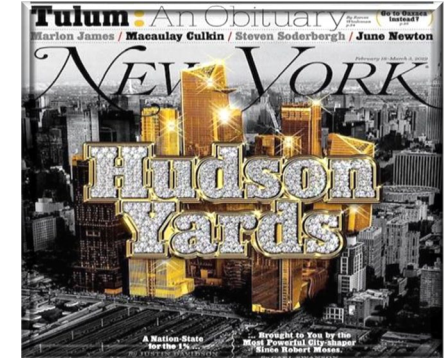
SHERATON WAIKIKI



TWA HOTEL AT JFK



COLUSA RESORT



HUDSON YARDS



TOSOH



QUAKER COLOR



UMASS HOSPITAL



HOSPITAL

What we are hearing from customers

Without the solar scope, the deal would not have happened

I'm being told to add renewables but I need to keep my plant running

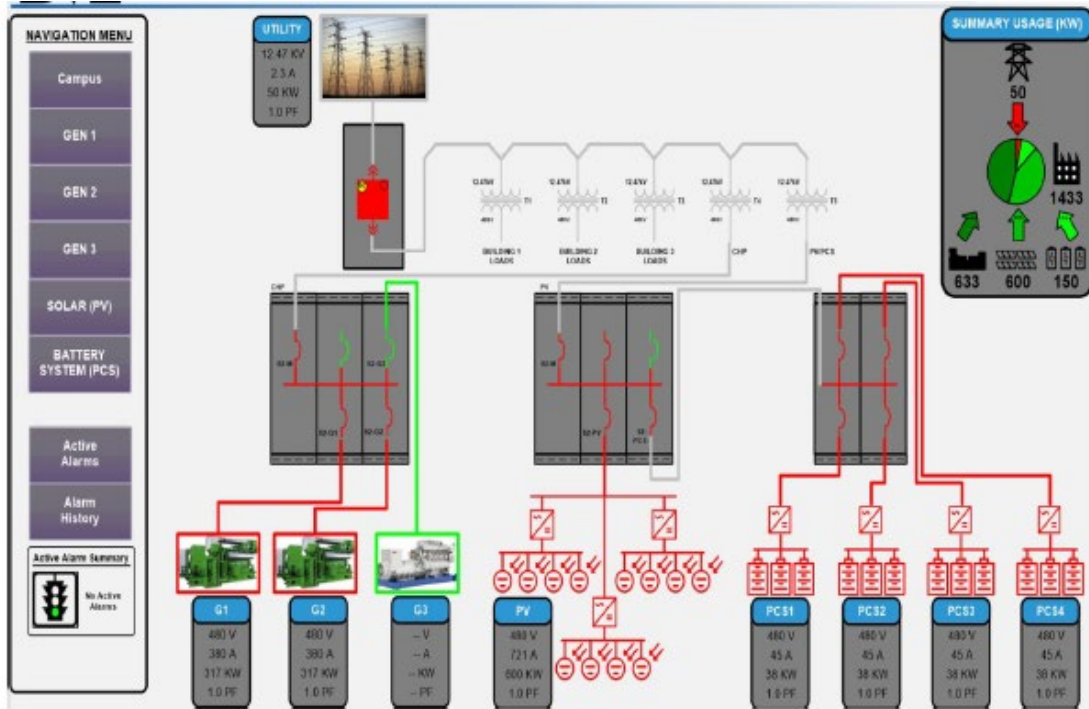
Only going to incentivize projects that minimize the amount of fossil fuels used

If we cannot show a carbon reduction then we will not do the project

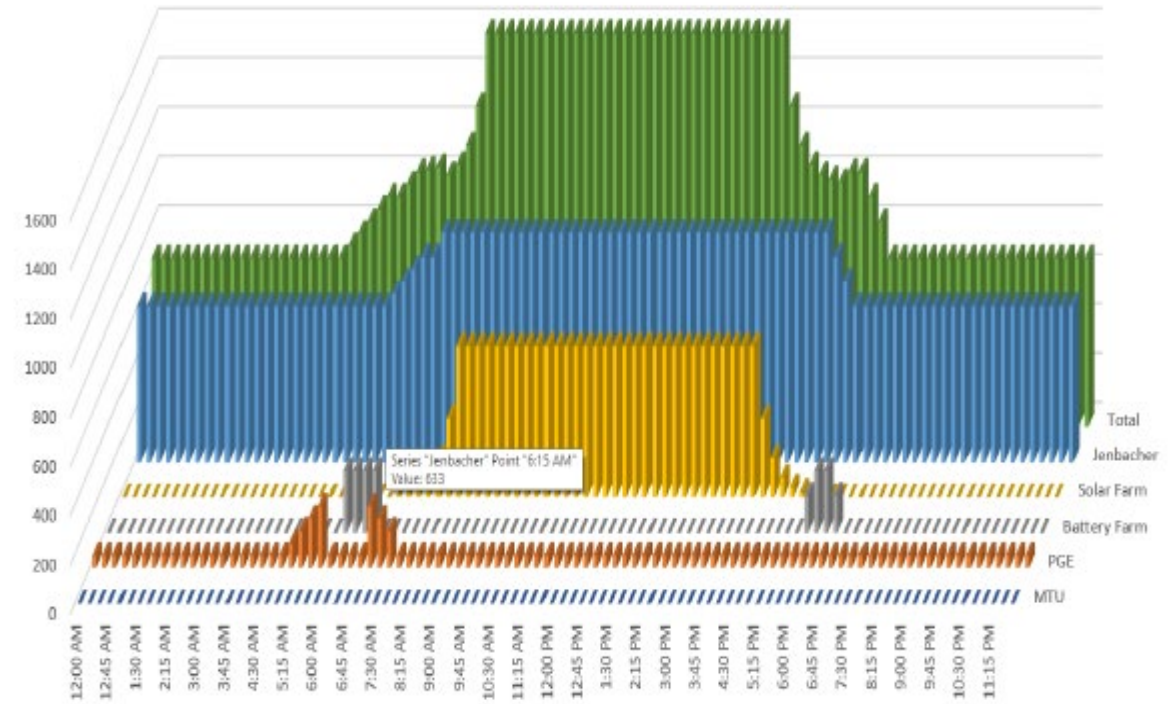
How can we add a renewable energy component to this project?

Hybrid Power: A more complicated math problem

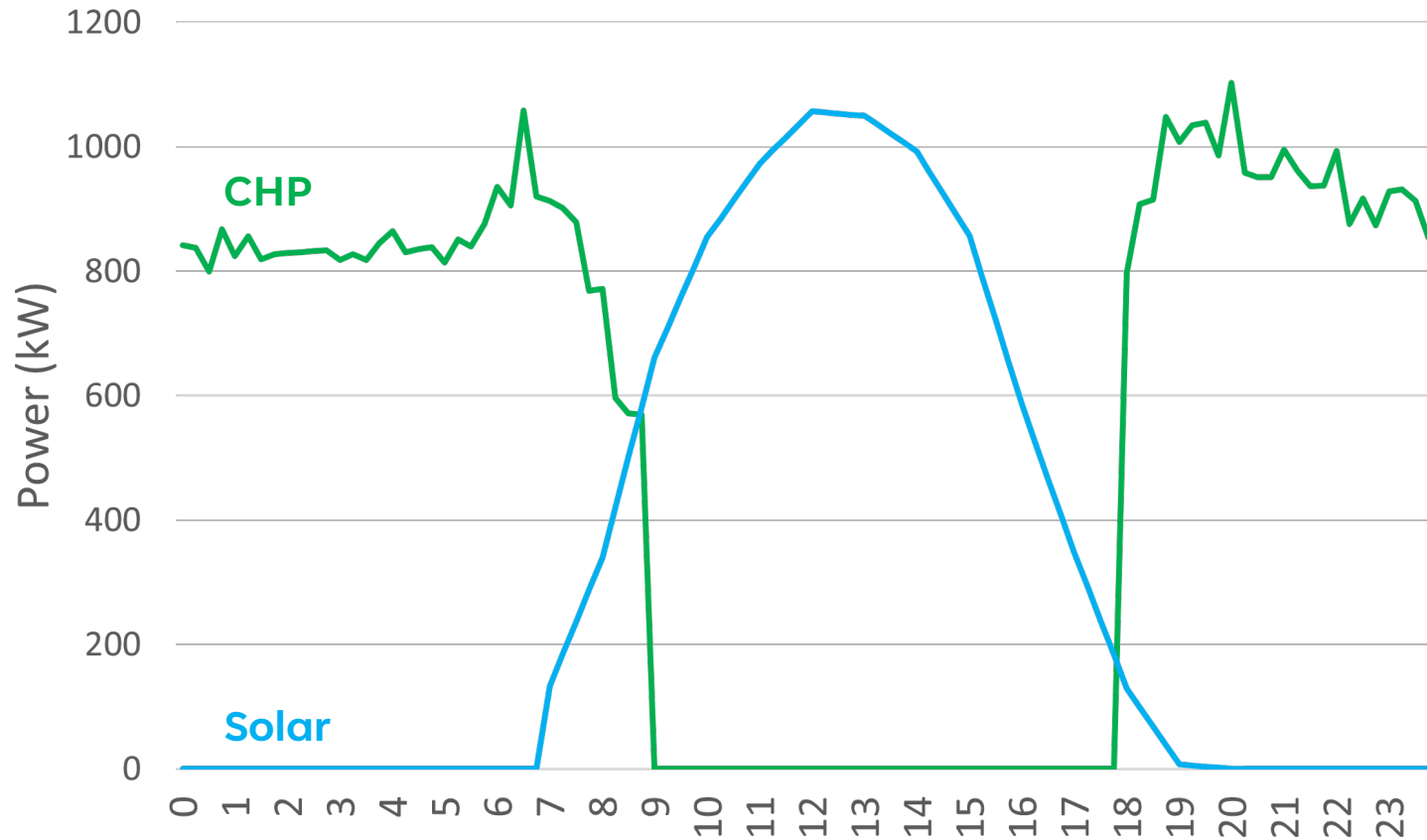
Illustrative Single Line Diagram



Illustrative Operational Load Profile



Mullica Hill Hospital Hybrid Microgrid



Design considerations

- ☐ Technical
- ☐ Commercial
- ☐ Regulatory
- ☐ Timing

NREL Case Study: California Hospital

THE MATH OF ONSITE POWER IS CHANGING

	Base case	CHP only	PV + battery	CHP + PV + battery
<i>CHP system size (kWe)</i>	0	4540	0	3300
<i>PV system size (kWe)</i>	0	0	18,400	5,844
<i>Battery power size (kWe)</i>	0	0	2,820	720
<i>Battery energy size (kWh)</i>	0	0	13,200	1,440
<i>Firm Backup Power (kWe)</i>	0	4,540	550	3300
<i>Emissions (tonne CO2/year)</i>	15,980	15,190	9,400	11,043
<i>% Emissions Reduction</i>	0	4.9%	41.2%	30.9%
<i>Life Cycle Cost (\$M)</i>	86.3	55.4	66.2	51.5
<i>% Savings from base</i>	0	35.5%	23.3%	40.3%

Menu of onsite power options

		Installed cost	Emissions	Availability	Space needed	Ease of implementation
Technologies	Emergency gensets	Green	Red	Green	Green	Green
	CHP gensets	Yellow	Yellow	Green	Green	Yellow
	Solar	Yellow	Green	Red	Red	Green
	Energy storage	Red	Green	Red	Yellow	Yellow
	Hybrid	Green	Green	Green	Green	Red

Pittsburgh International Airport: A Hybrid Microgrid in Action



The Design Challenge



- ✓ Provide resilience to a grid outage
- ✓ Reduce energy costs
- ✓ Improve sustainability
- ✓ Upgrade infrastructure
- ✓ Create a tailored solution for PIT
- ✓ No upfront capex

The Winning Solution

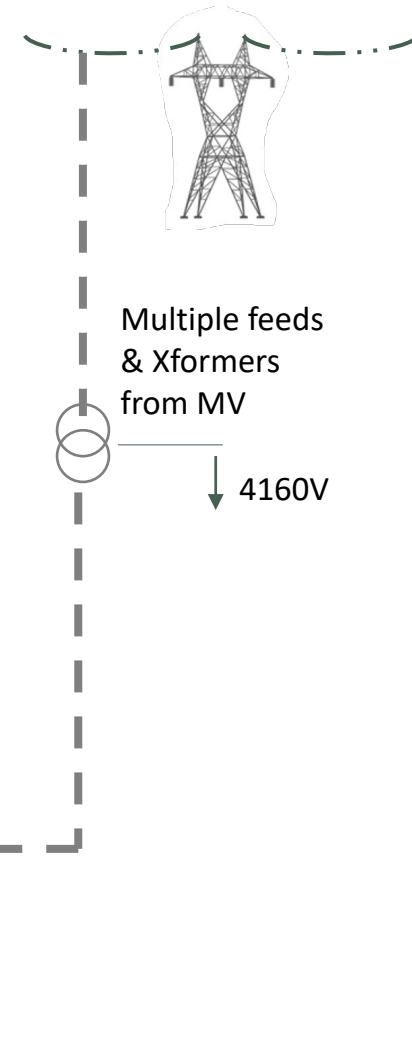
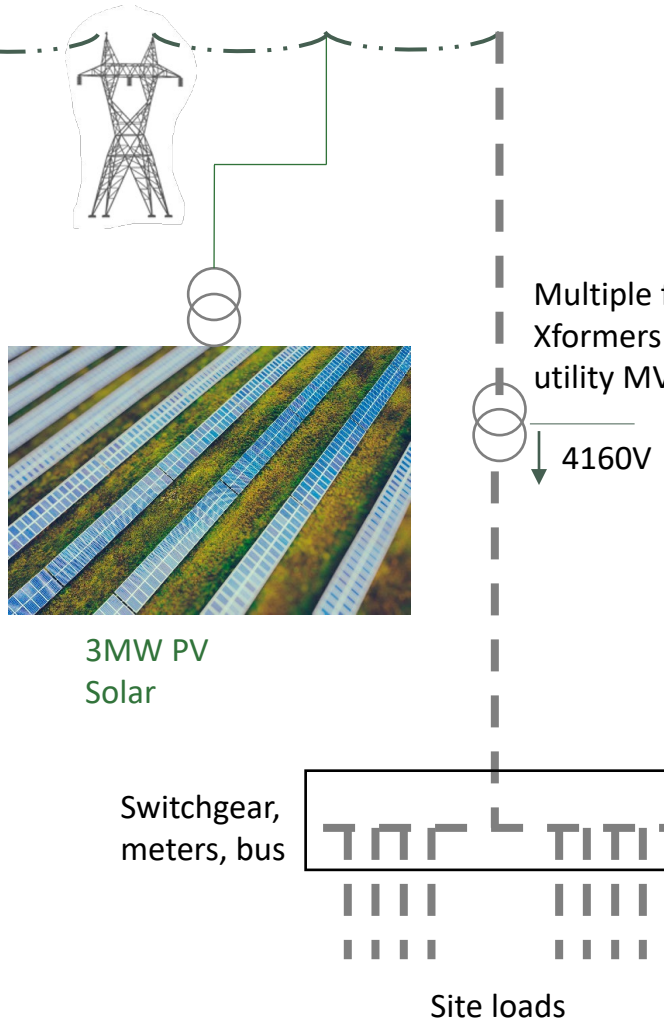
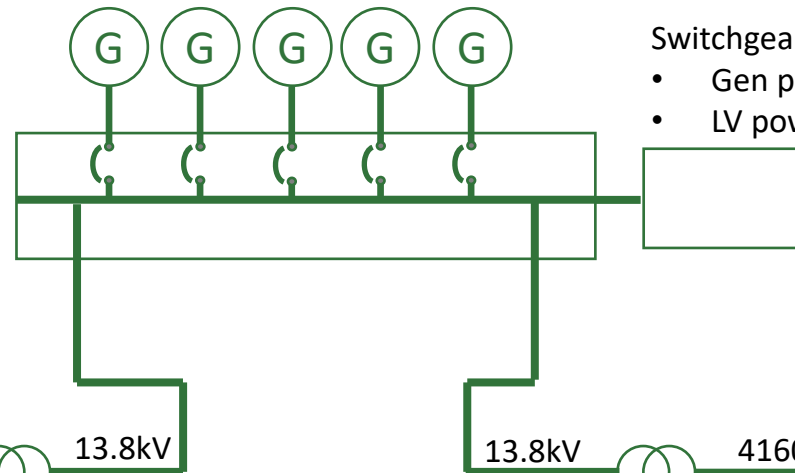


- ✓ 3 forms of electricity supply
- ✓ 20 MW of Jenbacher gensets
- ✓ 3 MW of solar
- ✓ Electric utility connection
- ✓ Seamless transition
- ✓ Advanced load shedding
- ✓ Onsite natural gas supply
- ✓ Uniquely Pennsylvanian

Simplified SLD



- 4.3MW, 13.8kV, Jenbacher J624
- Integral Power Modules



Engines vs. Solar vs. Hybrid

Engine Only



23 MW @\$1,500 / kW - \$34.5 M

Emissions @ 800 Lb CO₂ per MWh - 80,000 tons per year

Land needed - 1 acre
1.3 football fields

Capacity factor = ~95%

Solar Only



23 MW @\$1,800 / kW - \$41 M

Emissions @ 0 Lb CO₂ per MWh - 0 tons per year

Land needed - 92 acre
123 football fields

Capacity factor = ~15%

Hybrid Power



20 MW @\$1,500 / kW - \$30 M

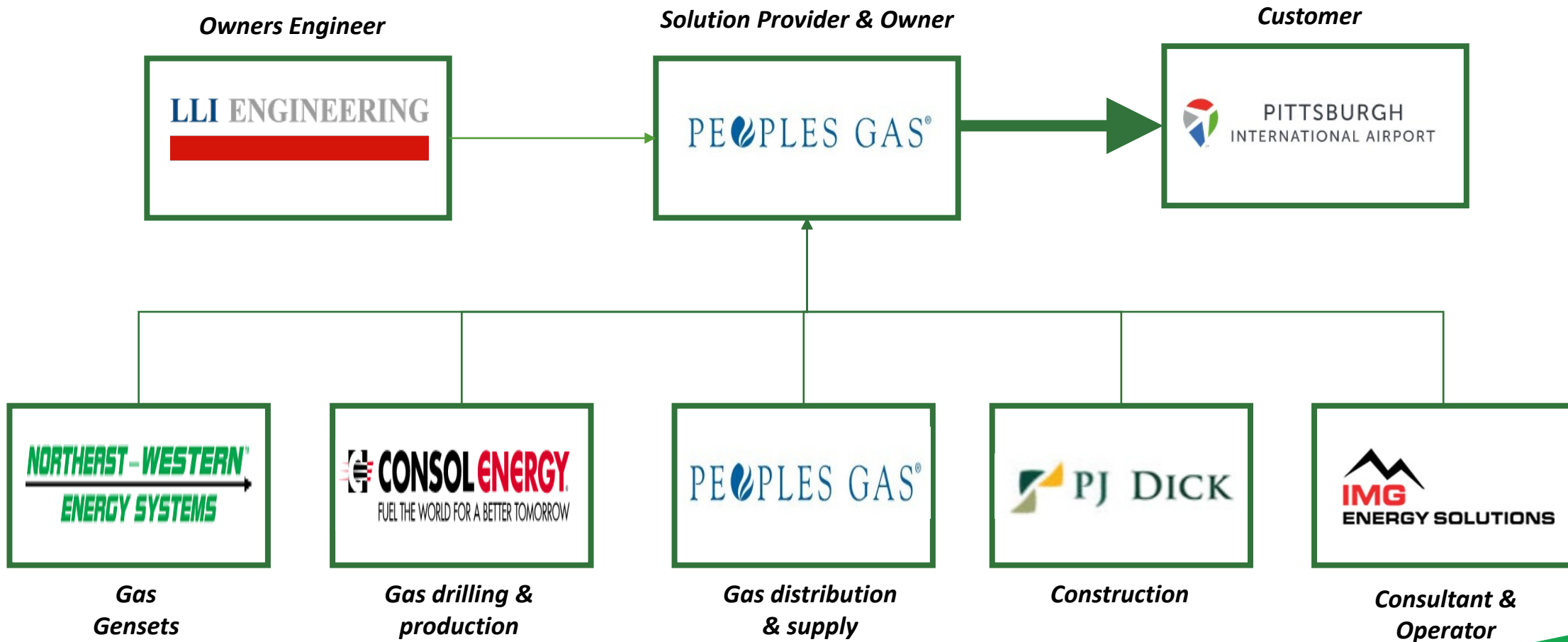
3MW @ \$1,800 / kW - \$5.4 M

Emissions @ 700 Lb CO₂ per MWh - 70,000 tons per year

Land needed - 13 acre
17 football fields

Capacity factor = ~85%

The Delivery Team



Power Island Design Approach

Use Integrated Power Modules (IPMS) to reduce design & execution risk

Key facts

✓ One containerized solution = **3 modules**

A Engine Module

B Ventilation Module

C Auxiliary Module

✓ Electrical Output = **4.4MW**

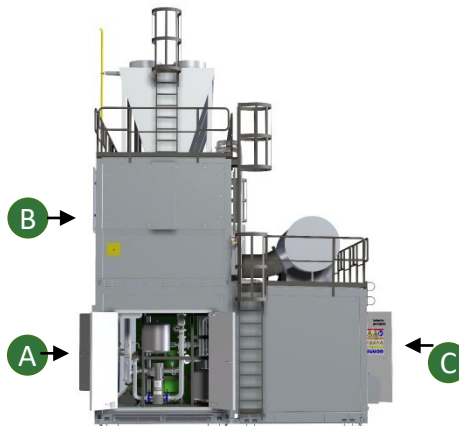
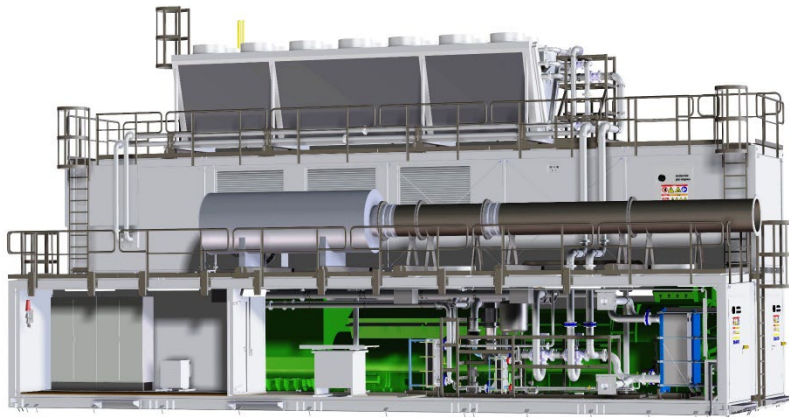
✓ Electrical Efficiency = **>45% (natural gas)**

✓ Assembly time at site = **1 week per containerized package**

✓ Order to COD = **12 months**

✓ Dimensions of single module = **56 ft x 10 ft x 10.5 ft**

✓ **Engine:** V-24, 150L, lean burn, 1500rpm w/ gearbox, dual stage turbocharging, SCR, COP (continuous) rated



Integrated Power Module (IPM)

Outside the IPM



Inside the IPM



Delegation of Responsibility

Our Scope

- ✓ JMC 624 H01 13.8 kV generator & containers
- ✓ SCR & Oxidation Catalyst
- ✓ Urea Tanks with Anti-Freezing Protection
- ✓ Lube oil systems
- ✓ Exhaust stack
- ✓ Engine control system w/generator protection relays
- ✓ Control room
- ✓ Remote messaging & data transfer capabilities
- ✓ Generator protection
- ✓ Grid monitoring device
- ✓ Medium voltage junction box
- ✓ Low temp & high temp radiators
- ✓ Transportation to site & duties
- ✓ Assembly supervision
- ✓ Commissioning

Customer Scope

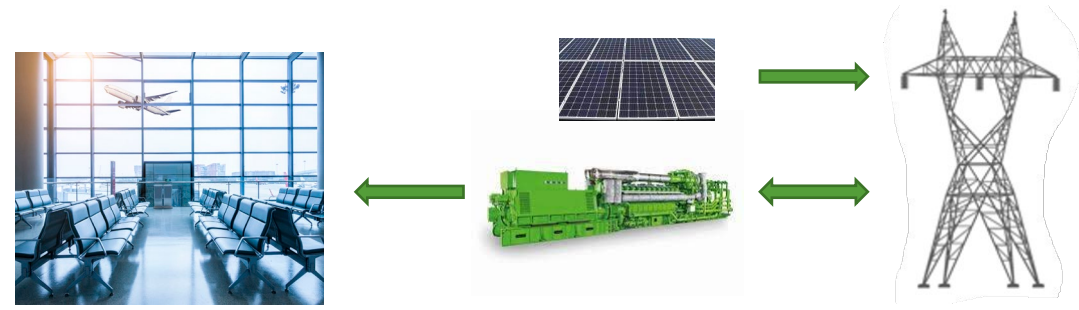
- ✓ Laying foundation
- ✓ Mechanical piping to/from IPM
- ✓ Electrical connections to/from IPM
- ✓ Step-up transformer
- ✓ Crane rental
- ✓ Three (3) skilled workers for mechanical & electrical assembly

Installation of a 20 MW power plant in 30 days

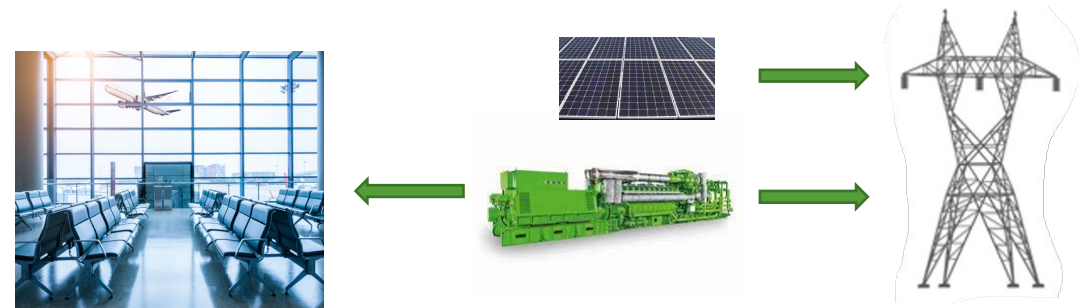
Day	Activities	Crane used
1	Positioning of crane, checking of foundations, preparation of tools, safety mtg	500 ton
2	Positioning of engine module 1-5, supplying of Infra module to foundation	500 ton
3	Positioning of infrastructure module 1-5	500 ton
4	Sealing of modules	500 ton
5	Installation of generators in engine modules 1-5, preparing of ventilation modules	500 ton
6	Positioning of ventilation-module 1-5, incl. assembly to other modules	500 ton
7-17	Mechanical completion of the containers, incl. all piping connections (water, gas and exhaust), setting V-cooler on top	40 ton
18-29	Final container assembly (finishing works incl. all internal cabling), cleaning	None
30	Electro-mechanical completion	None

Operating Modes

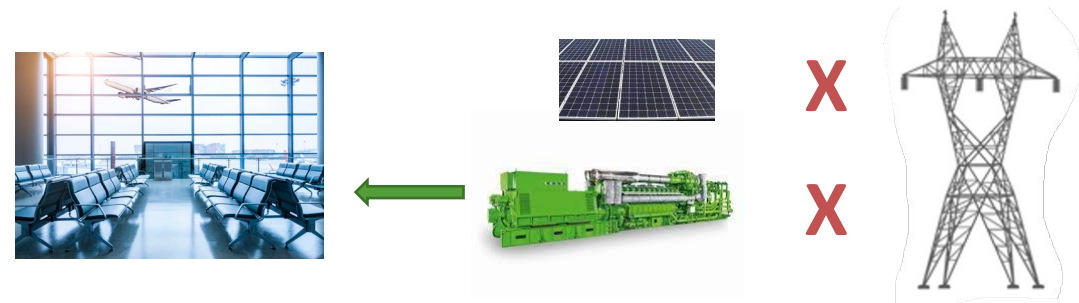
1) PV export, gensets load following, grid parallel



2) PV export, gensets net export, grid parallel

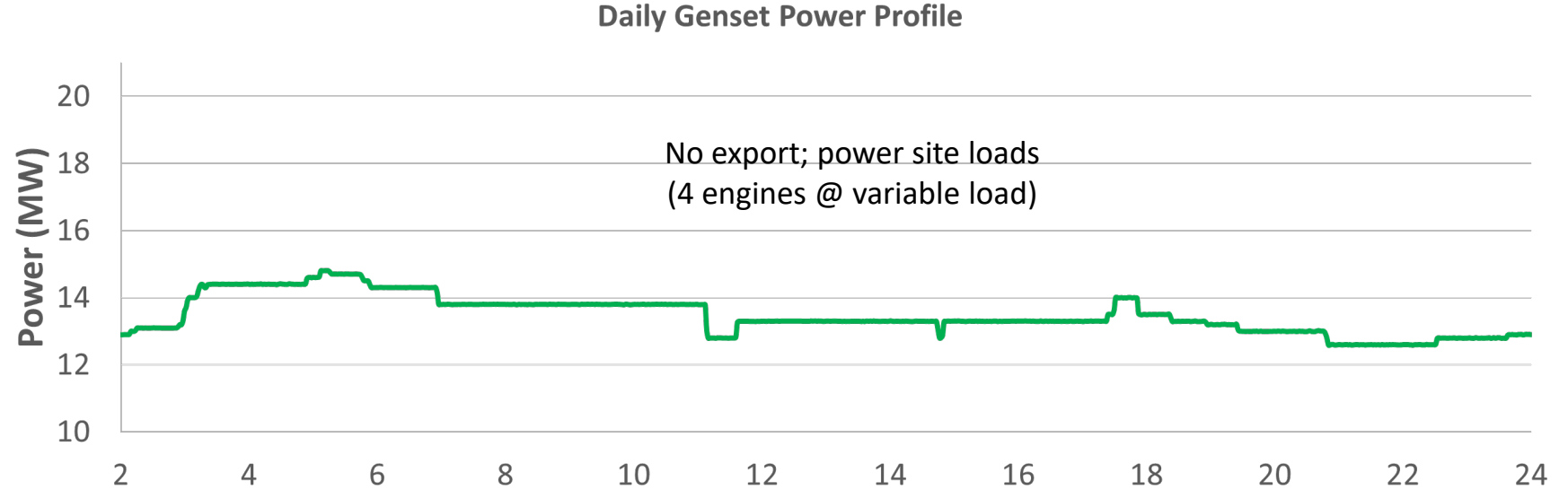


3) Island mode, grid outage, no PV generation

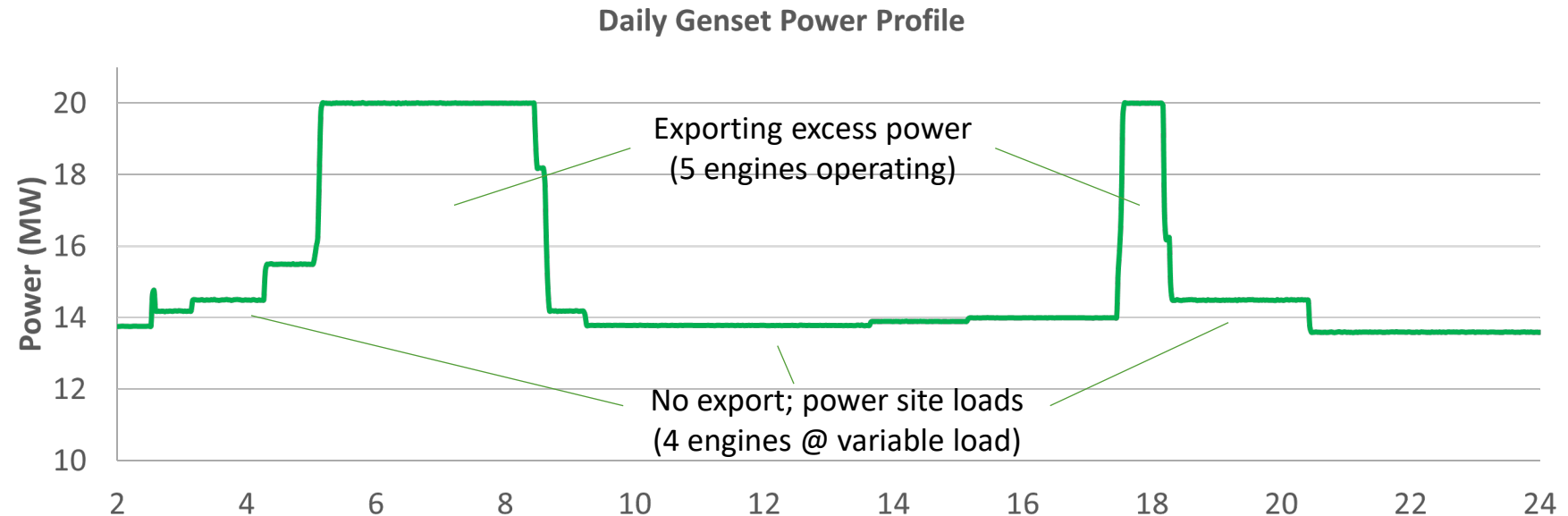


Operating Modes

**Load following day
(from 2-27-22)**



**Exporting day
(from 2-18-22)**



Energy Sell Back

ASSUME:

- SITE RETAINS CAPACITY VALUE
- SELLS ONLY ENERGY TO THE GRID
- PJM WEST PRICING (CME FUTURES)
- 9 MW EXCESS POWER TO SELL
- ON PEAK SALES ONLY

REVENUE OPPORTUNITY:

- CME FUTURES PRICE – \$55.00/MWH
- 3,100 HOURS OF POWER SALES
- VALUE DERIVED **\$1,500,000 PER YEAR**

Easy to Complex

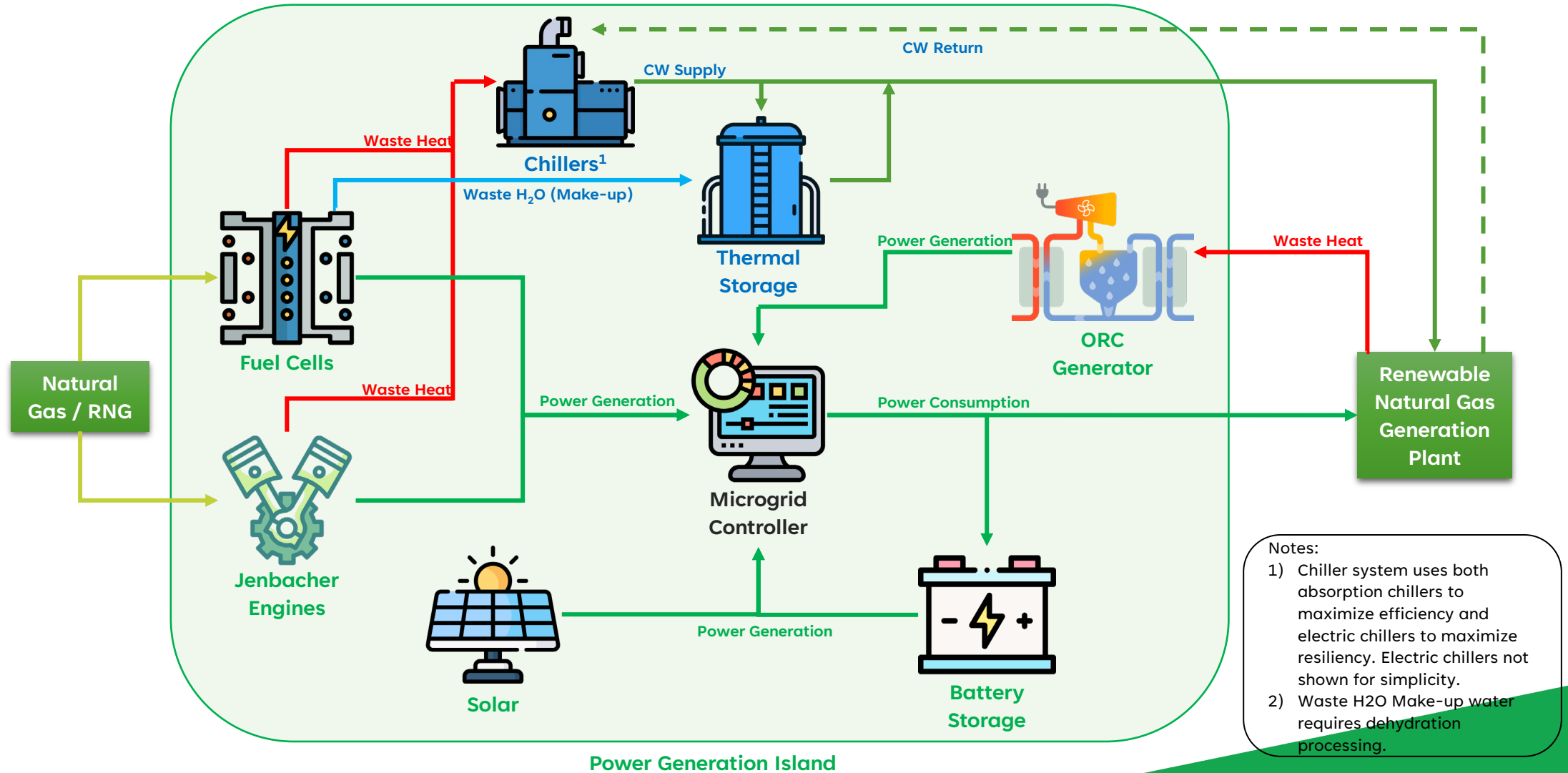
MARKET REALITIES

- HYBRID MICROGRIDS ARE GETTING MORE COMPLEX
- CLIENTS ARE LOOKING FOR MORE INNOVATIVE SOLUTIONS
- THE NEED FOR INCORPORATING MORE **"GREEN"** RESOURCES IS BEING COMING MORE COST COMPETITIVE

EXAMPLE PROJECT

- **CLIENT:** (CONFIDENTIAL)
- **LOCATION:** CALIFORNIA
- **STATUS:** FINISHED SCHEMATIC DESIGN- PERMIT PACKAGE DUE BY JUNE, IFC SET DUE BY END OF YEAR.
- MAJOR COMPONENTS
 - 5 MW SOLAR
 - 8 MW ORC
 - 2 MW FUEL CELLS
 - 11,000 TON-HOURS THERMAL STORAGE
 - 2 MWH ENERGY STORAGE
 - 12 MW ENGINES (COFIRED ON H₂ & NG)
 - CARBON SEQUESTRATION

Renewables Microgrid Flow Diagram



The path forward

- **The market is changing ... embrace it in a pragmatic way that works for your business**
- **Need a strong partner that understands all the technologies**
- **Listen to clients to determine what is their motivation (the 3R's)**
- **No one pursues a project unless it meets their financial hurdles; so be sure to understand their value proposition (i.e., energy savings, value of "green" to their customers, added sales...)**
- **It takes a team to make these projects work**