Distributed CHP Powering Remote Facilities

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Case Study: 3.5 MW CHP-Based Microgrid

For Controlled Environment Agriculture in Rural Pennsylvania

- 3.5 MW Combined Heat and Power System
- 100% island-mode operation
- Full N+1 redundancy of power and HVAC equipment
- Operates on trucked-in LNG
- Commissioned April 2022

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PA Options for Wellness Cannabis Cultivation Facility

A state of the art cultivation facility near Harrisburg for medicinal cannabis production

- 25,000 sf of canopy
- LED grow lighting
- Chilled water for space cooling
- Desiccant dehumidification
- Hot water for desiccant regeneration, reheat, and space heating

Energy Challenge

- Insufficient utility grid power
- No access to pipeline natural gas
- 24/7 need for reliable electricity, chilled water and hot water

CHP-Based Microgrid Solution

3.5 MW CHP System

- 2 x 555 kW, 2 x 1200 kW
- High-efficiency low-NOx lean-burn natural gas engines
- Exhaust and jacket water heat recovery for hot water supply to central plant

Central Utility Plant (CUP)

- 2 x 600 RT mag-bearing water-cooled chillers
- Cooling towers
- Back up HW boilers
- CHW, CW and HW pumps

CHP Controls (by ComAp)

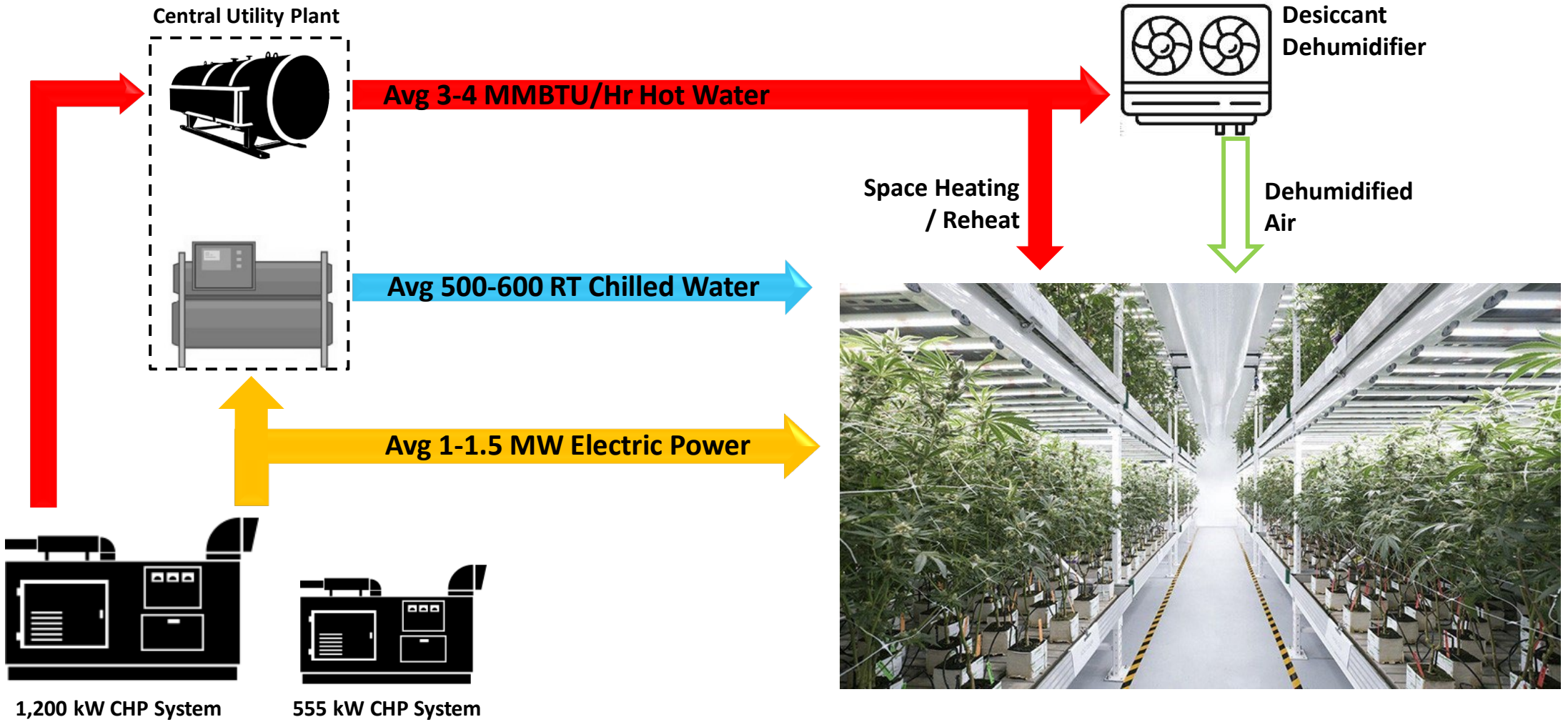
- Shares load between CHP system
- Dispatches CHPs based on electric load
- Monitors system electrical frequency and initiates immediate load-shedding

LNG Supply

- LNG trucked in weekly from local PA gas supplier

CHP and Central Plant Output

Power and recovered thermal energy from the CHP systems is utilized in a closed loop system by the central utility plant and cultivation facility to maximize efficiency



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Challenges and Solutions

CHALLENGE

High Reliability

- Facility is 100% dependent upon CHP power output

Load management

- CHP engines should run between 50% and 90% of rated output
- CHP engines can handle 10-30% load steps

Load shedding

- A shut down of one generator can result in overloading the remaining units

SOLUTION

High Reliability

- N+1 redundancy of CHP units
- CHP controllers autonomously start standby engine if needed

Load management

- Install a diversity of engines to maximize flexibility
- Minimize load steps with HVAC and lighting controls
- Units start and stop automatically to maintain reserve power margin and ensure capacity for transients

Load shedding

- Automatic load shed function detects frequency drop and instantly shuts off facility lighting

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Generator Control

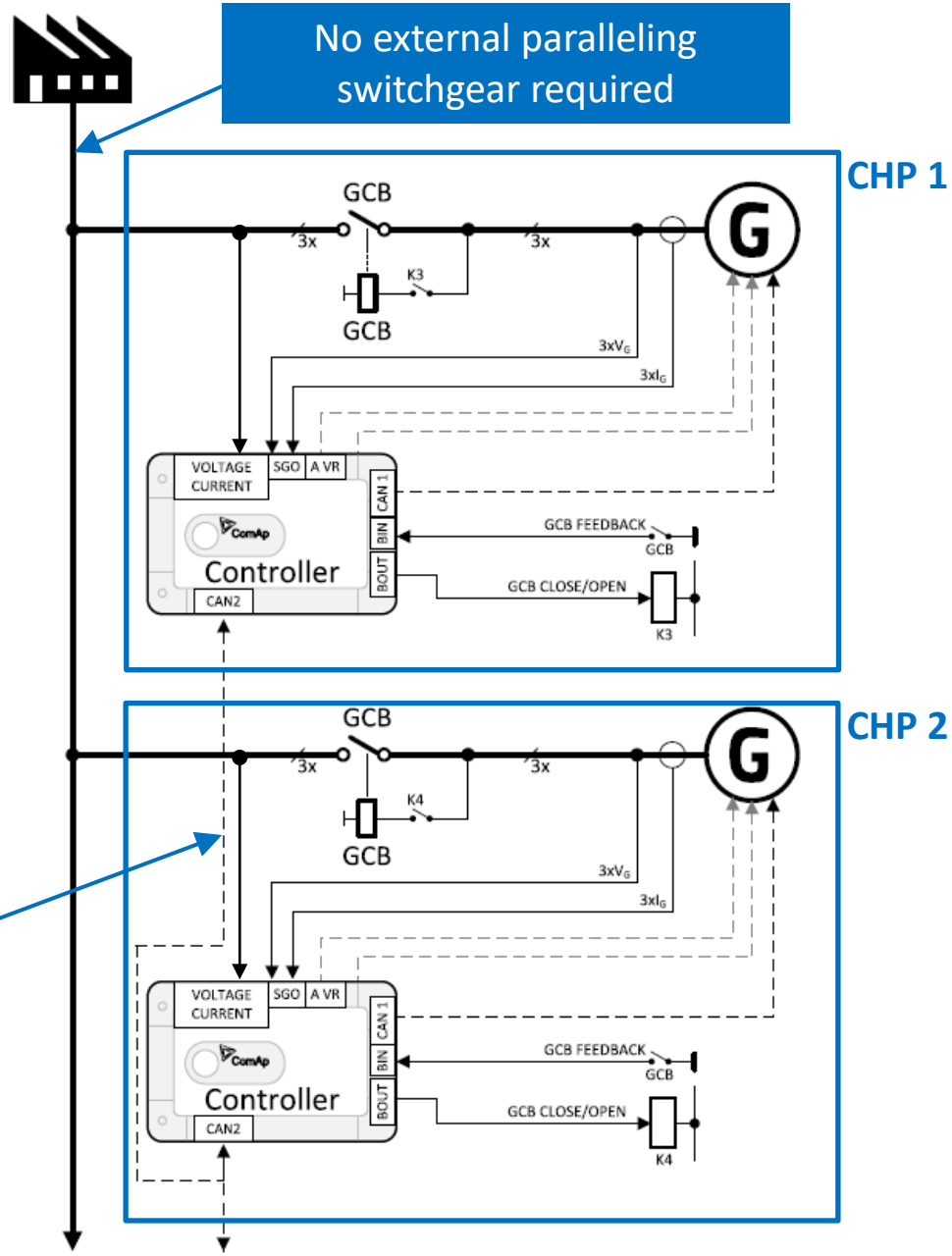
CHP controllers manage paralleling and matching capacity to load

ComAp
The heart of smart control

InteliSys Gas Genset Controller

- Parallels gensets
- Maintains frequency on main bus
- Automatically start/stops gensets to match load
- Initiates load-shedding
- Controls all CHP BOP

Controllers communicate over CAN Bus



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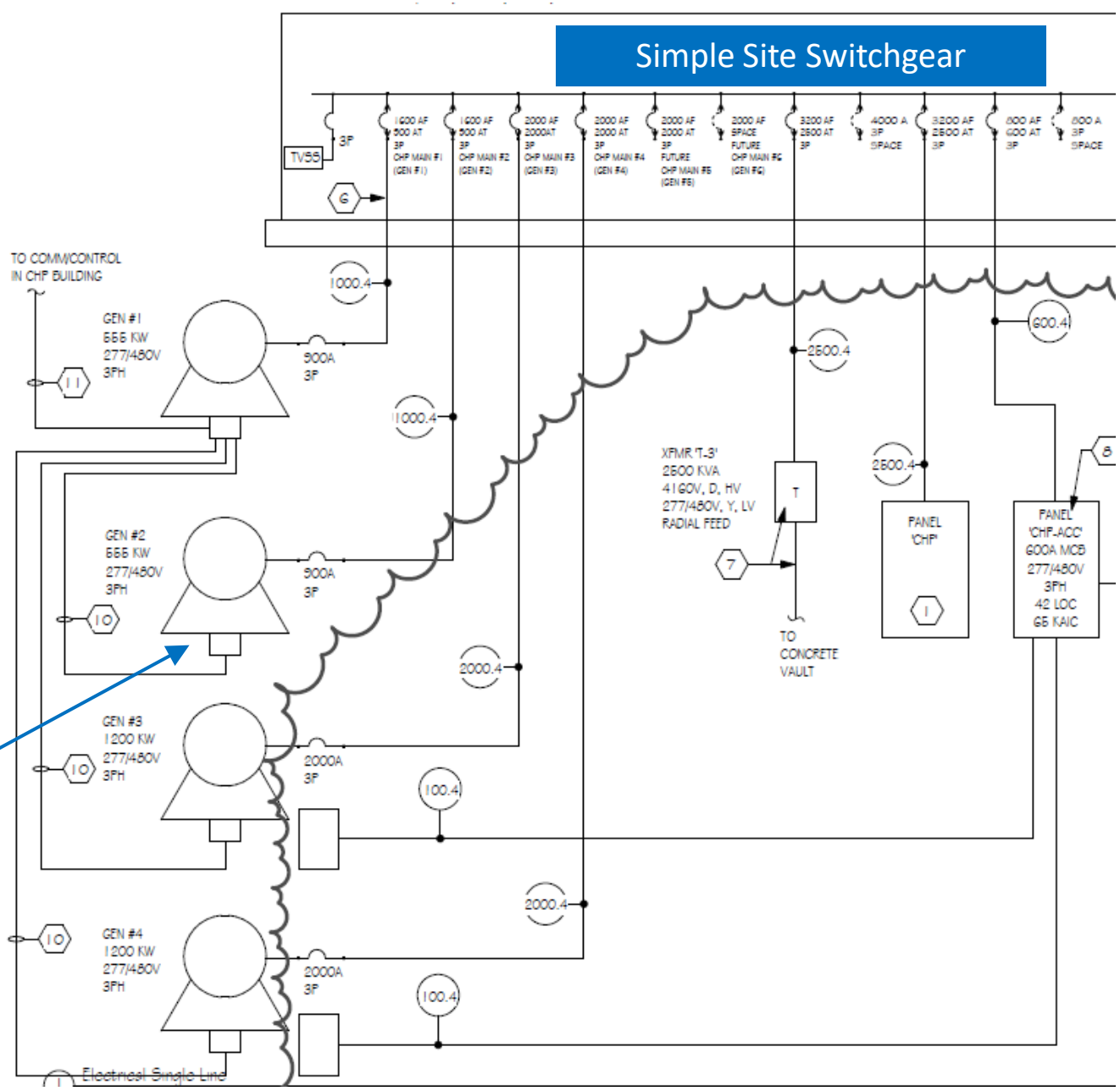
Site Electrical Design

Simple site switchgear for accepting CHP power

- Generator paralleling and load-sharing controls integrated with CHP systems
- Simple site switchgear with non-operated breakers for CHP power input

Genset paralleling and load-sharing integrated with each CHP system



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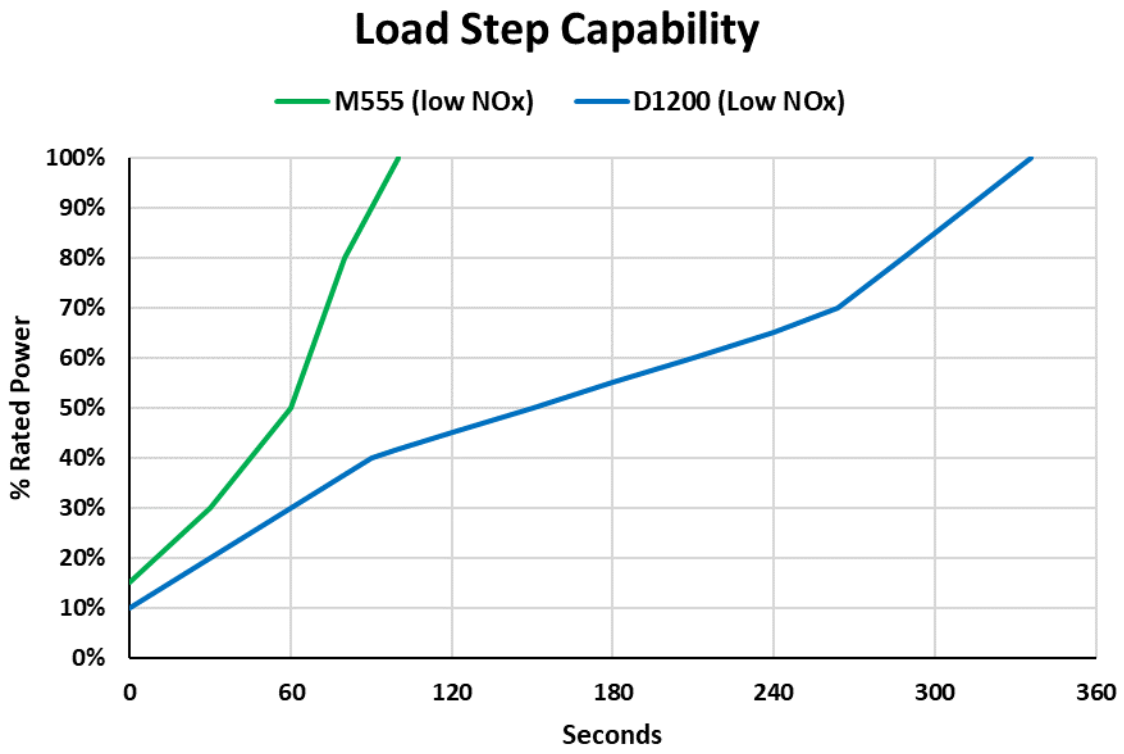
Electrical Load Management

Natural gas engines have limited step load capability



- Low NOx tuning reduces capability by 50%
- 555 kW are more responsive, and are used as primary response
- Load-smoothing essential to minimize unnecessary steps

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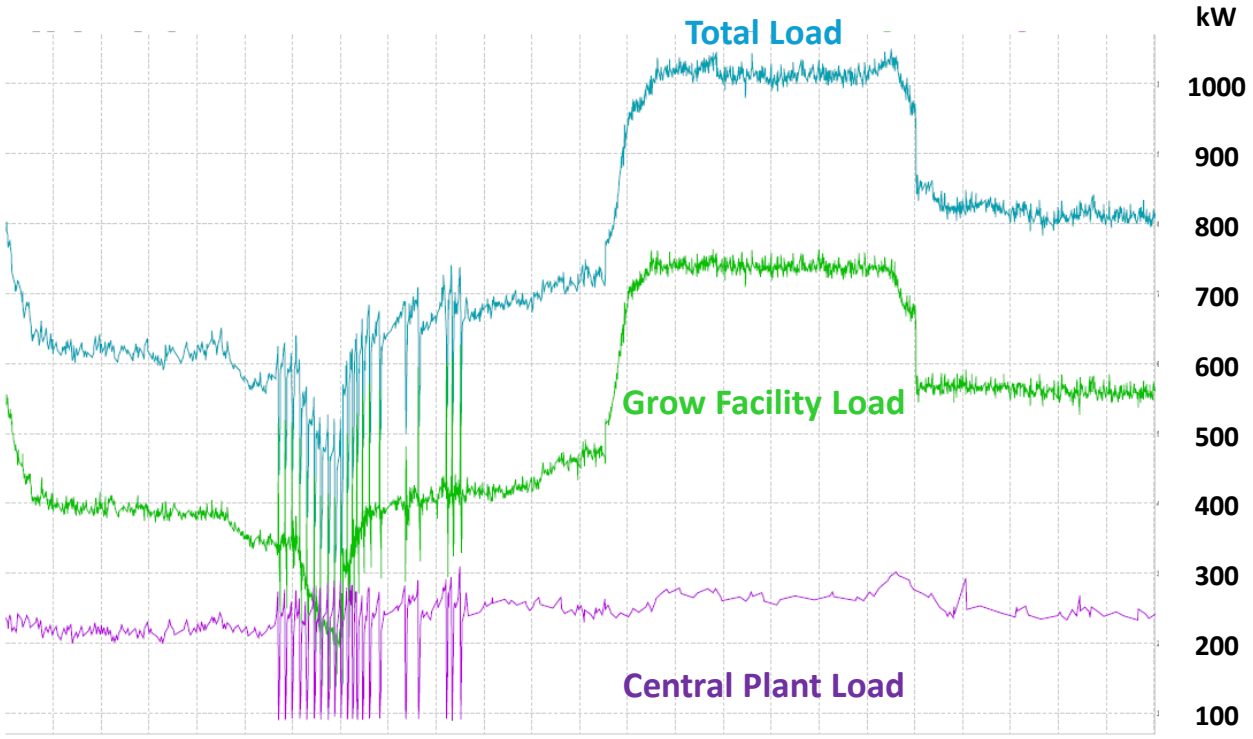
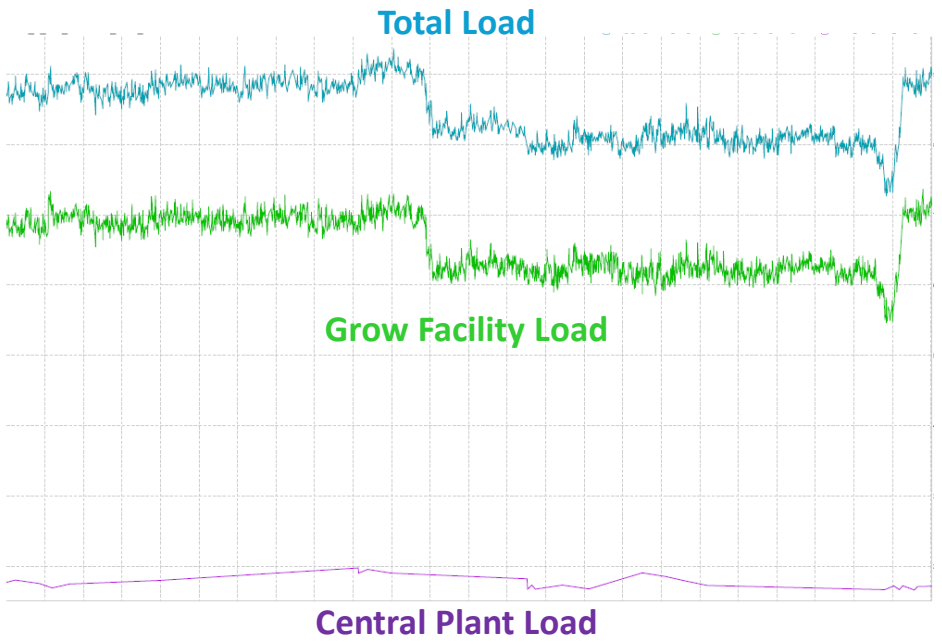
Electrical Load Smoothing

Careful management of electric loads limits load steps



July 2022



November 2022

After smoothing grow facility loads & eliminating chiller short cycling

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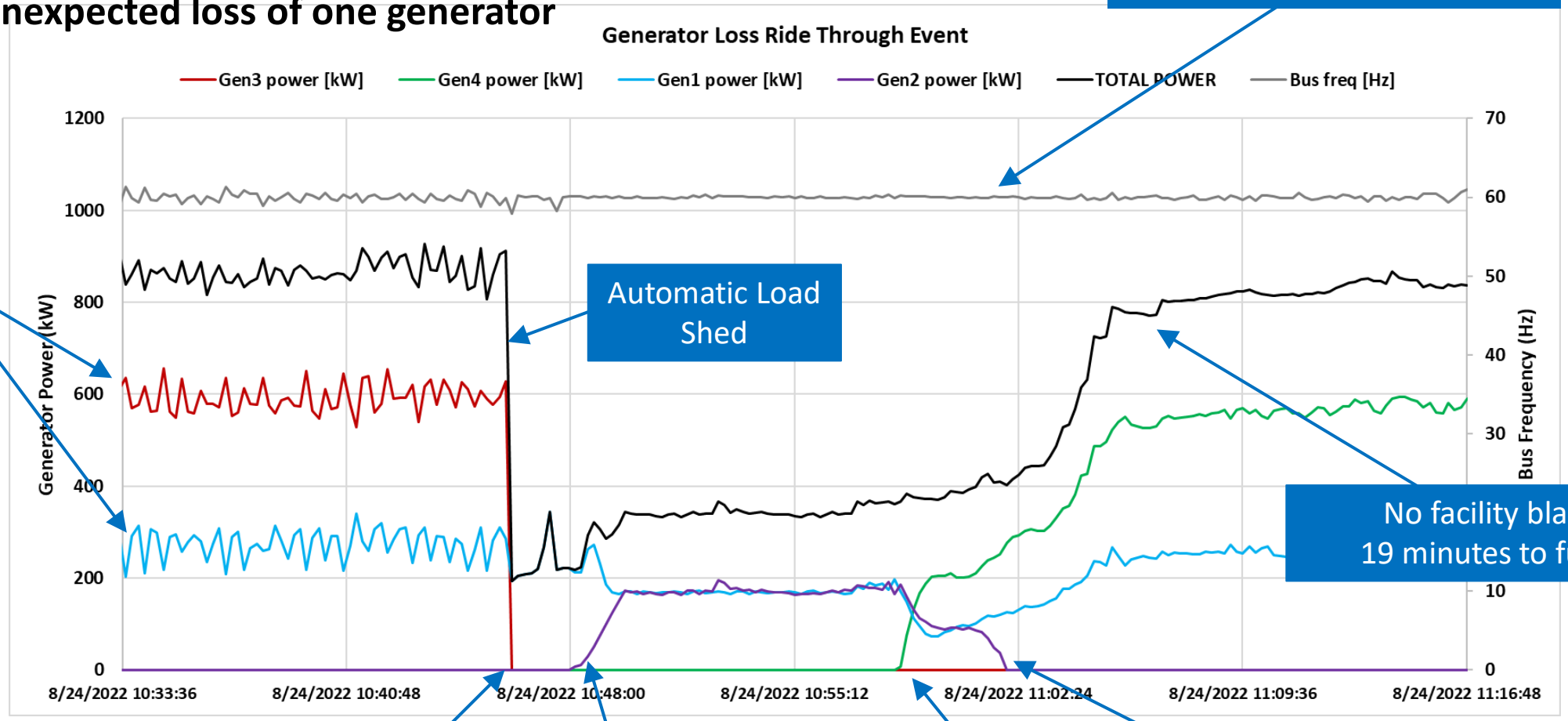
Load Shedding / Standby Generator Start-up

Automatic load shedding and standby generator start-up to manage unexpected loss of one generator

ComAp controls generator output to maintain bus frequency at 60Hz



Gen1 (555kW) & Gen3 (1200kW) Supplying Load

Automatic Load Shed

No facility blackout
19 minutes to full load

Gen3 Shut Down

Gen2 AutoStart < 2 min.

Gen4 Manual Start

Gen2 Shutdown

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PA Options for Wellness Current Status

- ✓ Commissioned April 2022
- ✓ Operating continuously between 800 - 1300 kW
- ✓ 6,227,709 kWh generated to date (as of Jan 2023)
- ✓ Air permit secured – first implementation of PA CHP Permit-by-Rule (GP-20)

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Islanded CHP for WASTE-TO-RNG

Vanguard Renewables

Salisbury, VT

- 800 kW TEDOM Quanto 800
- 100% islanded with backup diesel
- RNG from anaerobic digester / upgrader
- Hot water recovery for digester heating

- Commissioned: Dec 2020

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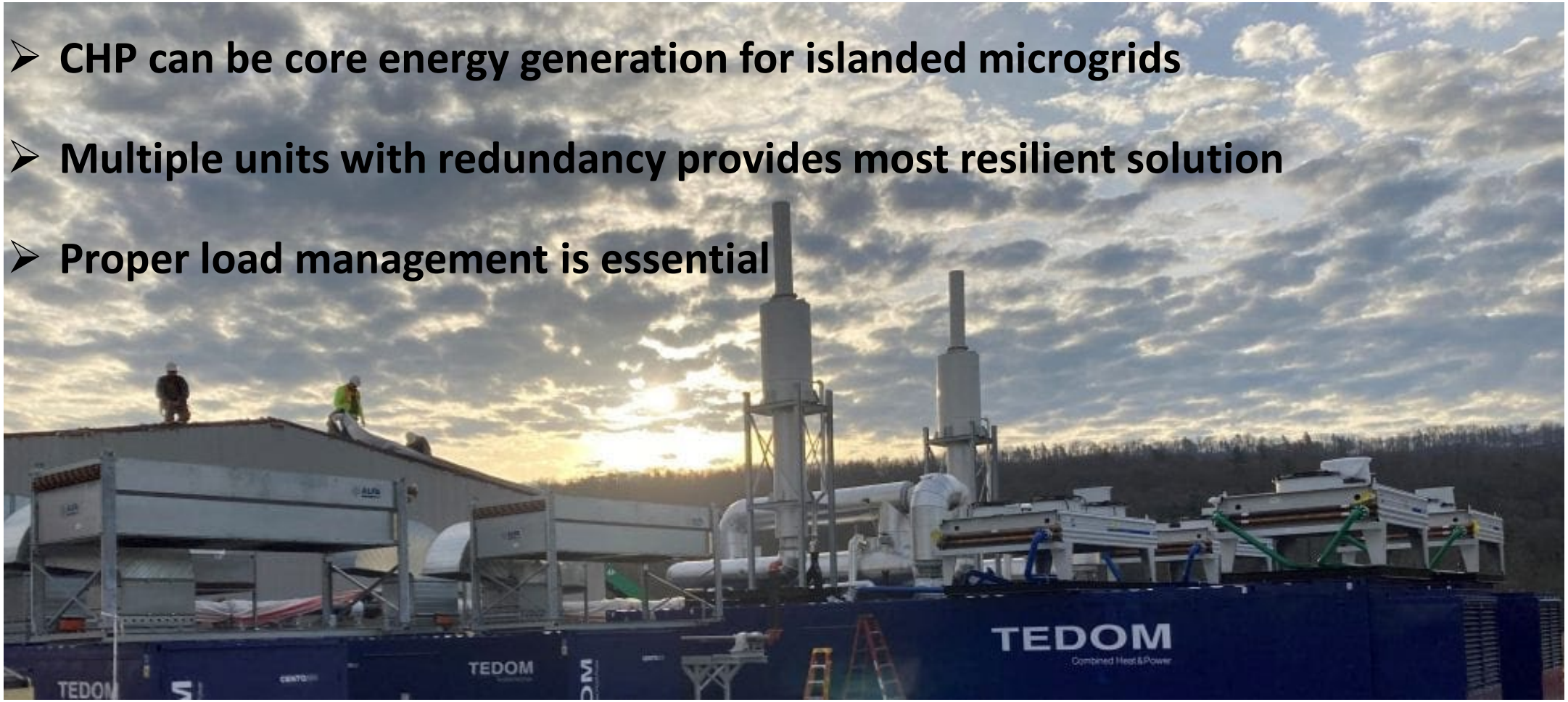
Conclusions



- CHP can be core energy generation for islanded microgrids
- Multiple units with redundancy provides most resilient solution
- Proper load management is essential

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THANK YOU!

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