Plug-and-Play Microgrid Control Systems

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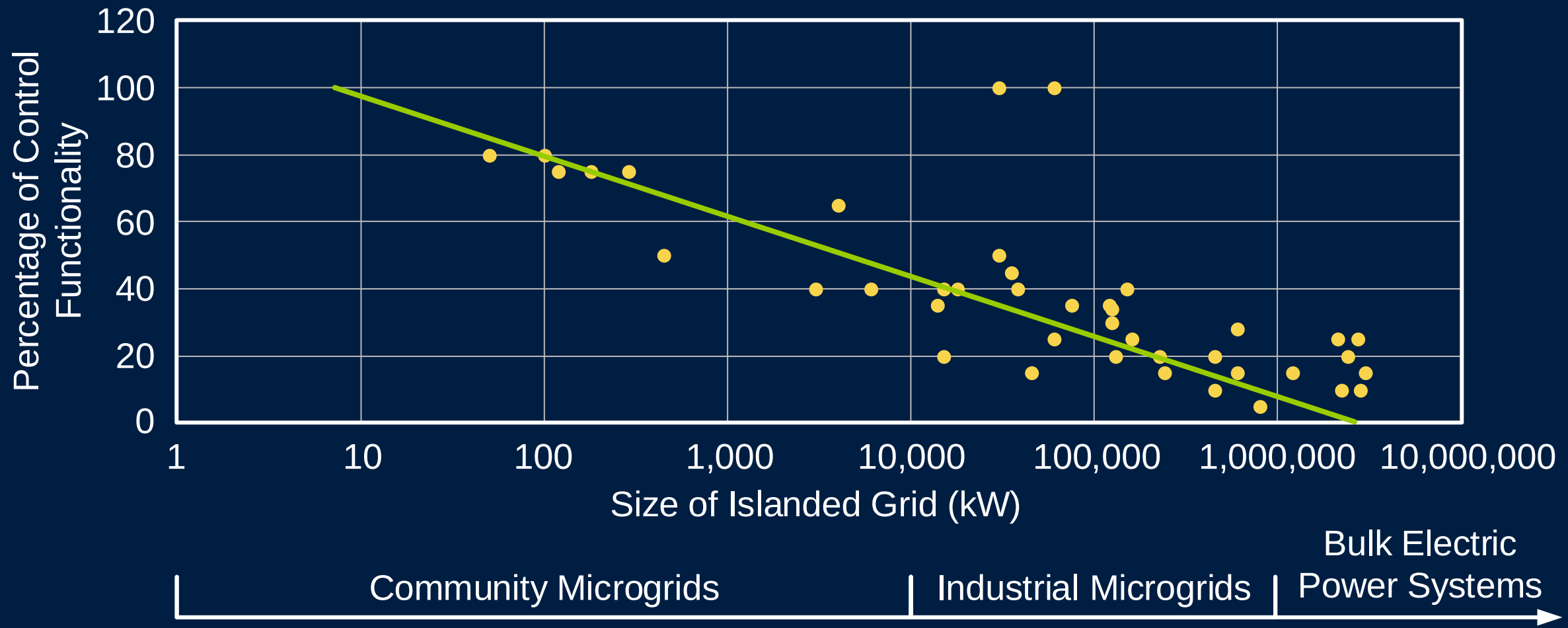
Microprocessor Relays Control Small Grids



Relay-Based Microgrid Technology Won Microgrid Shootout

- Worldwide competition
- Hardware-in-the-loop testing
- Cyber-physical testbed

Microprocessor Relays Are Microgrid Controllers

- Multifunction protection
- Remote I/O
- Metering
- Power quality monitoring
- Programmable logic controller
- IEC 61850
- Sequence of Events recorder
- Embedded and whitelisted controllers
- Military-specified environmental ratings

Microprocessor Relays Are Microgrid Controllers

- High-speed communication
- Continuous self-diagnostics
- Synchrophasors
- DC battery monitoring
- Human interface displays
- Trip and close controls
- Oscillography recorder
- No operating system
- Hundreds of thousands of units in operation

Plug-and-Play Microgrid Design Objectives

- Reduce complexity
- Scale from 10 kW to 10 MW
- Ensure cybersecurity
- Leverage relay-based control
- Interoperate with all gensets and inverters
- Reduce fuel usage
- Improve grid resilience
- Reduce operational costs
- Simplify commissioning
- Simplify testing
- Improve equipment protection
- Ensure human safety

Military Tactical Microgrid Standard (TMS)

Providing the Next Generation of Operational Power for the U.S. Department of Defense

Tactical Quiet Generator (TQG)

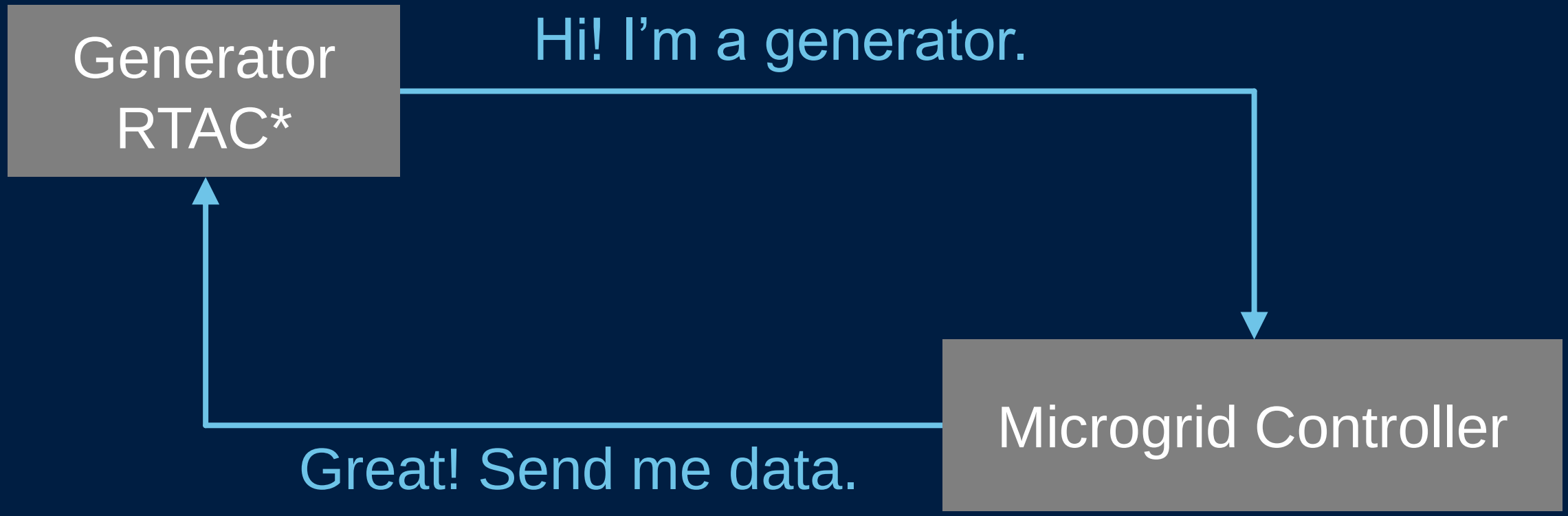
Quiet (1980)

TMS

Interoperable (2018)

U.S. Army Demonstration Project Opportunity

Data Distribution Service (DDS) Brings Plug-and-Play Communications



* Real-time automation controller

User-Friendly RTAC Configuration

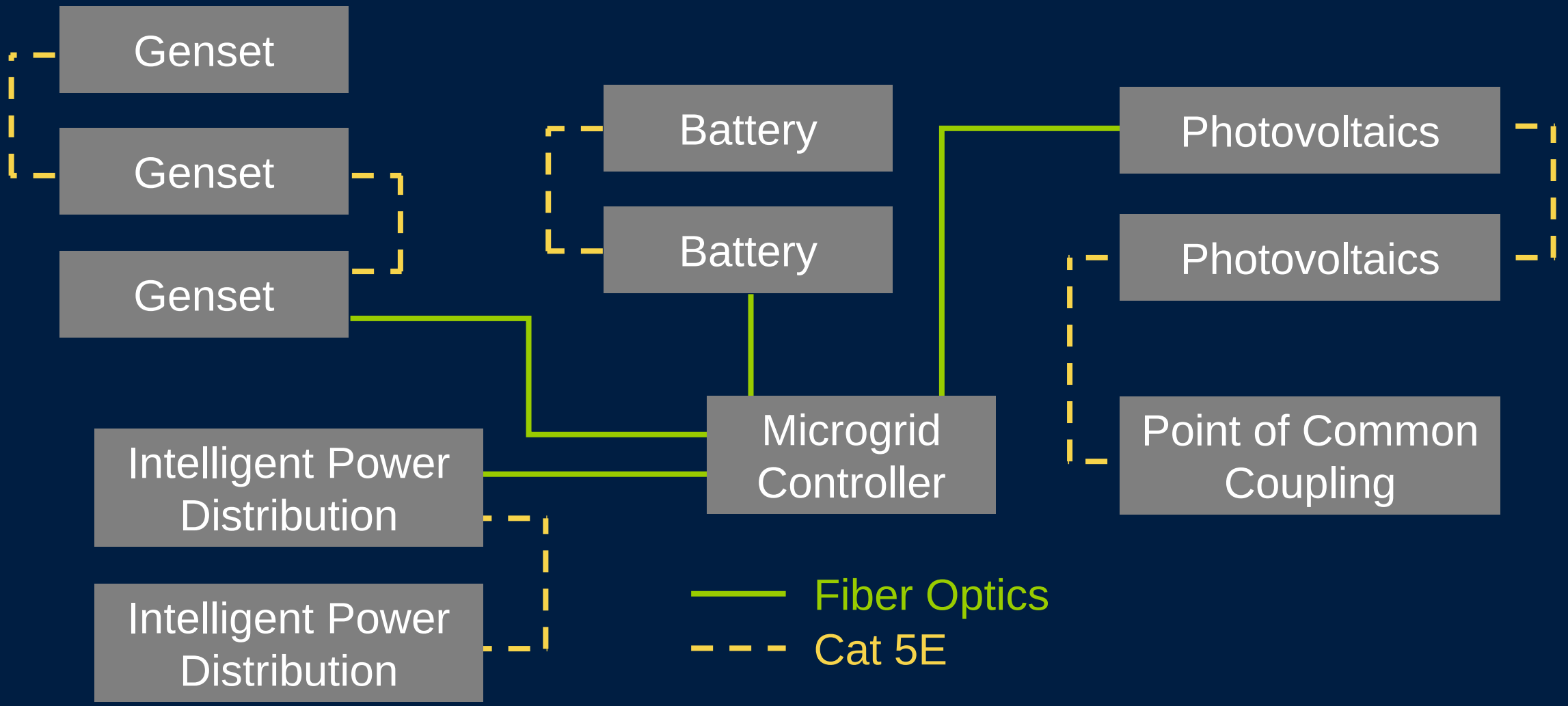
Reduced Part Count Increases Reliability

TQG Before Refurbishing

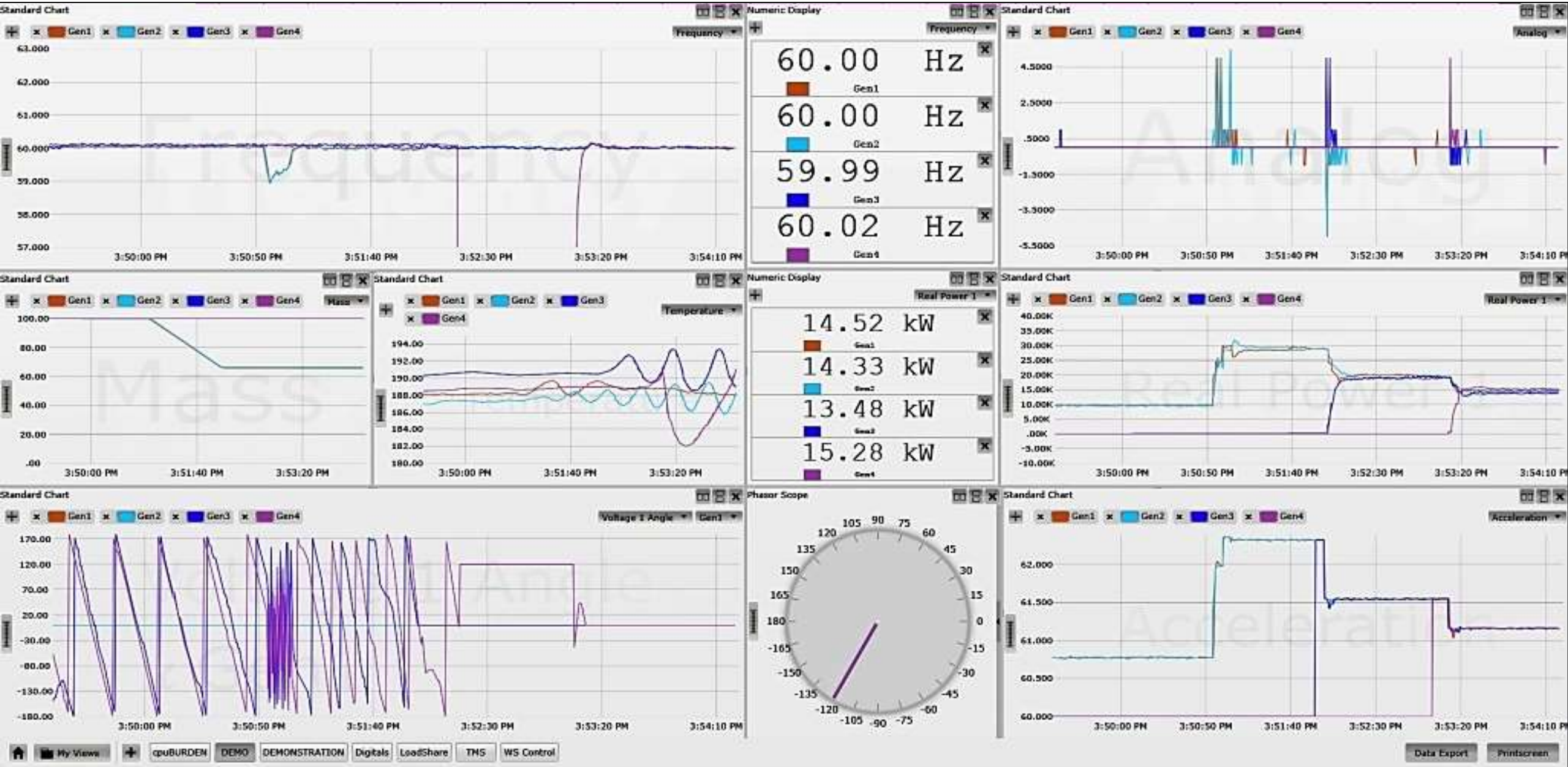
Custom-Built Electronics Removed

Replaced With Fewer, Lighter, Off-the-Shelf Parts

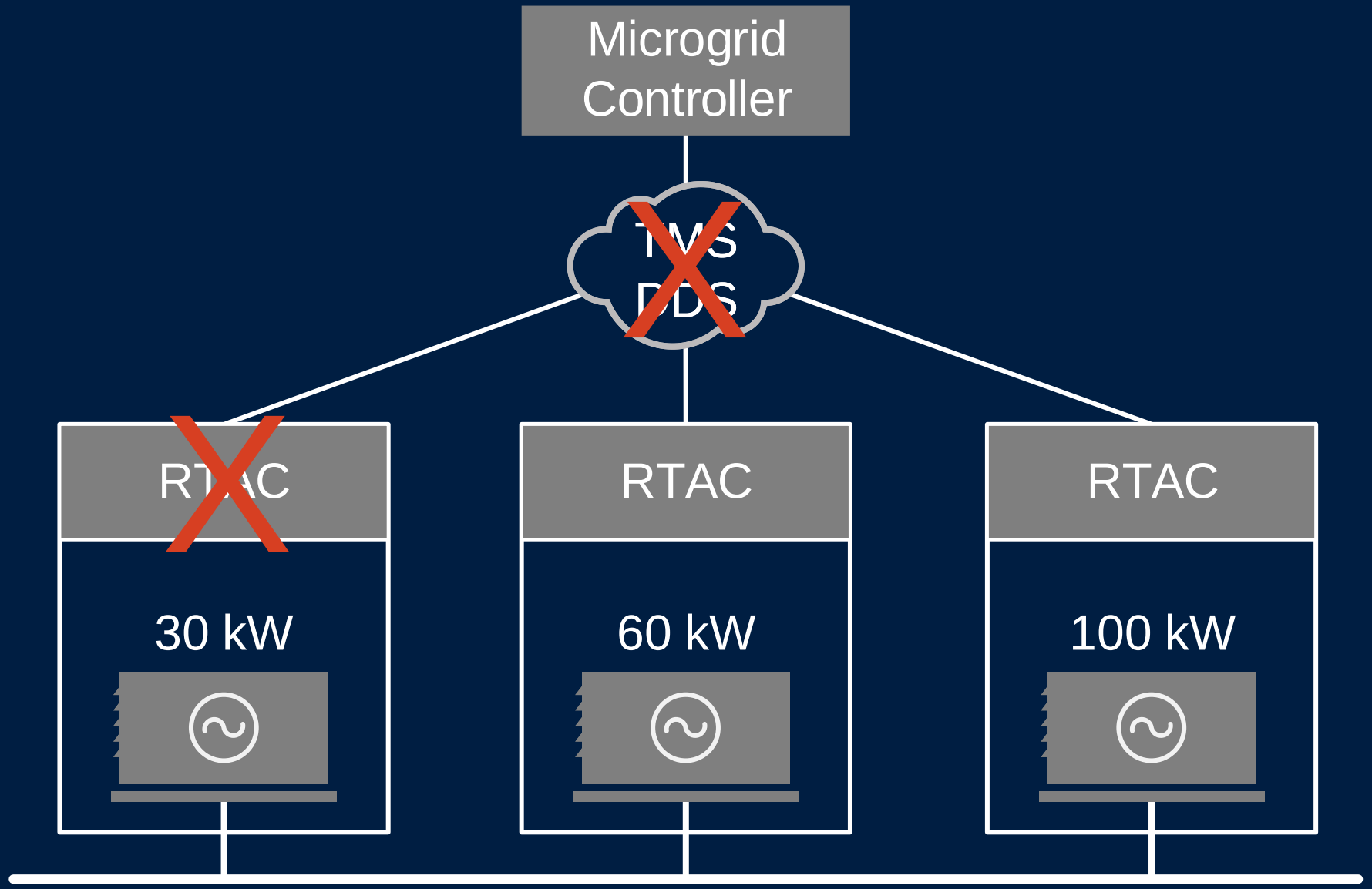
Secure Networks Support Any Distance



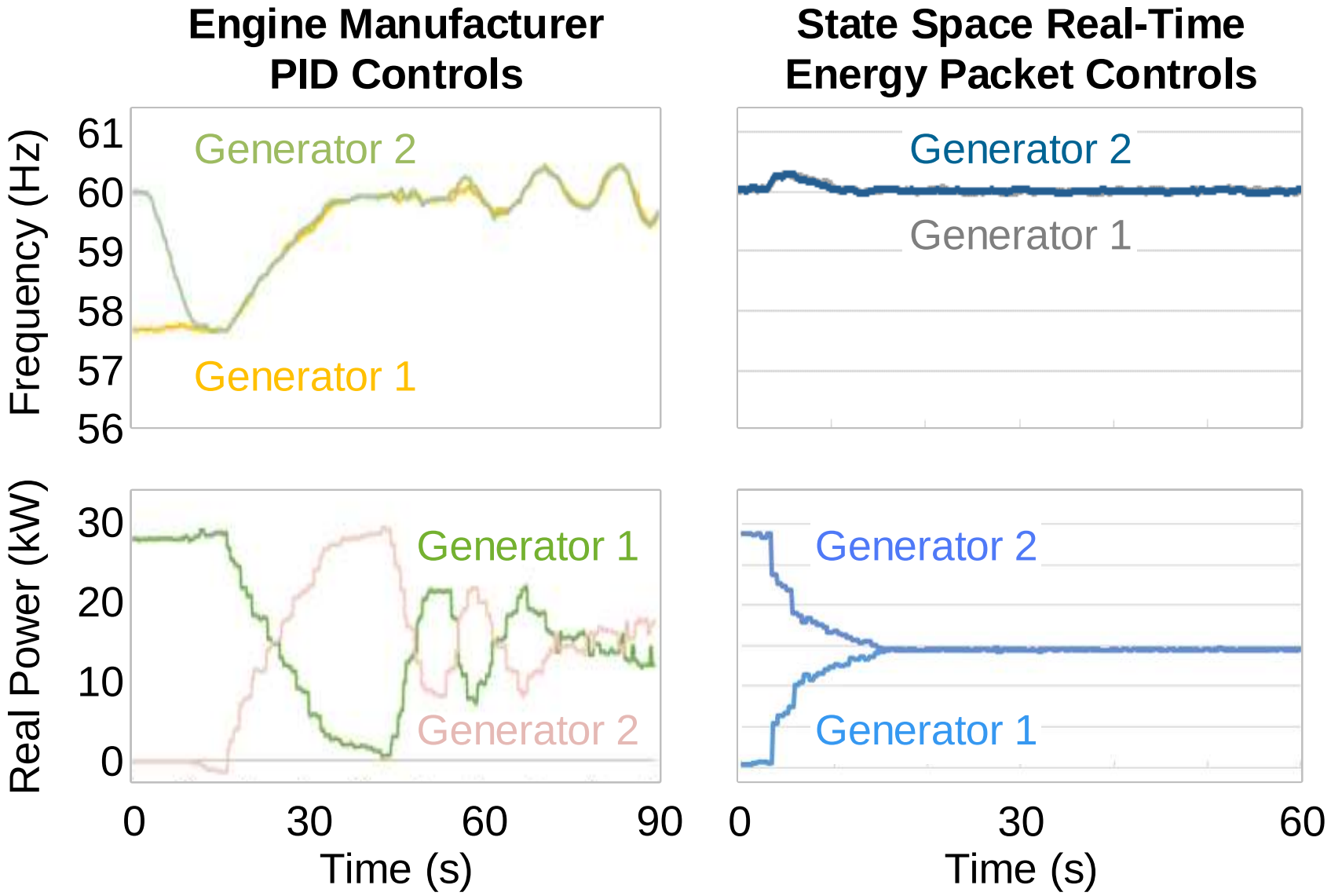
Time-Synchronized Condition Monitoring



No Single Point of Failure



Superior Load Sharing and Frequency Control

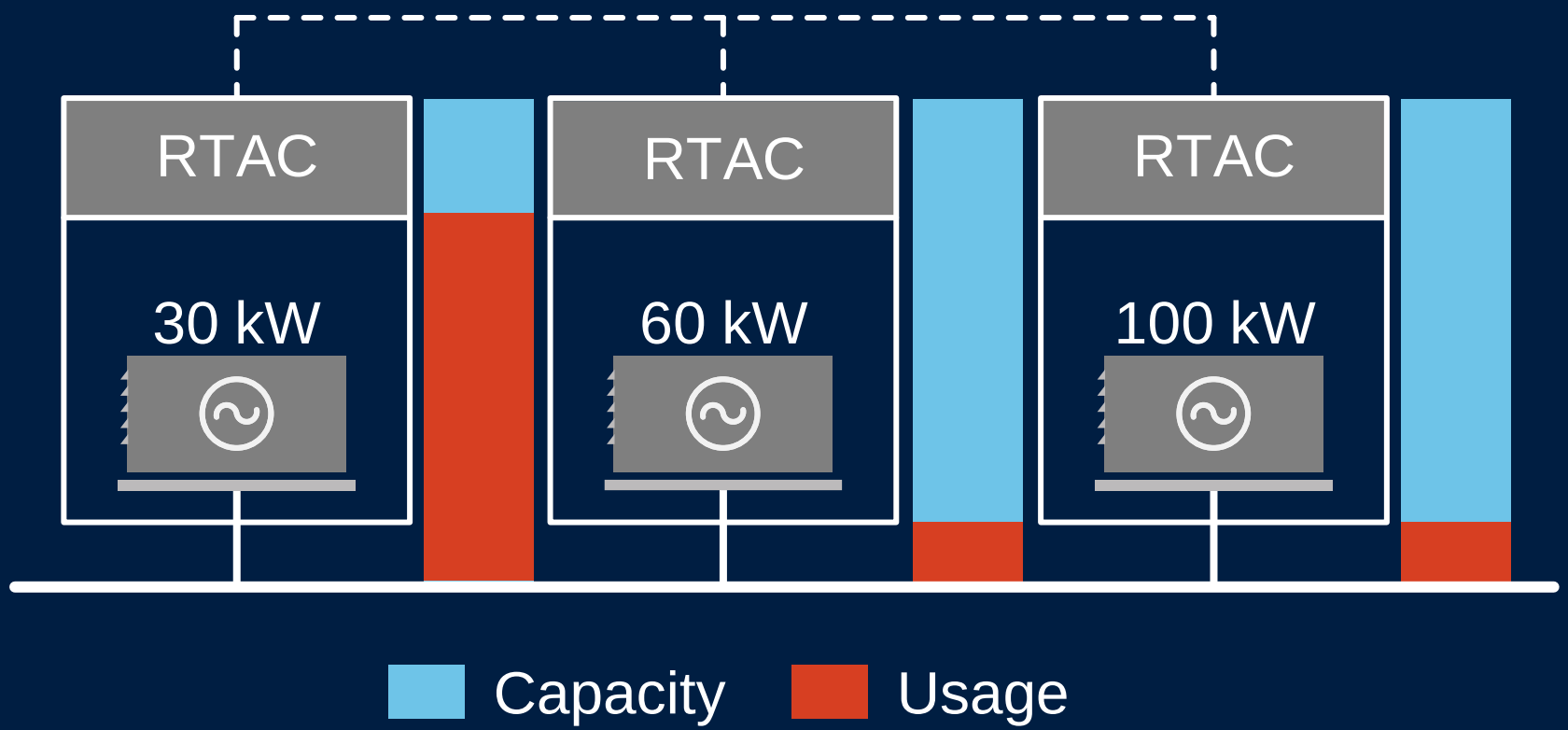


No overshoot
No integral windup
No oscillations
No tuning
Fully interoperable

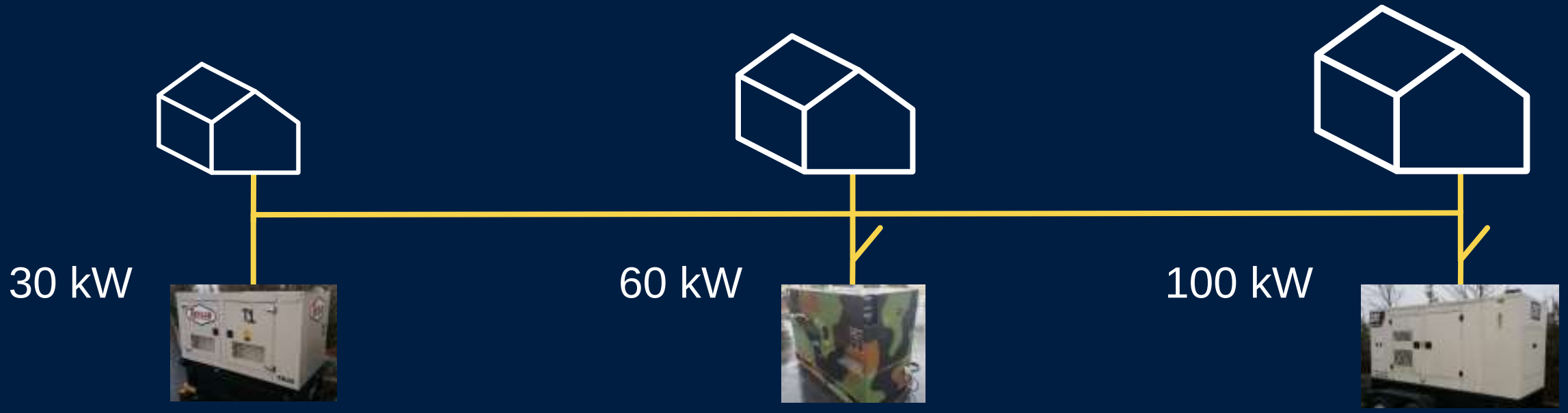
Cybersecure by Design

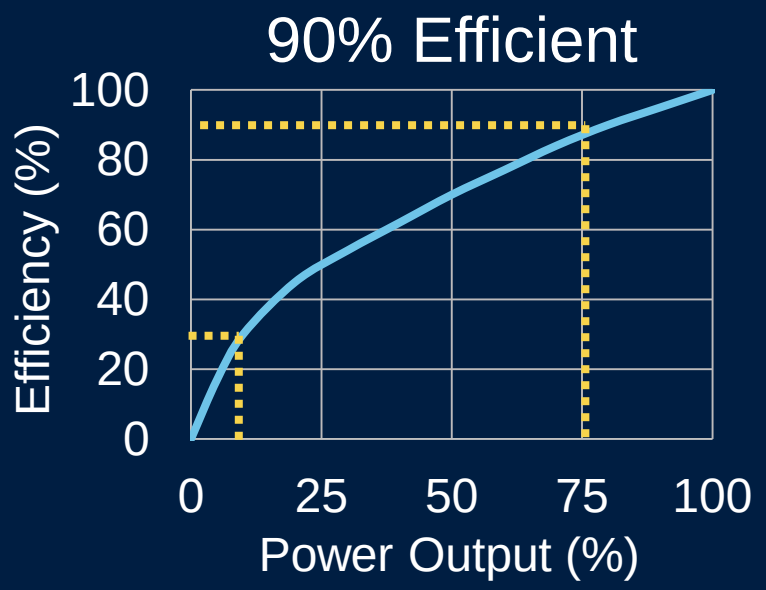
- Software-defined network
- Embedded, whitelisted controllers
- Secure supply chain
- Electronics manufactured in U.S.
- Policy, plan, and procedure
- Mature processes

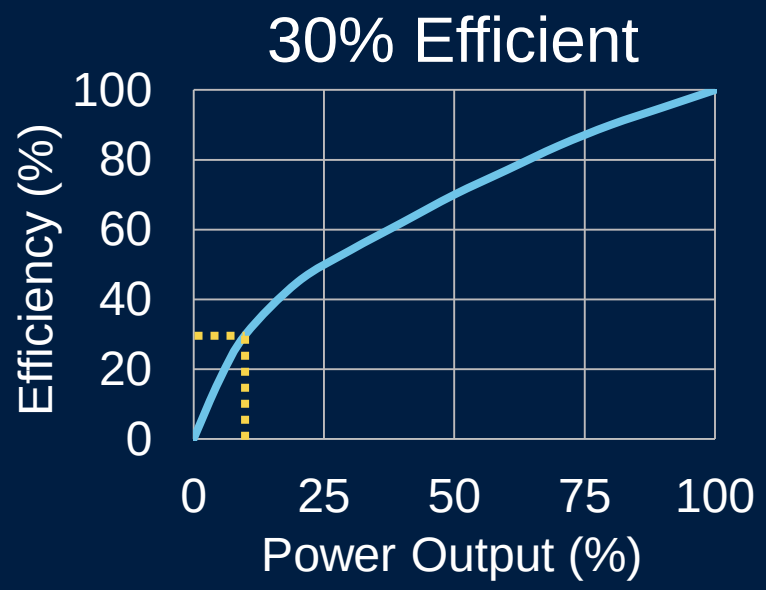
Wet-Stacking Correction Strategy Does Not Burn Extra Fuel

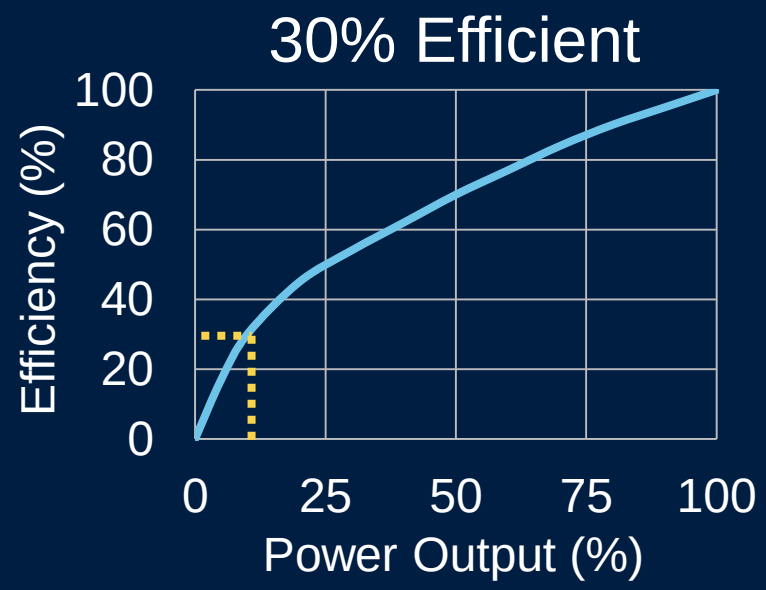


Microgrid Consumes Less Fuel









Conclusions

- Interoperability between gensets achieved
- Minimal skill required to operate and configure
- 30–60% fuel saved
- Engine life prolonged
- Power system survives all manner of failures
- IEEE 1547, 2030.7, and 2030.8 standards met
- Costs reduced >70%

Questions?