Digital Twin for Microgrid

Smarter Design to Insure Mission Assurance

Power Up Energy Expo

October 2024

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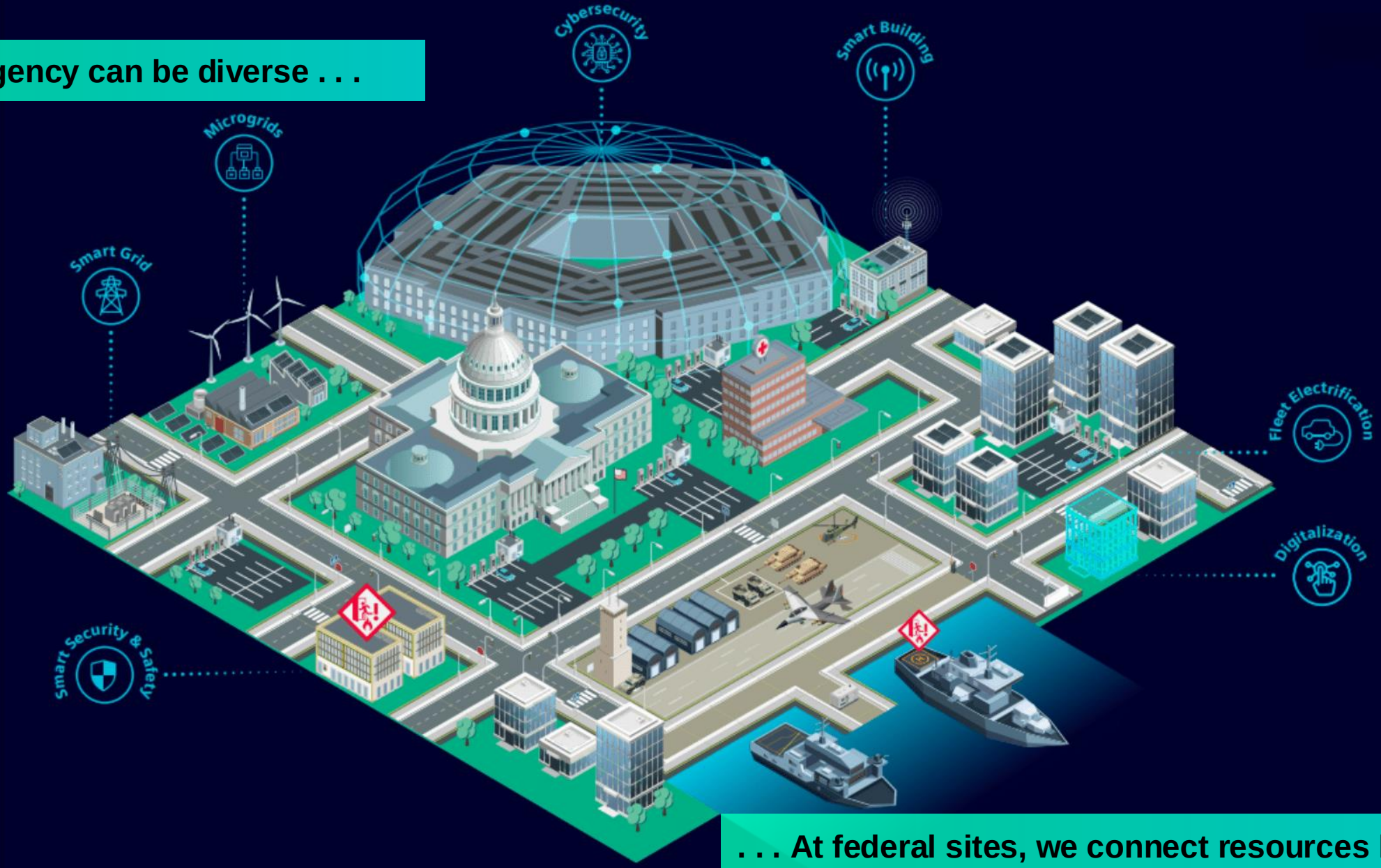
A federal agency can be diverse . . .



. . . At federal sites, we connect resources like a city

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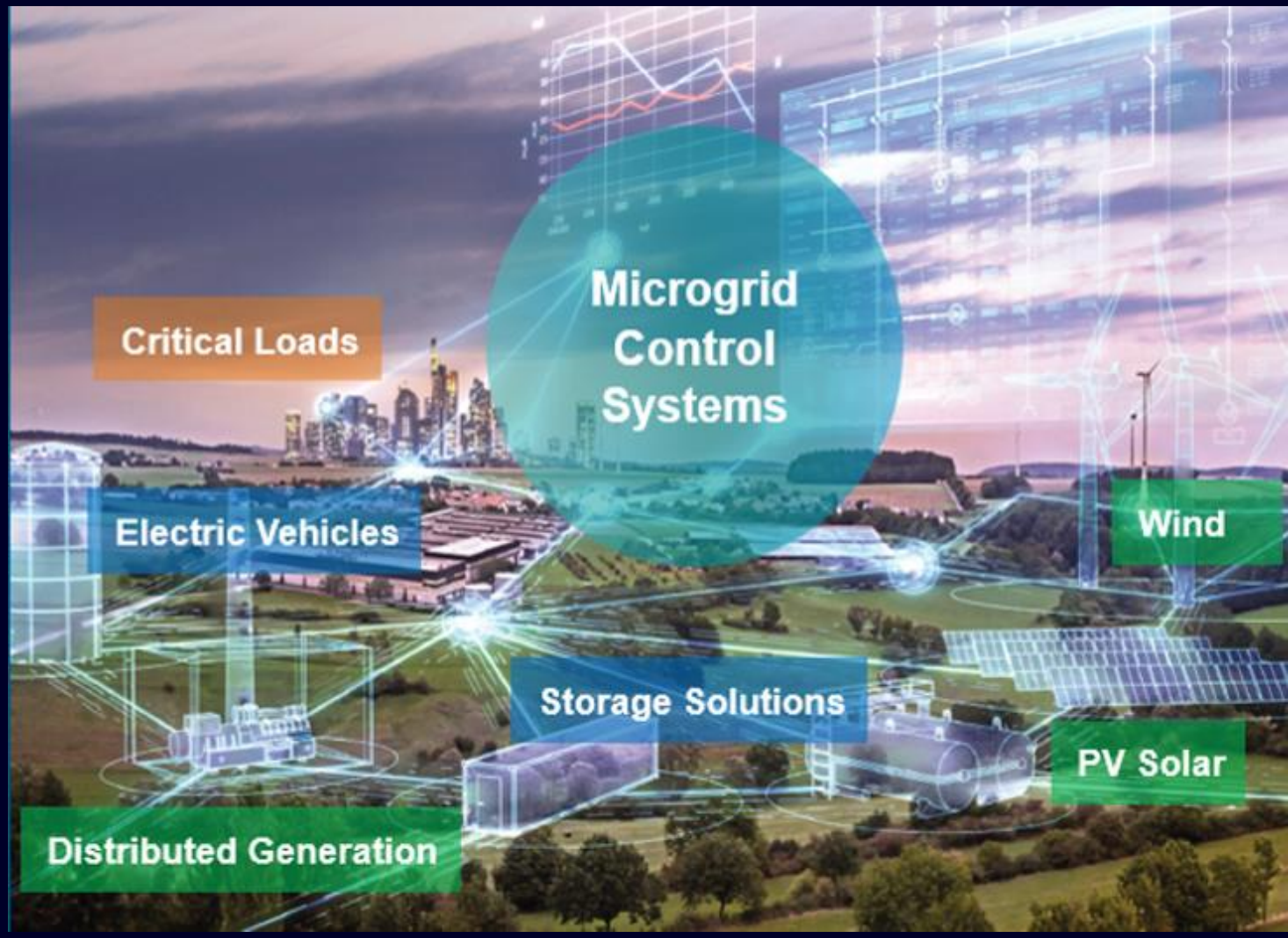
What is a Microgrid?

Department of Energy:

"A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island mode"

A power grid that:

- Operate in conjunction with the areas main electrical grid (Grid–Connected)
- Optionally Independent (Island Mode)
- Integrates multiple energy sources



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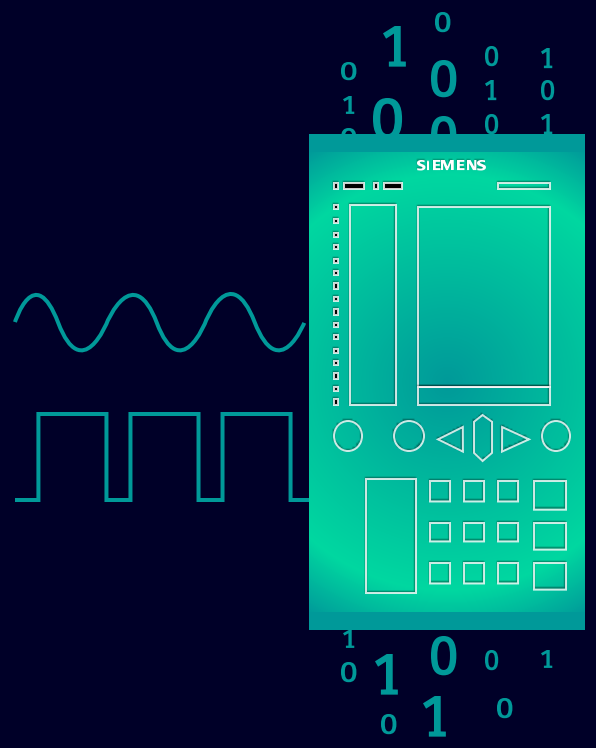
What is the Digital Twin concept?

A digital twin is a virtual model of a real-world object, system, or process that can be used to simulate its behavior and performance. Digital twins are created using real-time data and modeling techniques to mirror the physical counterpart. They can be used for a variety of purposes, including:



Simulation
Digital twins can be used to simulate how changes may affect the physical object. For example, a city could use a digital twin to monitor its energy use and plan for extreme weather.

Monitoring
Digital twins can be used to monitor operations and identify potential faults.

Maintenance
Digital twins can help make better-informed decisions about maintenance and lifecycle.

Decision-making
Digital twins can be used to optimize performance and facilitate decision-making.

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What can we do with a digital twin?

Digital Twin for Industrial Applications

Concept

A place to experiment with design concepts to meet mission requirements

Development

A place to analyze & test engineered solutions with respect to functional requirements

Planning

A place to plan & optimize specific production sites

Operations and Assets

A place to monitor, optimize & plan maintenance for specific plants or products (fleet)

Digital Twin

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What can we do with a digital twin for microgrids?

Digital Twin of the microgrid enable researcher and engineers to:

- Validate design concept and generation asset sizing
- Analyze solution requirements
- Test control functionalities and interoperability
- Test microgrid performance against grid standards
- Predict financial payback
- Evaluate system performance

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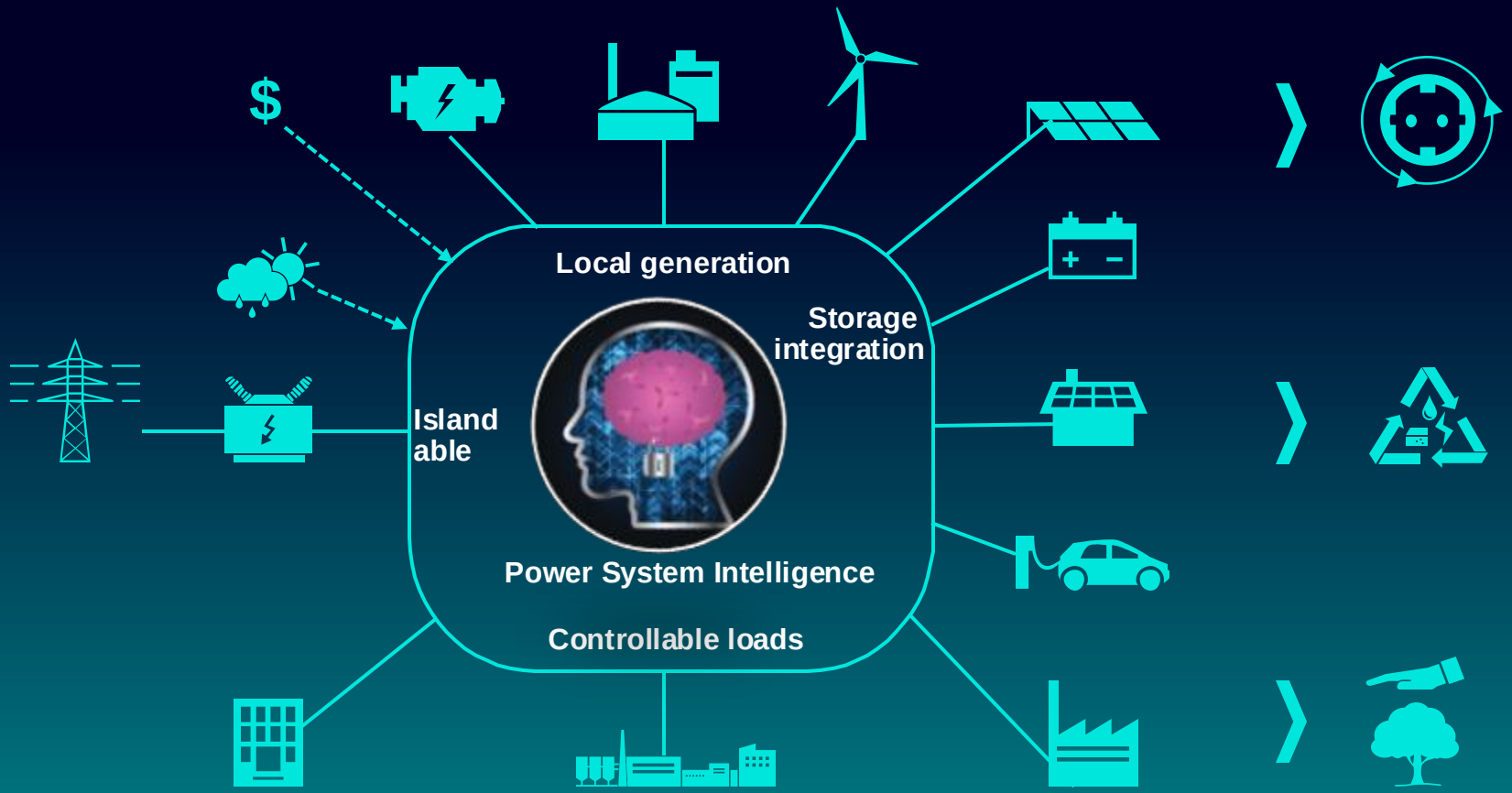
Testing the Digital Twin in Real Time



Resiliency & Reliability

- Small models imitate the loads and DERs
- Controls set for optimum operation
- Islanding testing

Energy Efficiency

- Test Load shaving, shifting
- Model Economic arbitrage (storage & DG)
- Power quality analysis and remediation

Sustainability

- Interactivity with grid
- Long term operation testing
- Dispatch
- Generation and load forecast

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Customer projects where Digital Twin has been extensively used during project execution

Rocky Mountains

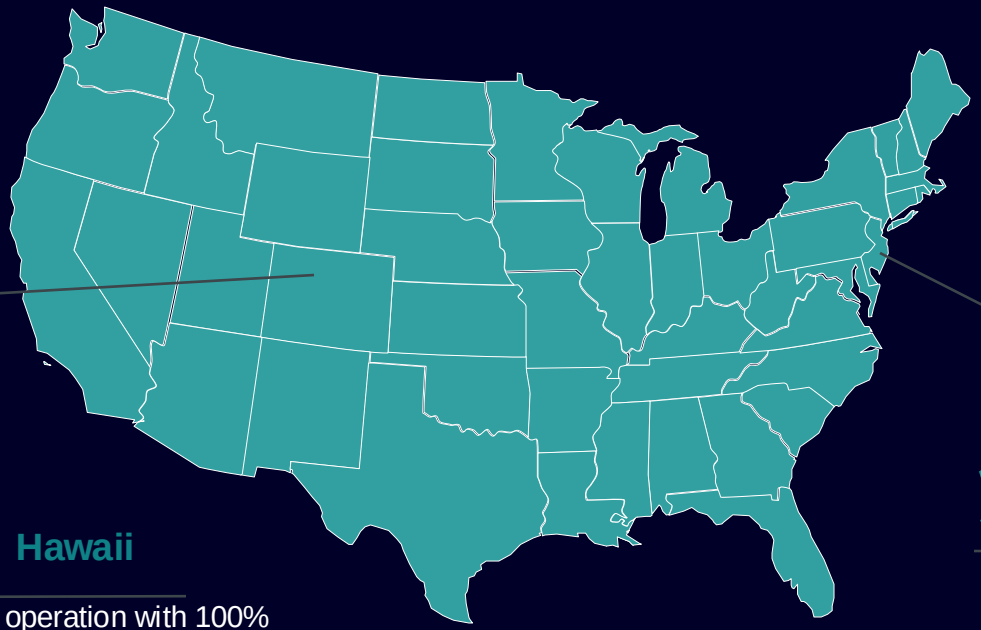
Autonomous blackstart with 25 parallel grid-forming inverters (lab test)

Hawaii

Resilient operation with 100% renewable generation (real-time simulation)

Galapagos

N-1 resilient operation with 100% renewable generation since 2018

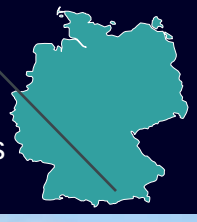


Princeton

Microgrid with zero-inertia islanding capability

Wildpoldsried, Bavaria

Zero-inertia customer field test with 6 commercial parallel grid-forming inverters



Naval Station Guantanamo Bay

N-1 resilient operation with high renewable integration

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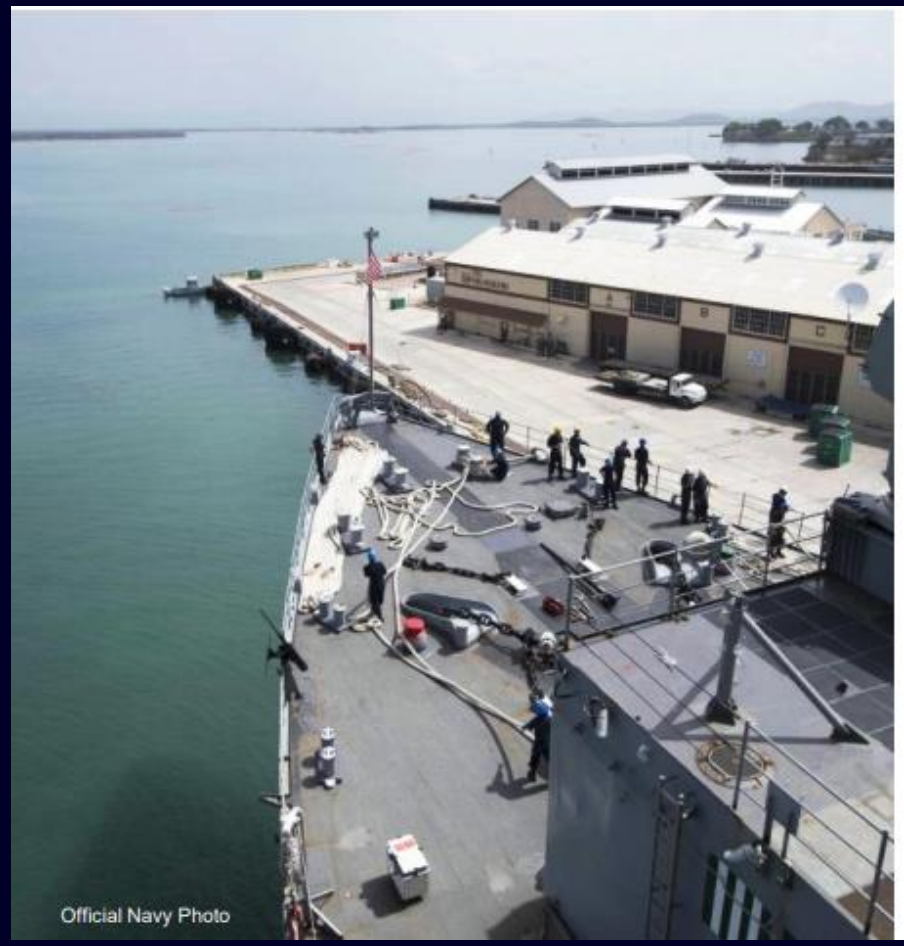
Naval Station Guantanamo Bay (NSGB)
Scope & Schedule



- Largest Energy Savings Performance Contract in Department of Defense
  - $344 million implementation period
  - $828 million total contractor payments
- Siemens teamed with AECOM to bring the strength of two ESCOs
- Schedule:
  - Construction and acceptance: 31 months
  - Performance period: 21 years, 2 months

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NSGB Project Overview

Key Features of the ESPC:

- Whole base solution providing energy resiliency, reliability and efficiency
- Liquefied natural gas (LNG) as primary fuel source
- LNG procured through Defense Logistics Agency (DLA)
- Cyber secure architecture
- Renewable energy – Photovoltaics, battery storage, and monitoring of the existing wind turbines
- Dual fuel capability providing resilience of supply
- Microgrid management system connecting together the installation's power generation
- Enhanced maintenance, repair and replacement paid for through guaranteed savings

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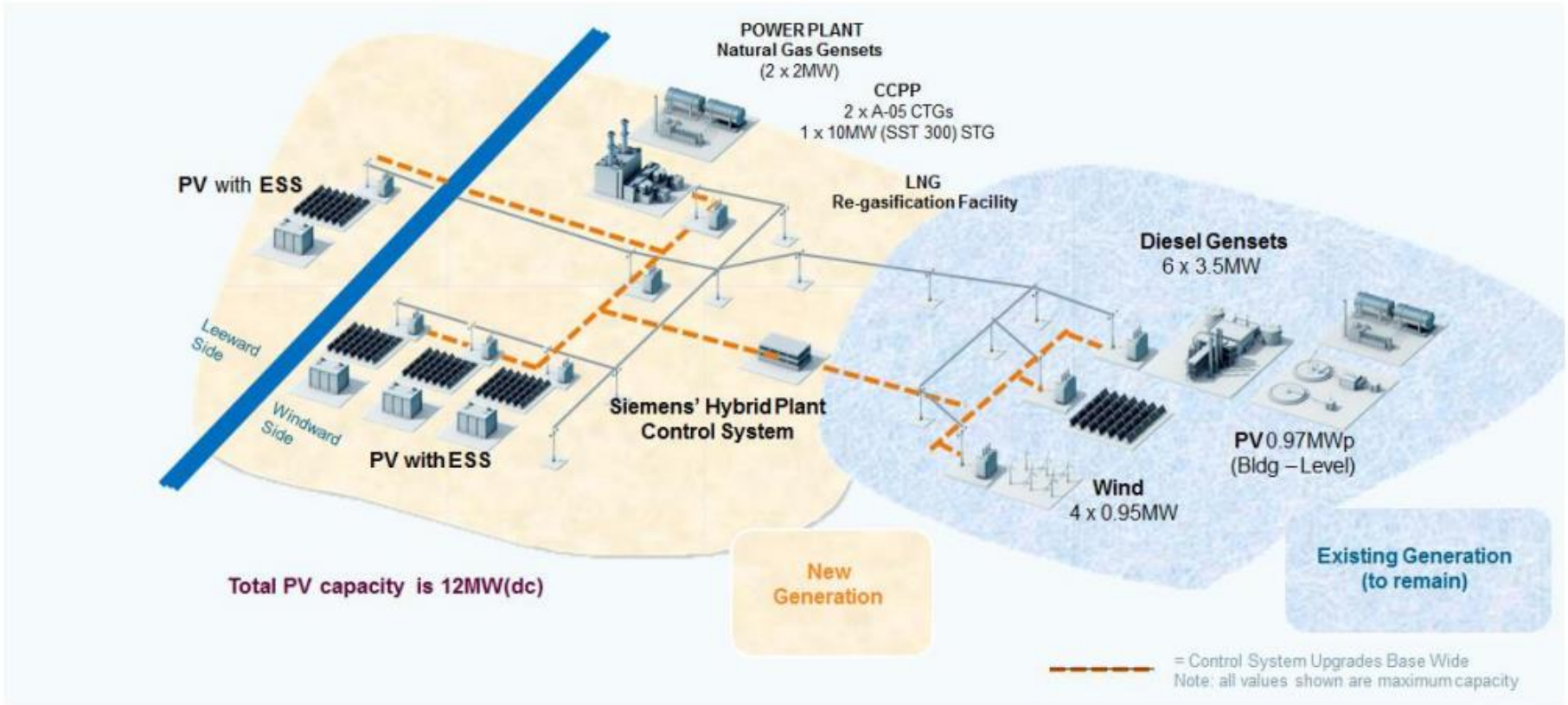
Where Old Meets New



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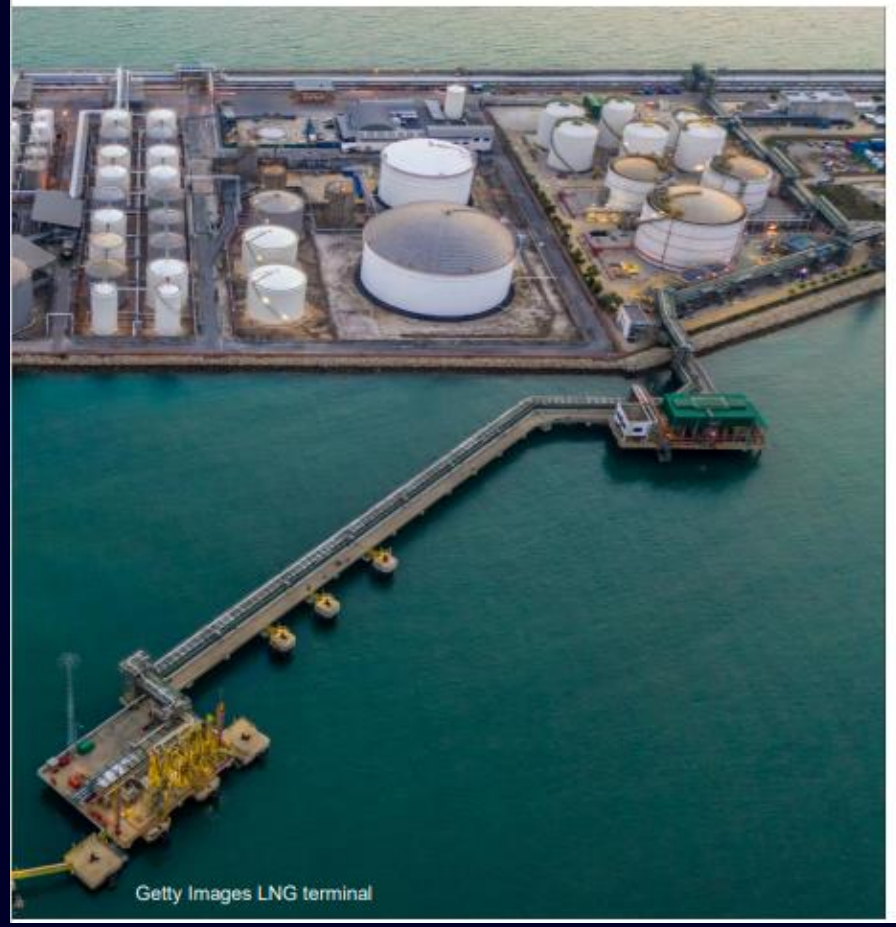
Supply-Side Overview



Scope:

- Distributed Generation –24 MW nominal combined cycle power plan (CCPP) with 4000 m3 LNG facility and storage
- New dual fuel power plant
- New LNG regasification and fuel storage terminal
- Two Siemens 5 MW class SGT-A05 high-efficiency dual fuel gas turbine generators
- One Siemens 10 MW nominal SST-300 steam turbine generator
- Two 2 MW natural gas engine generators
- One air-cooled condenser
- New seawater intake

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Contact

Siemens SI

Norm Campbell

Federal BDM, Power Solutions

300 New Jersey Ave NW
Washington, DC 20001
United States of America

Phone +1 317-476-7368

E-mail norman.Campbell@siemens.com

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