IDEA2018
Local Solutions, Global Impact

Energy Systems for Island Resilience

Case Study : Guam

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High Performance Communities

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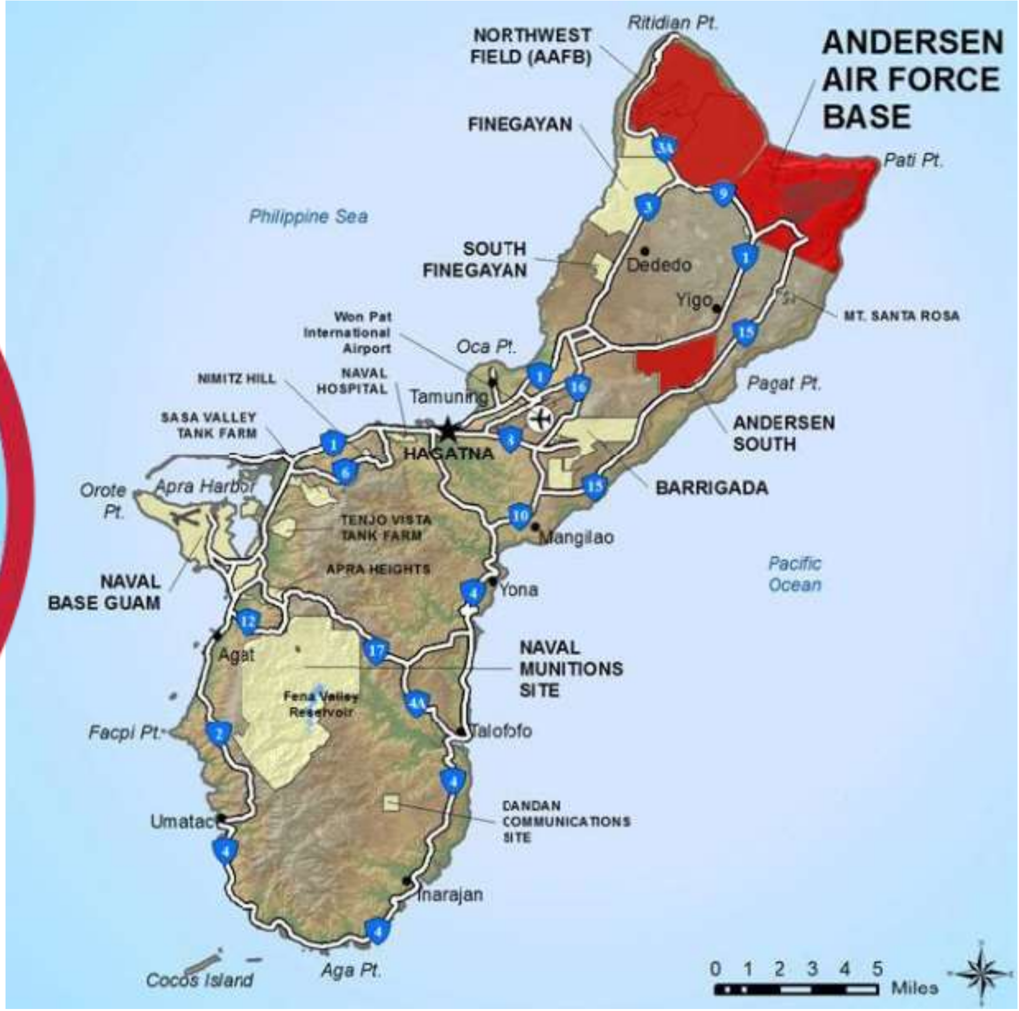
Overview

- Integrated planning process focusing on resilience
  - Existing conditions and the need for resilience
  - Developing a resilient energy plan for Guam
- Methodology for assessment
  - Identifying critical loads
  - Methods of quantification and comparison of energy solutions
- Resultant plan
  - Technology integration
  - Phasing
  - Performance
  - Making Resiliency Investments Worthwhile
- Lessons learned and applicability elsewhere

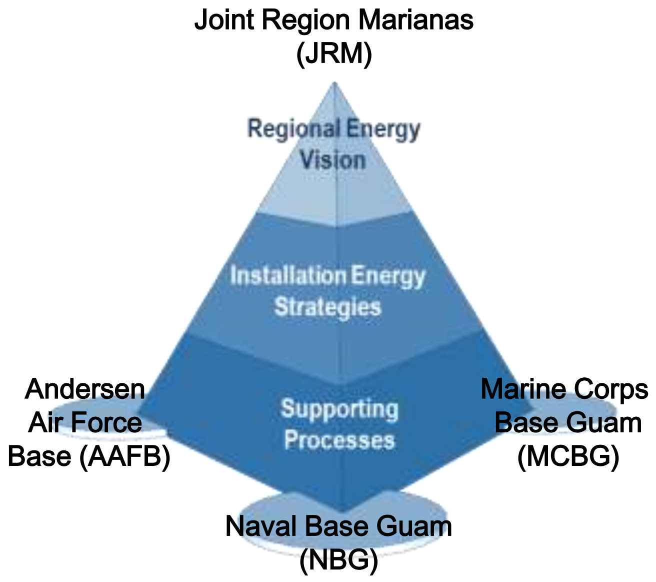
Guam


GUAM


NORTHWEST FIELD (AAFB)
Ritidian Pt.
ANDERSEN AIR FORCE BASE
FINEGAYAN
Pati Pt.
Philippine Sea
SOUTH FINEGAYAN
Dededo
Yigo
MT. SANTA ROSA
Won Pat International Airport
Oca Pt.
NIMITZ HILL
NAVAL HOSPITAL
Tamuning
Pagat Pt.
SASA VALLEY TANK FARM
HAGATNA
ANDERSEN SOUTH
Orote Pt.
Apra Harbor
BARRIGADA
TENJO VISTA TANK FARM
Mangilao
APRA HEIGHTS
Pacific Ocean
NAVAL BASE GUAM
Yona
Agat
NAVAL MUNITIONS SITE
Fena Valley Reservoir
Facpi Pt.
Talofofo
Umatac
DANDAN COMMUNICATIONS SITE
Inarajan
Cocos Island
Aga Pt.
0 1 2 3 4 5
Miles

Strategic Energy Master Plan

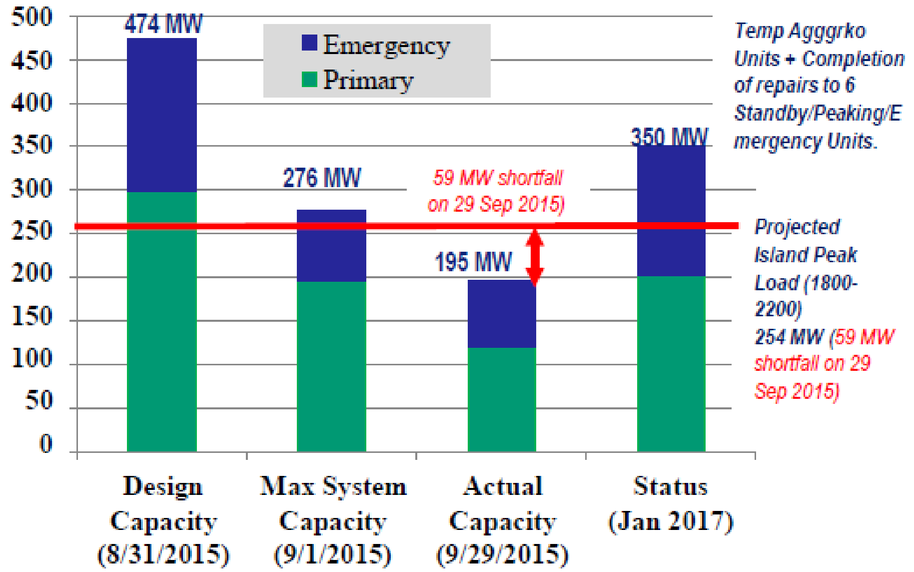
- The Strategic Energy Master Plan (SEMP) seeks to provide energy resiliency and security using efficiency, redundancy, and reliability in support of the forward operating mission.



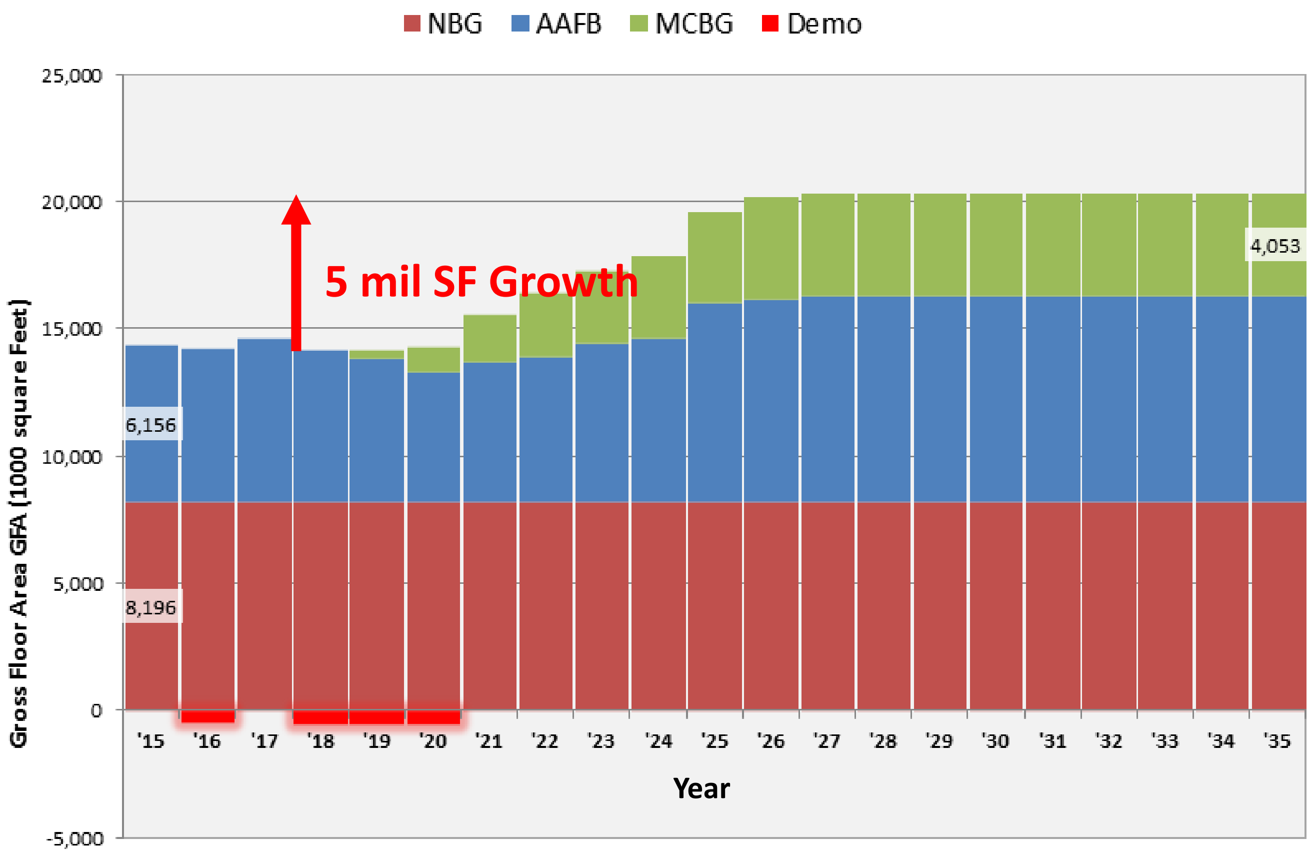
Strategy Energy Planning

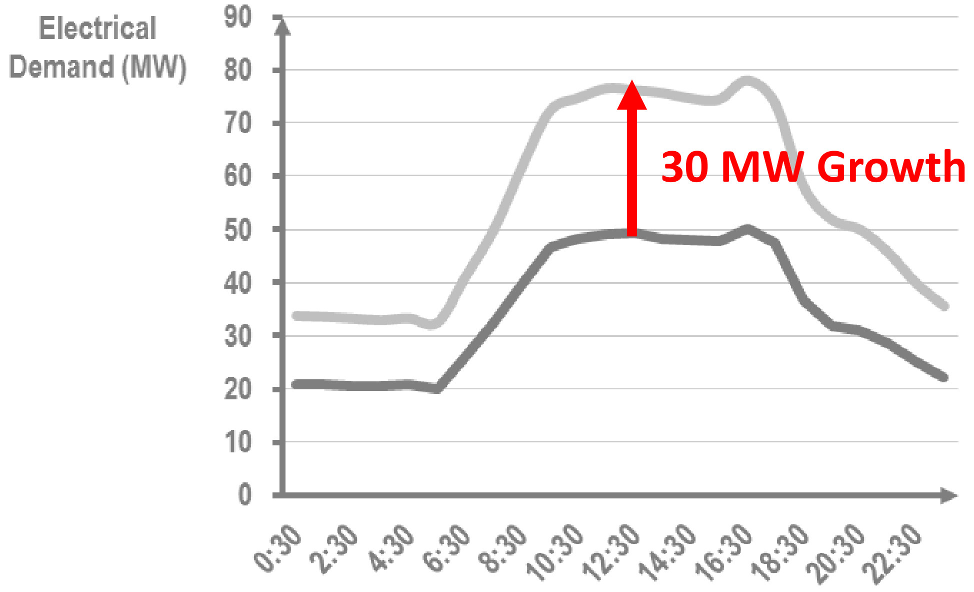
Existing Conditions: Power Crisis

- GPA lost 80 MW generation
- JRM required to run on-site generation
- >400 power outages from 2010 - 2015



Future: Growth



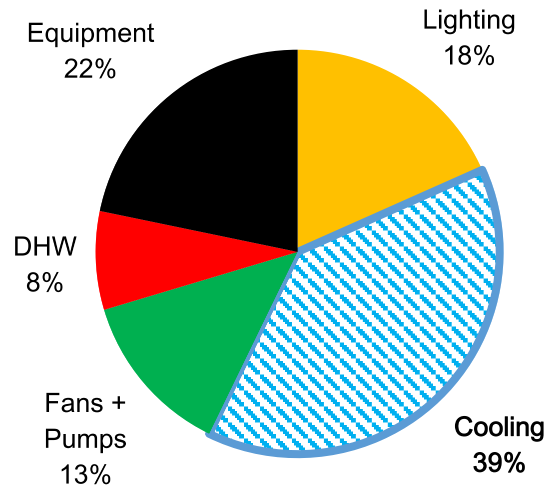


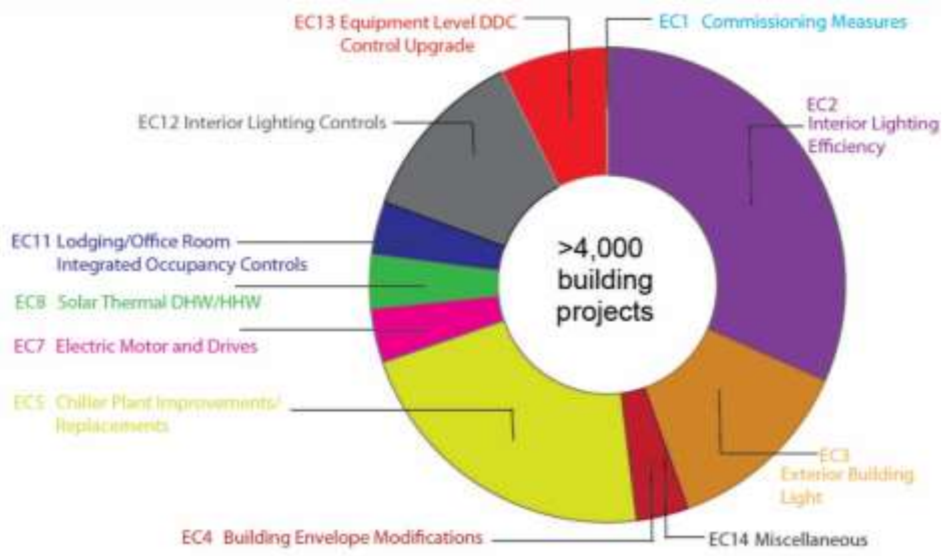
Future: Goals

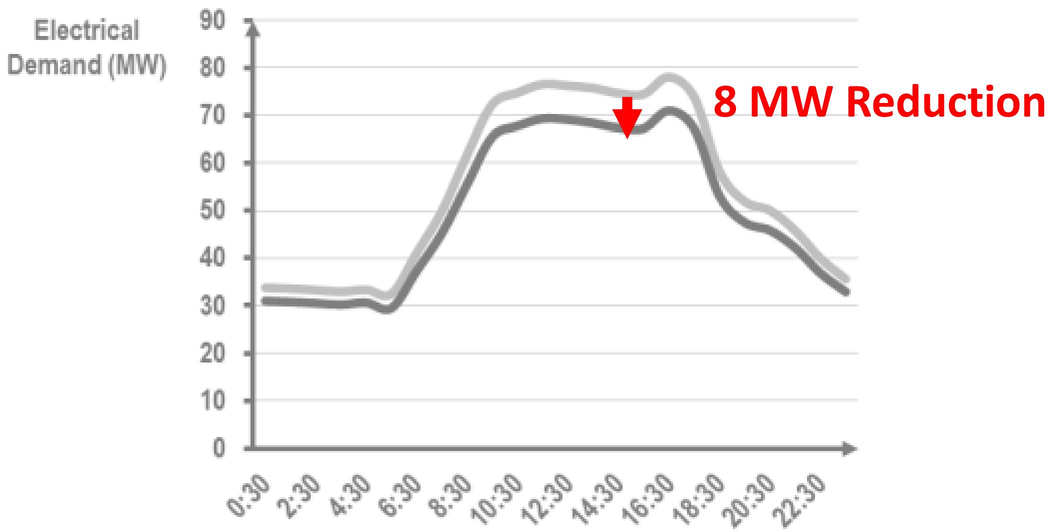
- Federal Mandates (EO 13693)
  - Energy Use Intensity (EUI) – 25% reduction by 2025
  - Renewable Energy % - 25% by 2025
- SECNAV Goals
  - 50% alternative fuel sources by 2020
  - Net zero energy by 2030
- Resilience Goals:
  - Provide durable energy solutions
  - Avoid single points-of-failure
  - Ensure sustainable maintenance
  - Use cost-effective energy strategies
  - Meet required energy mandates and goals

Strategies: Demand reduction

- Demand reduction 1st step
- Utility capacity constraint accentuates its resilience value
- >4,000 projects

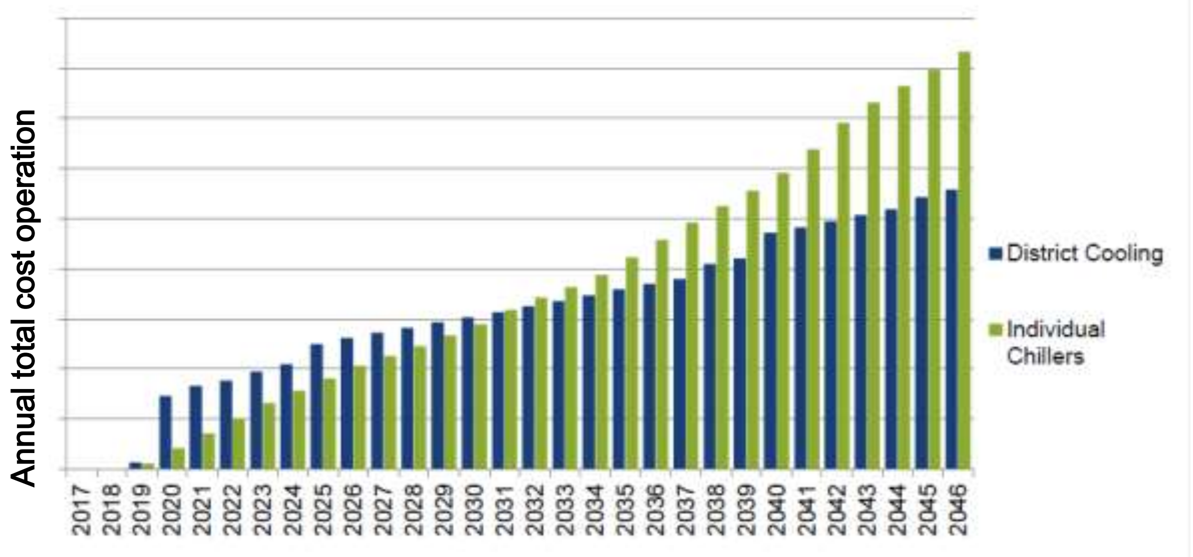


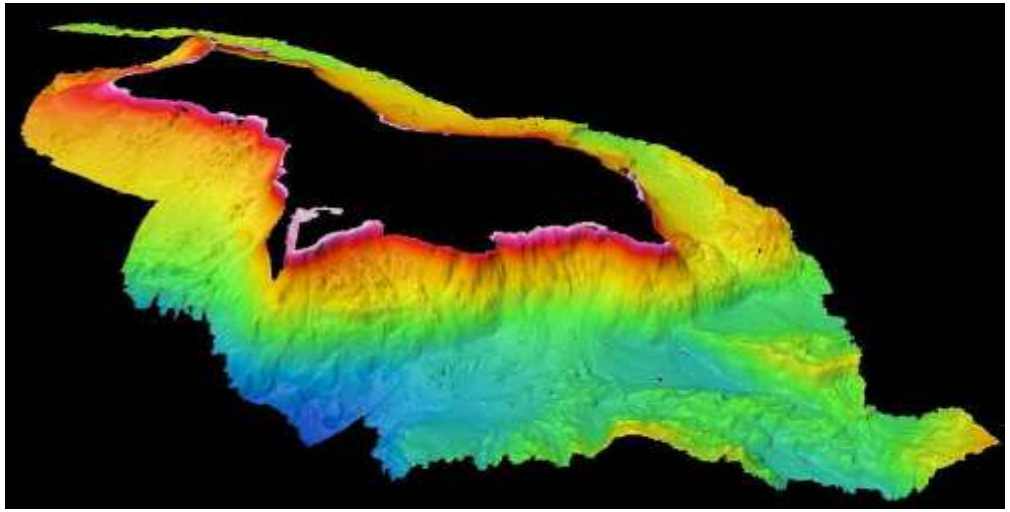




Strategies: District Cooling + SWAC

- District energy is key for reducing energy demand
- District Cooling
  - Centralized generation more efficient
  - Secondary maintenance benefits
- SWAC
  - Requires only approximately 20% of the electricity of conventional cooling (to power the pumps)
  - Numerous studies identified SWAC to be cost-effective at Guam



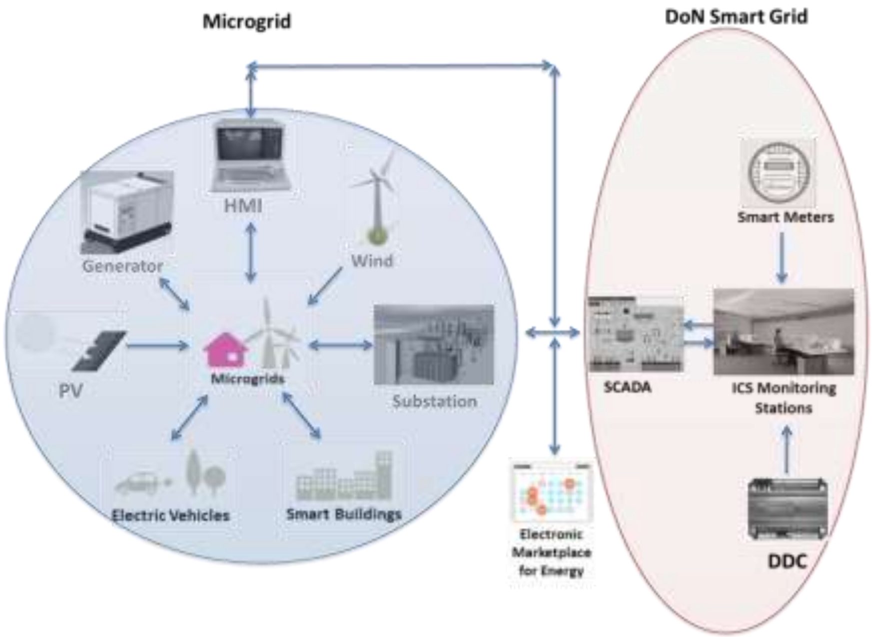


Strategies: Solar + Storage

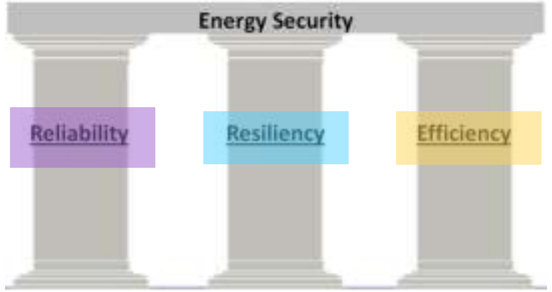
- Number of sites suitable for PV
  - Up to 45 MW of rooftop solar
  - Adjacent land of solar farms
  - Off-site government land with direct-connection opportunities
- Energy storage serves dual purpose
  - Load balancing to use PV energy
  - Demand management to reduce costs

Strategies: Microgrid

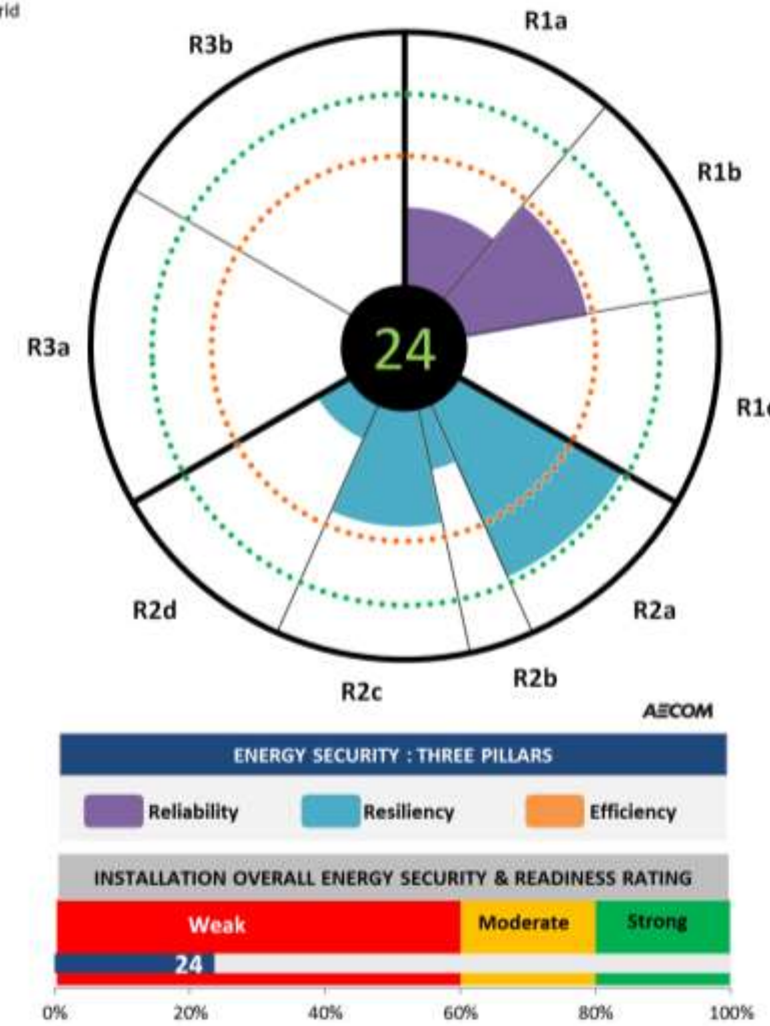
- Why Microgrids? …. Mission Assurance
- DoN has 2 overarching Shore Energy Goals:
  - Assure Energy Security for Critical Installation Operations
  - Maximize Availability of Renewable Energy
- Renewable energy systems require an energized electrical distribution to operate
- Microgrids allow renewable energy systems to support the mission during commercial power outages
- Microgrids deliver operational flexibility to sustain critical operations during extended outages



Methodology: Resilience Assessment

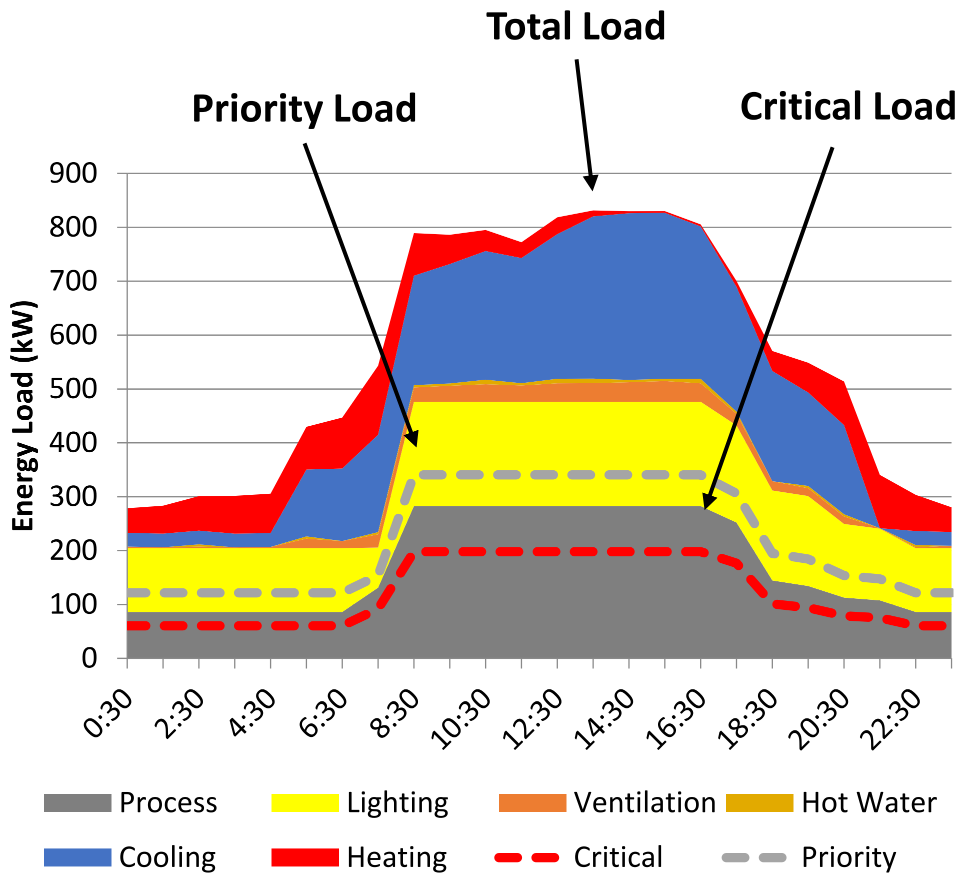


	Critical Mission Energy Demand Component % of total annual energy demand for installation	**30%** based on Microgrid Studies
R1	**Reliability** Reliability is concerned with the delivery of energy systems within acceptable regulatory standards and quality. It has 3 main metrics:	
R1a	**Grid Reliability** Reliability of energy distribution systems	33%
R1b	**Smart Grid Capability** Visibility and automation or operations	33%
R1c	**Advanced Peak Demand/Power Management Capability** Active load and power quality management	33%
R2	**Resiliency** Resiliency is defined as the ability of Energy Systems to anticipate, resist, absorb, respond, adapt, and recover from a disturbance. It has 4 main metrics:	
R2a	**Redundancy & Availability** Avoidance of Single Points of Failure (SPOF) in energy infrastructure and ensuring that there is adequate supply of energy in emergency situations.	30%
R2b	**Diversification** Capability of receiving energy through a variety of sources in order to ensure stability in supply and pricing.	10%
R2c	**Cyber Security & Hardening** Mitigating risk from cyber attacks; hardening infrastructure from physical damage.	30%
R2d	**Recovery & Operability in Emergency** Ability to restore operational capacity of critical facilities post an emergency that disrupts normal energy supply, and sustain operations in emergency mode.	30%
R3	**Efficiency** Efficiency contributes towards operational savings and reduction of loads that directly impact other resiliency and readiness aspects. It has 2 metrics:	
R3a	**Energy Efficiency** Reduction in energy use intensity	50%
R3b	**Energy Operational Savings** Lifecycle reduction in energy utility bills and maintenance operations	50%



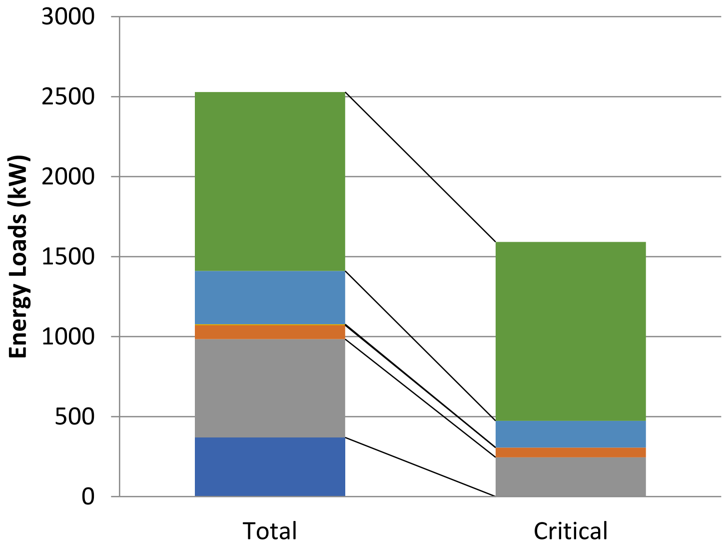
Methodology: Identifying Critical Loads

- Within these critical facilities, the use of energy varies significantly
- Need to consider:
  - Operational times
  - Scale of demand
  - Type of demand
    - Process loads
    - Lighting systems
    - Heating, cooling and ventilation
  - Quality of supply
  - Role under critical operation
  - Ability to load-shed
  - Changing functionality

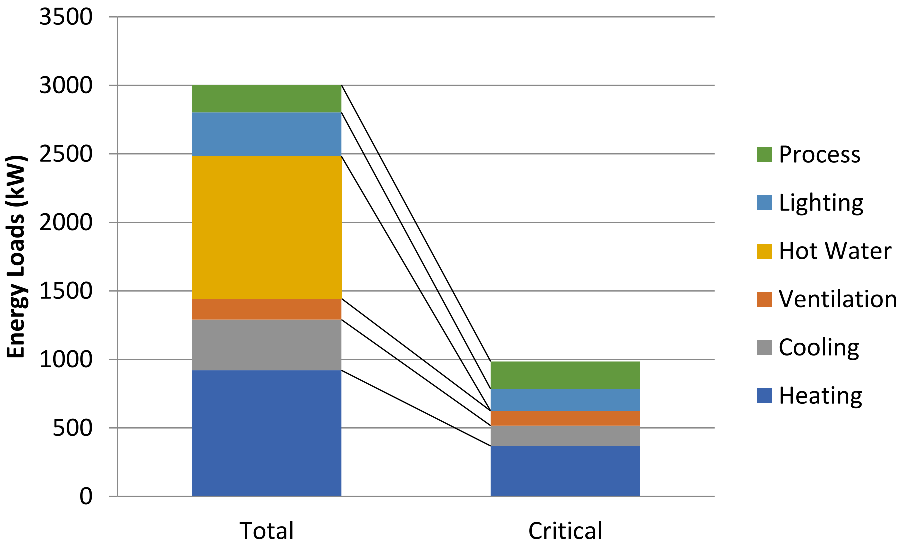


Methodology: Identifying Critical Loads

- A communications building has different demand than a training facility, armory, or airfield



Communications Facility



Recreational Facility

Methodology: Identifying Critical Loads

S1-4: Critical Load Profile

Critical Load

30% of the Annual Energy Demand

~350 MWh/day of Demand

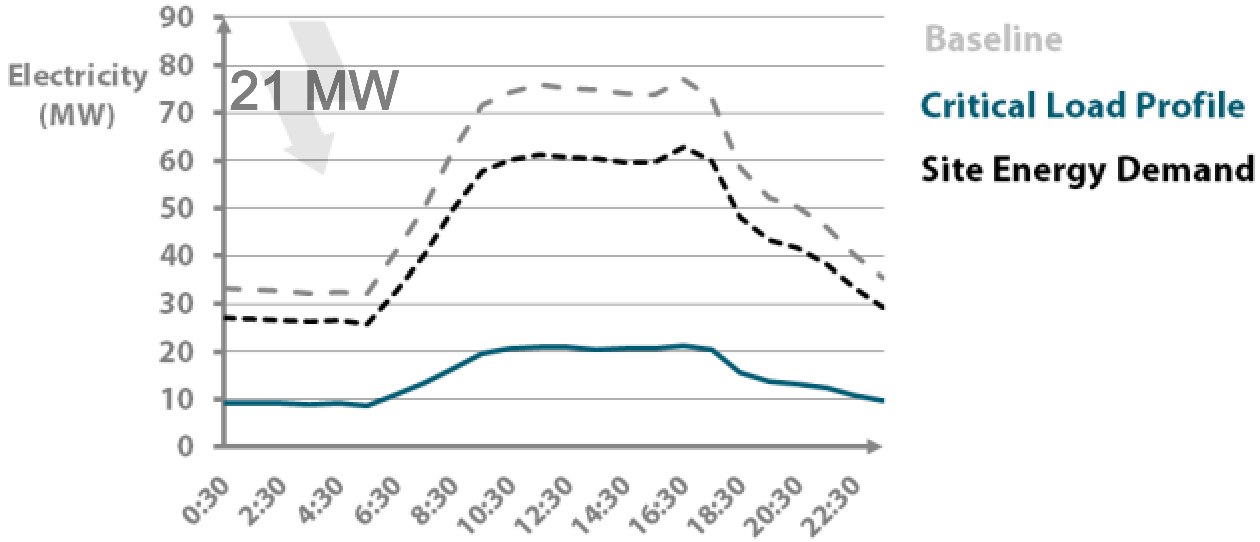
Storage can help meet this demand

System Capacity

25 MW Generators

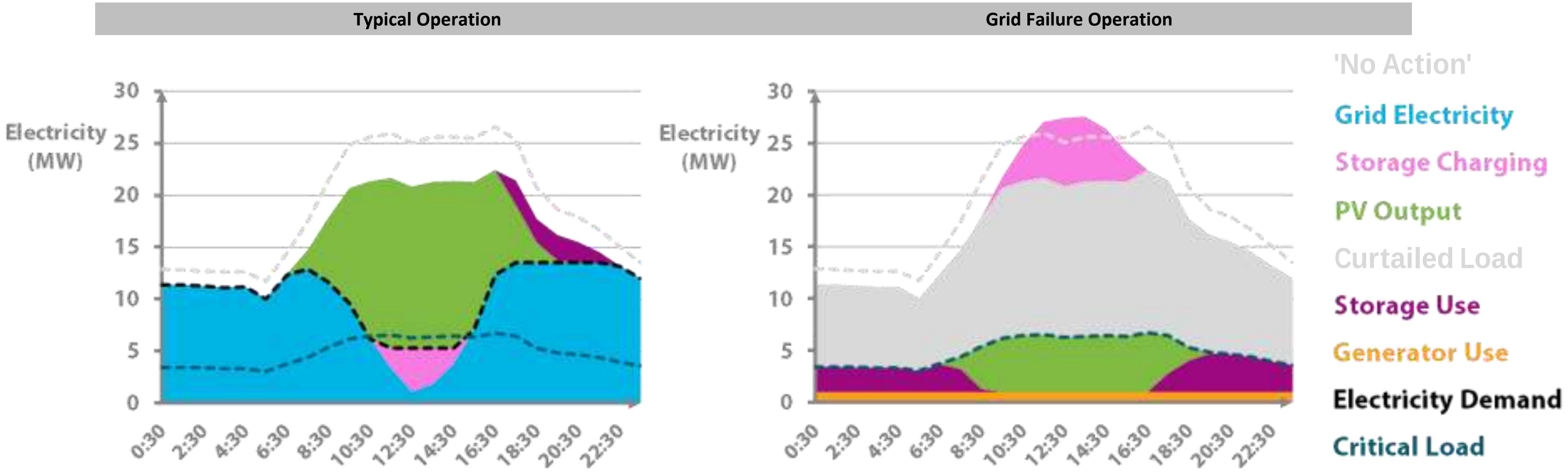
OR ~350 MWh of Battery Storage

Critical Load Profile



Methodology: Operational Configurations

- Design systems to maximize economic case
- Example is microgrid, solar and storage strategy at Guam



- Peak demand reductions allow system to pay for itself

Methodology: Operations

Storage: Peak Solar Day

Operation

Sized for critical supply resiliency

Peak Day Peak Output 80 MW

Solar with battery reduces peak demand by 50% under typical operation

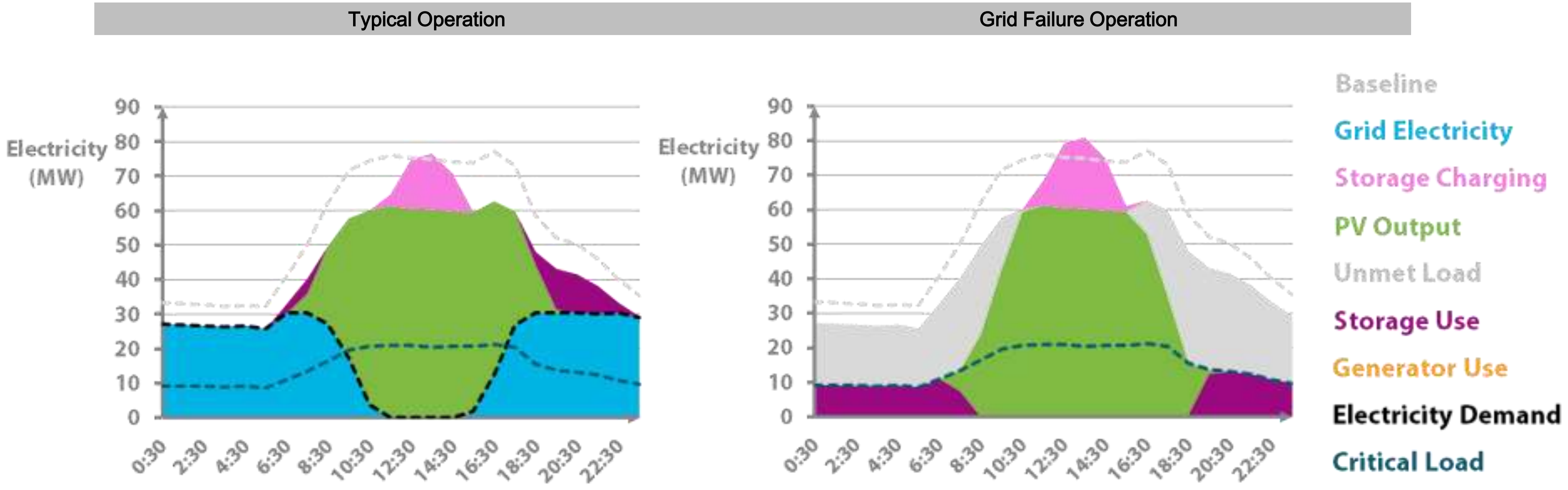
System Capacity

110 MW PV

220 MWh Battery Storage

50 MWh used for peak shaving

15 MW Generators (0% needed)



Methodology: Operations

Storage: Average Day

Operation

Average Day Peak Panel Output 58 MW

45 MW grid demand during the day

All solar serves critical load

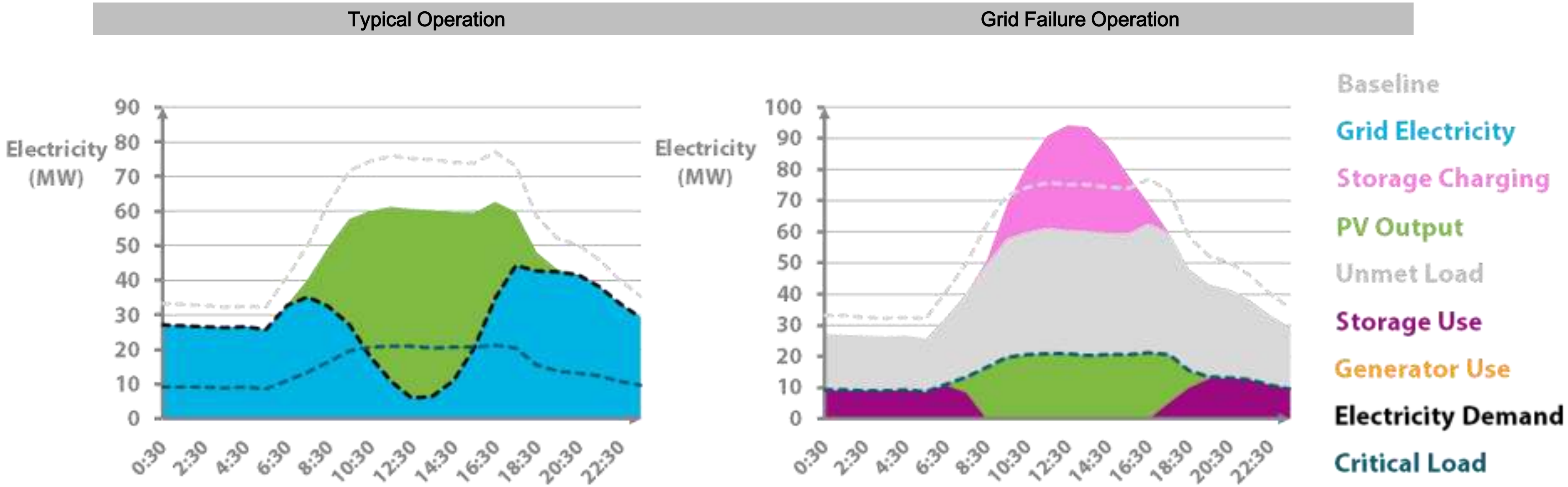
Does not require use of generators

System Capacity

110 MW PV

220 MWh Battery Storage

15 MW Generators (0% needed)



Methodology: Operations

Storage: Minimum Day

Operation

Minimum Day Peak Output 3 MW

4 MW grid demand during the day

All solar serves critical load

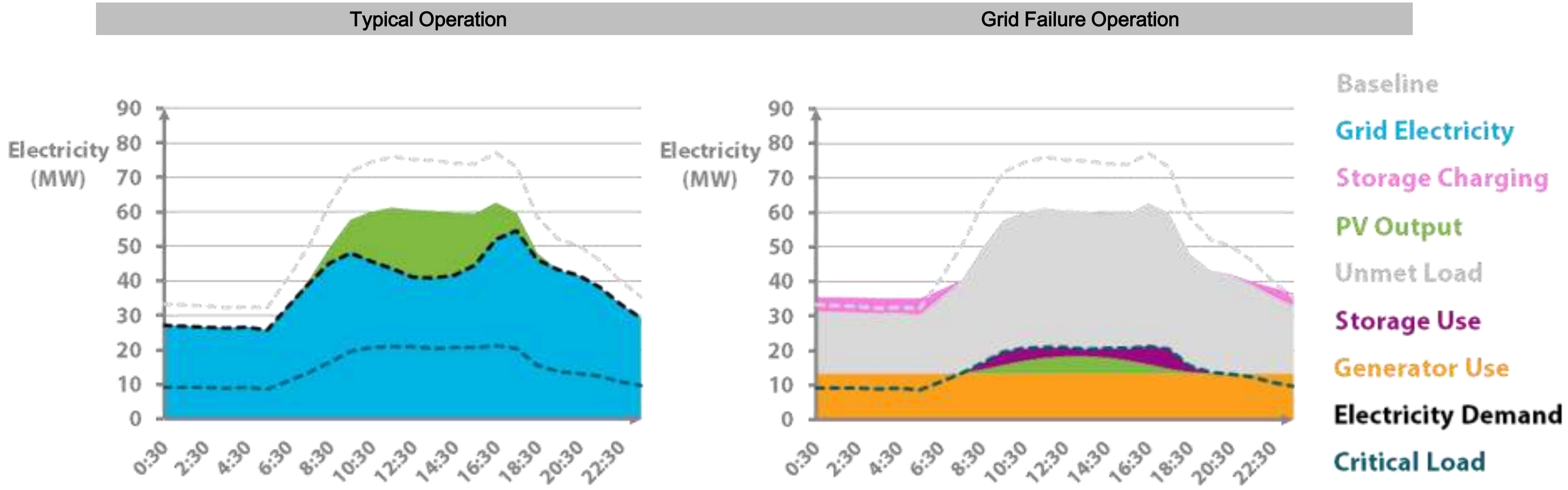
Requires additional generator operation

System Capacity

110 MW PV

220 MWh Battery Storage

3 MW Generators (50% needed)



Methodology: Operations

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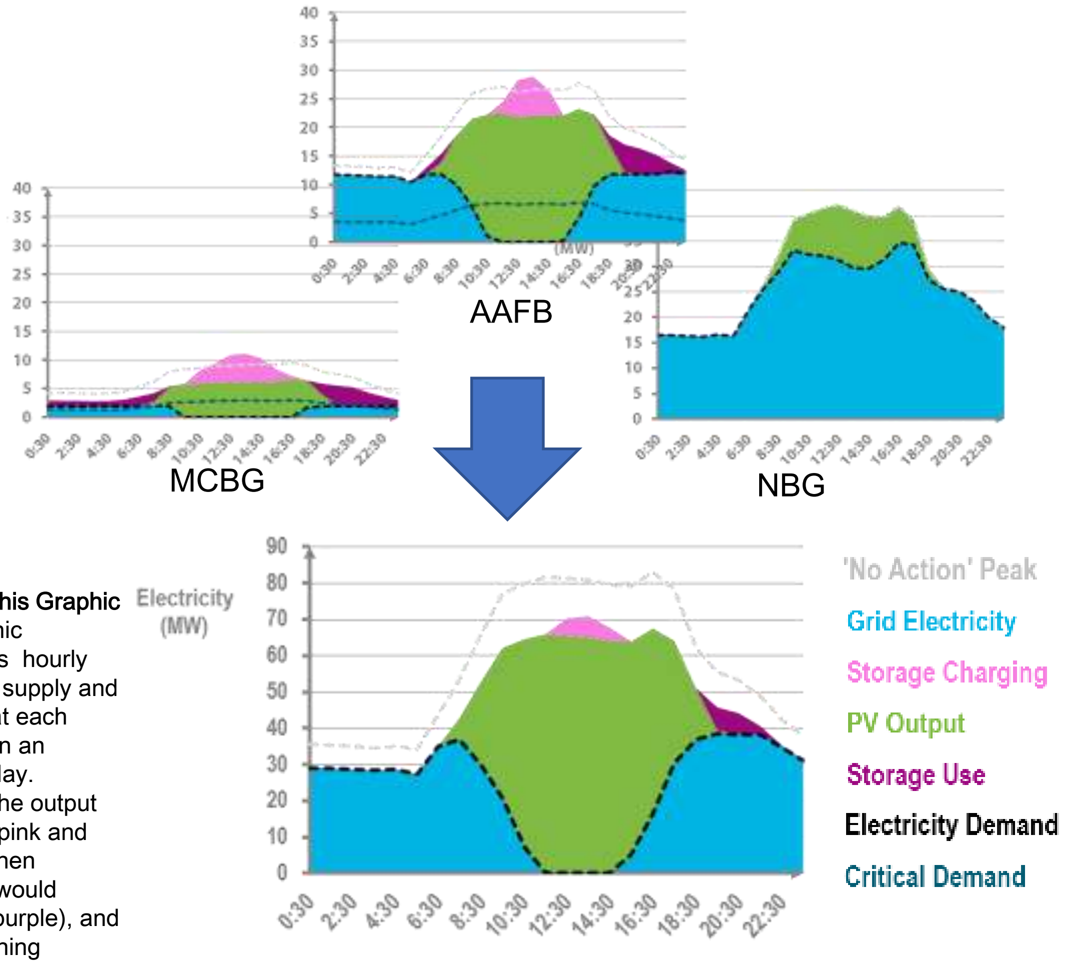
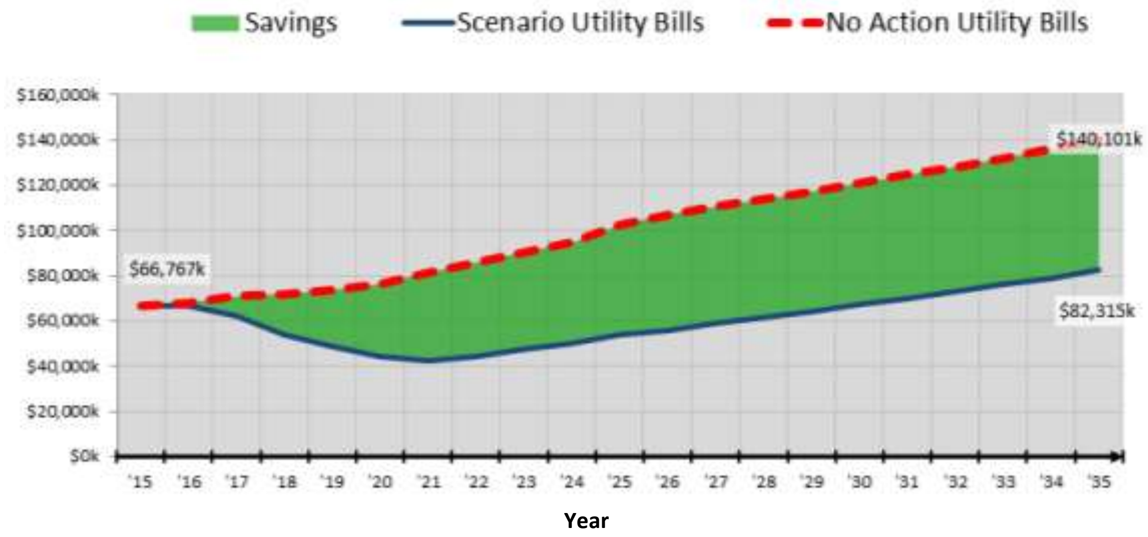
Reading this Graphic
The graphic represents hourly electricity supply and demand at each location on an average day.
It shows the output from PV (pink and green), when batteries would operate (purple), and the remaining demand from the grid.



Typical Day Operation of a Future JRM

By 2035,Under No Action, Utility Bills Increase by	$73,333k	110%
For Scenario, By 2035, Utility Bills will change by	-$57,786k	-41%
For Scenario, In 20 Years Projects will save	$844,203k	



* Model 3 PV (Rooftop and Ground Mounted) contributes to utility savings

Results: Resilience

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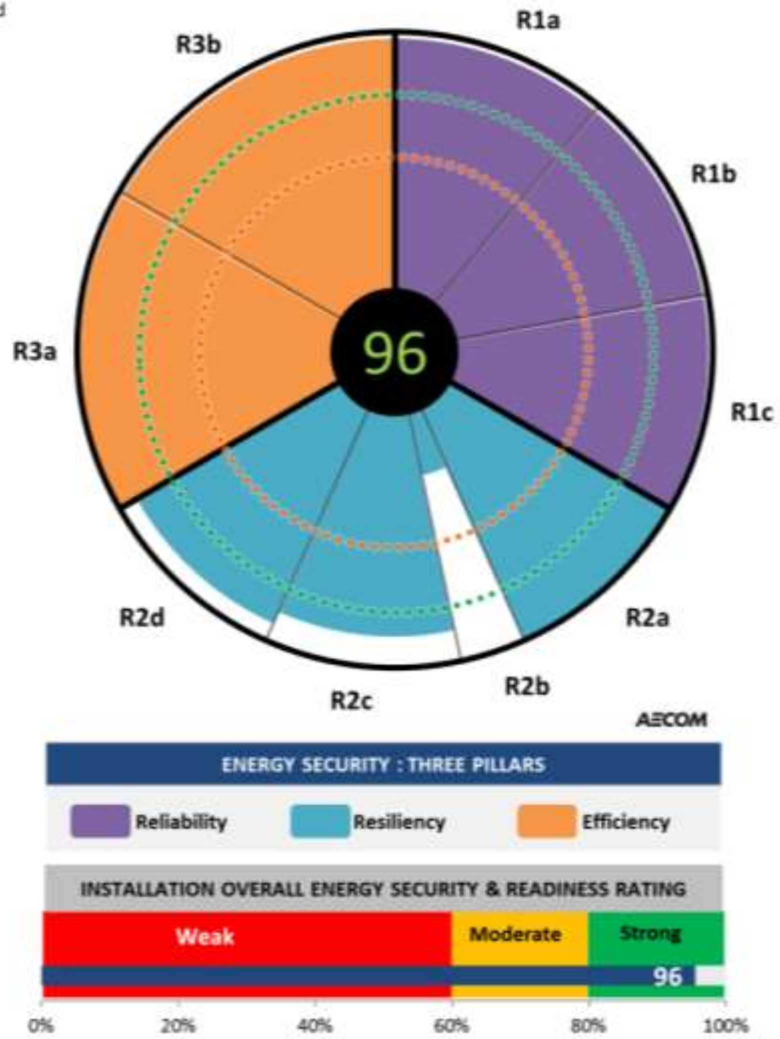
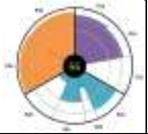
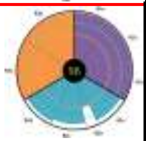
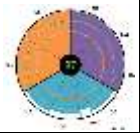


Results: Comparison

JRM Energy Scenarios		Energy Security and Readiness Scorecard				EO 13693 Mandates*			CNIC Goal*	SECNAV Goals*		Cost Metrics			
Scenario Number	Scenario Description	Reliability	Resiliency	Efficiency	Energy Security and Readiness Scorecard Snapshot[5]	Energy Intensity Reduction - 25% by 2025	Electric Renewable Energy - 30% by 2025	Renewables Mandate - 25% by 2025	Energy Consumption Reduction - 50% by 2020	Energy from Alternate Sources - 50% by 2020	Net-Zero (Utilizing Additional Sites[3]) - 100% by 2030	Cost ($M)[6]	By 2035 Projects Will Save ($M)	Cost $ / MBTU Saved	Positive Cash Flow
1	**Business as Usual + Government Planned Projects[1]**	**57**	**48**	**95**		48%	84%	84%	26%	35%	28%	$	$$	$$	**14 Years (2029)**
2	**Mandate Compliance[1]**	**60**	**52**	**96**		49%	100%	100%	26%	50%	44%	$	$$	$	**13 Years (2028)**
3	**Resilient with Net-Zero MCBG[1,2,3]**	**100**	**87**	**100**		62%	113%	113%	26%	54%	42%	$$	$$$	$$$	**17 Years (2032)**
4	**Resilient Plus[1,2,3,4]**	**100**	**90**	**100**		65%	138%	138%	26%	55%	66%	$$$	$$$	$$$$	**22 Years (2037)**

Notes:
Red Values indicate a Mandate or Goal is not being met.
Green Values indicate that a Mandate or Goal is being met or exceeded.
*Performance against mandates and goals is projected to target year and covers the full installation load.

0-59	Weak - needs improvement
60-79	Moderate - improved
80-100	Strong - approaching the intent of guidance
	The Recommended Energy Scenario

Considerations Elsewhere

Climate Impact

- Alaska
  - Heating systems are critical
  - District heating & local boilers?
- Guam
  - Cooling is critical
  - District cooling and local chillers?
- San Diego
  - Could lose cooling / heating and be comfortable
  - Passive building design?

Considerations Elsewhere

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Utility Grid Reliability / Power Quality

- Seattle
  - Very reliable grid
  - Reduced back-up power requirements?

- Guam
  - Unreliable, poor quality power supply (400 outages in last 5 years)
  - Increased need for on-site generation infrastructure

Summary

Q&A

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