Development Considerations for Distributed Generation and Microgrids

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Free Island Energy

AZIMUTH ENERGY

free island energy renewable energy & microgrids

galvin center for electricity innovation at ILLINOIS INSTITUTE OF TECHNOLOGY

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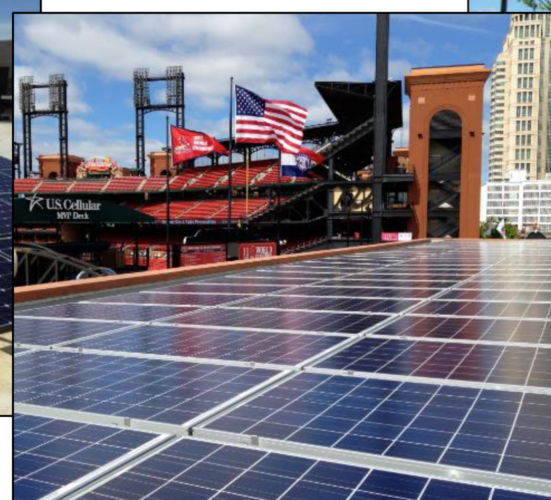
Agenda

- Market snapshot
- Development feasibility of RE & EE
- Phased approach to microgrid implementation



Azimuth Energy

- Solar Energy Development & Installation
- Microgrid Engineering & Construction
- Energy & Efficiency Services
- Project goals: Safety, Performance, Aesthetics

Renewables development 600+ projects, over 120 MW

US, Caribbean, Africa/Indian Ocean markets

LEED & Energy Star projects from 10,000 sf to 9,000,000 sq.ft.

30+ million kWh/year in energy reduction

NABCEP CERTIFIED
PV Installation Professional

Energy Star Partner

LEED AP BD+C

LEED AP O+M

What is a Microgrid?

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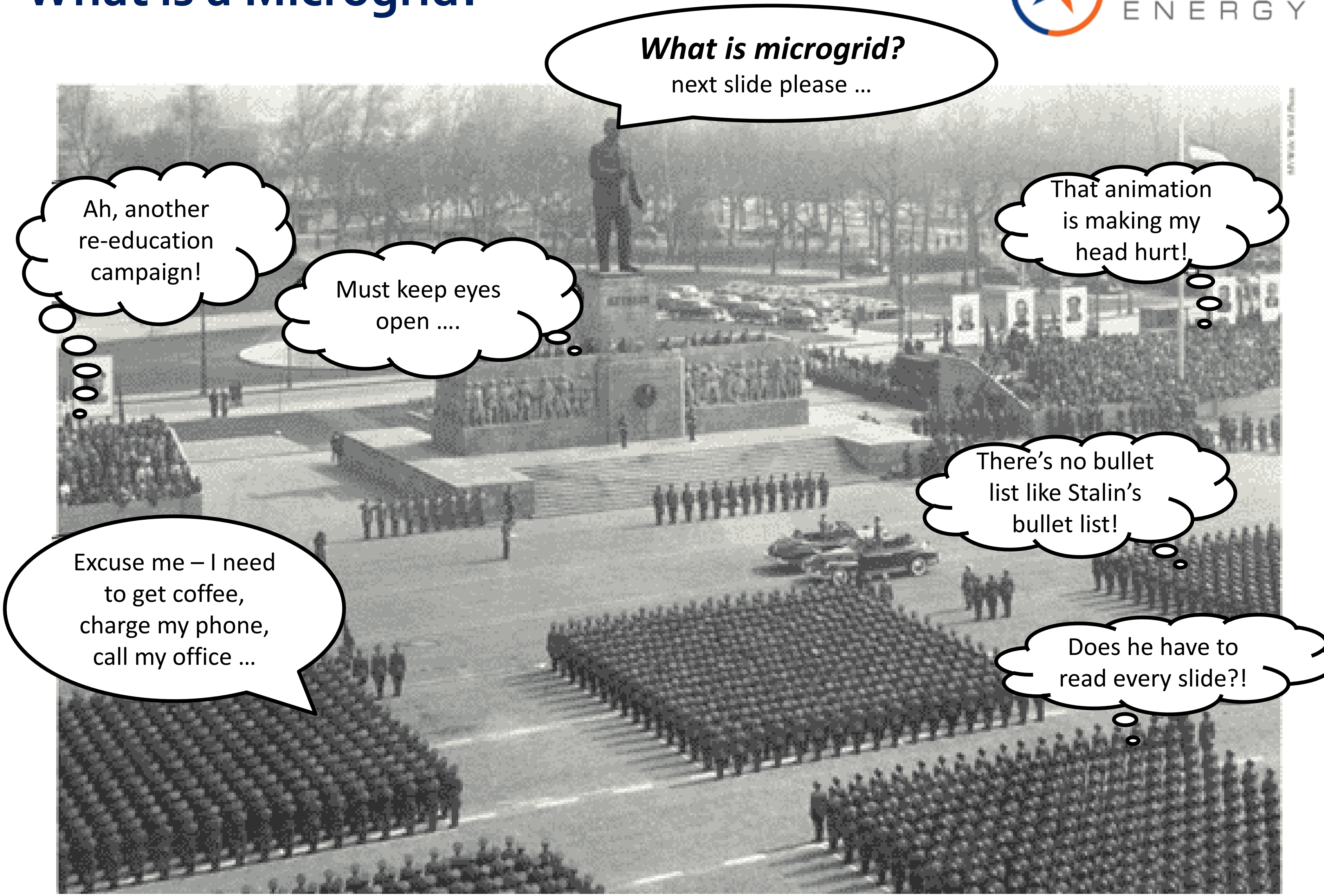
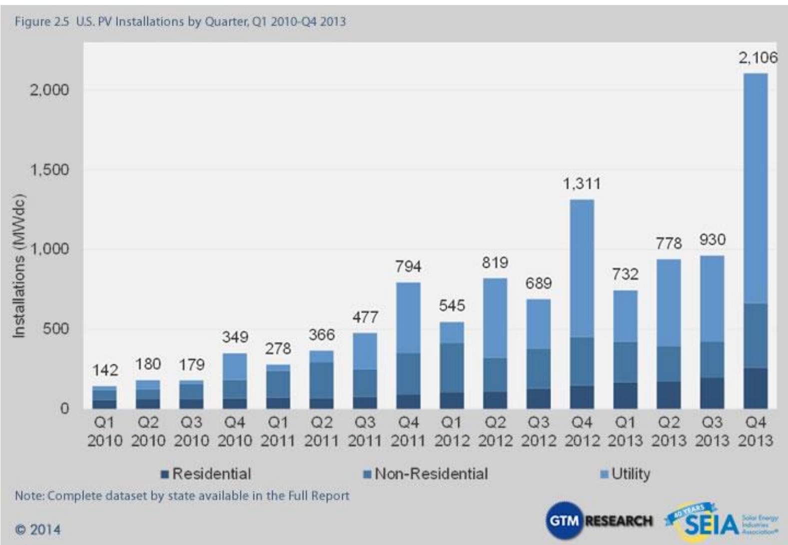
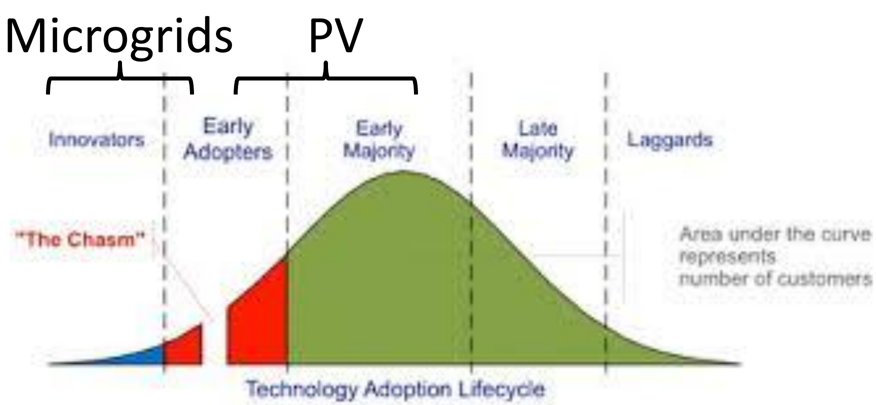


Drivers of Solar & Microgrid Markets

Growth of conventional PV systems

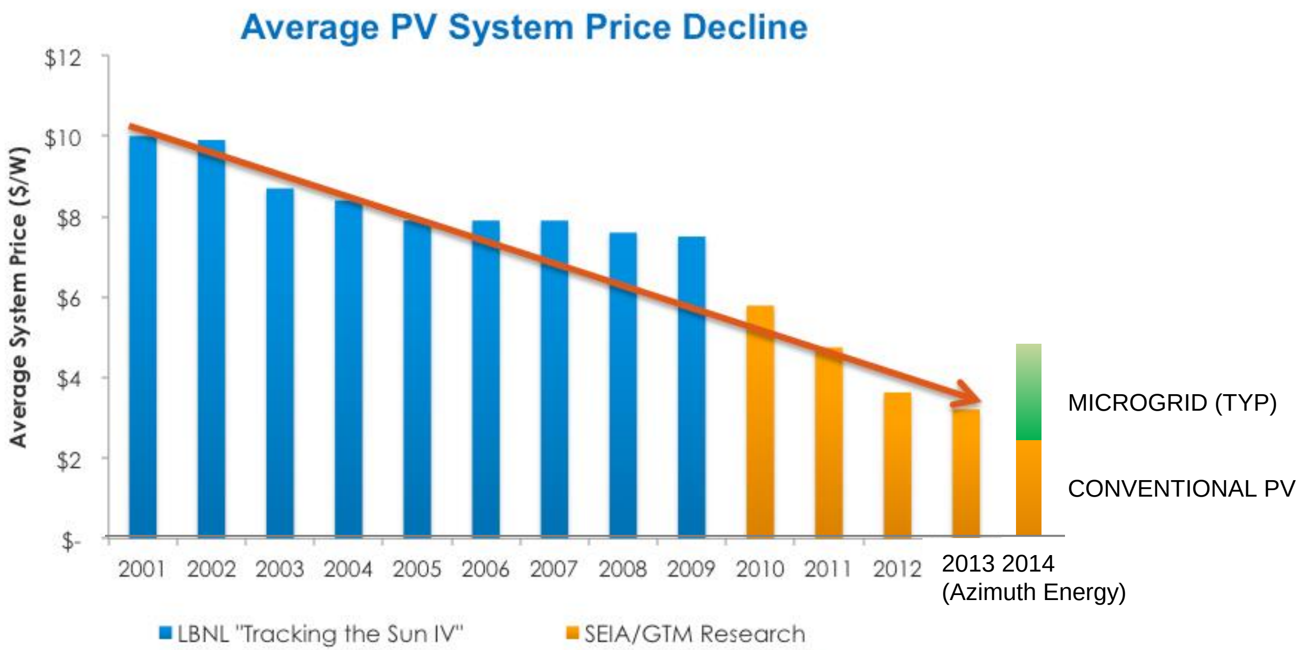


Growth of microgrids



Drivers of Solar & Microgrid Markets

- Installed cost reduction of PV systems
  - Labor cost, equipment cost, soft cost



Drivers of Solar & Microgrid Markets

- Installed cost reduction of PV systems
- Technological advances – performance, capabilities, benefits and cost
  - Chemical Storage: Lead Acid to Li-Ion, Aqueous Ion, Flow
  - Potential Storage: Capacitors, Compressed Gas, Flywheels
  - Microgrid Controllers & Inverters
  - Attraction of investors and major manufacturers

Drivers of Solar & Microgrid Markets

- Installed cost reduction of PV systems
- Technological advances – performance, capabilities, benefits and cost
- Third-party financing
  - Power Purchase Agreements (PPAs)
  - Operating Leases
  - Diesel Reduction Agreements (DRAs)
  - Key is full utilization “take-or-pay” provisions

Drivers of Solar & Microgrid Markets

- Installed cost reduction of PV systems
- Technological advances – performance, capabilities, benefits and cost
- Third-party financing
- Streamlined permitting, utility acceptance, policy & incentives
  - Steps: interconnect > backfeed the grid > net billing > net metering > FiT
  - Chicago Self-Certification, Easy PV Permit, and E-Plan
  - Rebates and credits: www.dsireusa.org
  - Value Trading Proposition

Drivers of Solar & Microgrid Markets

- Installed cost reduction of PV systems
- Technological advances – performance, capabilities, benefits and cost
- Third-party financing
- Streamlined permitting, utility acceptance, policy & incentives
- Marketing & cultural demand
  - Environmental stewardship
  - Attracting and retaining talent
  - Supply-chain pressure

Drivers of Solar & Microgrid Markets

- Installed cost reduction of PV systems
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- Marketing & cultural demand
- Risk management

Drivers of Solar & Microgrid Markets

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Google | china solar panels trade dispute

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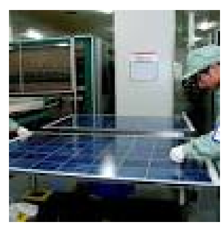


Oman Daily Obs...

US Imposes Steep Tariffs on Importers of **Chinese Solar P**...
New York Times - Jun 3, 2014
U.S. Imposes Steep Tariffs on Importers of **Chinese Solar Panels** ... **New** duties will range from 18.56 to 35.21 percent. ... The decision, in a long-simmering **trade dispute**, addresses one of the main charges in a ... out of **time**," Rhone Resch, chief executive of the **Solar Energy** Industries Association, the main ...

US to levy fresh tariffs of up to 35% on **Chinese solar panels**

Dual-Purpose Solar

Development Feasibility of Renewable Energy and Energy Efficiency (EERE)

Identify Resources / Sources

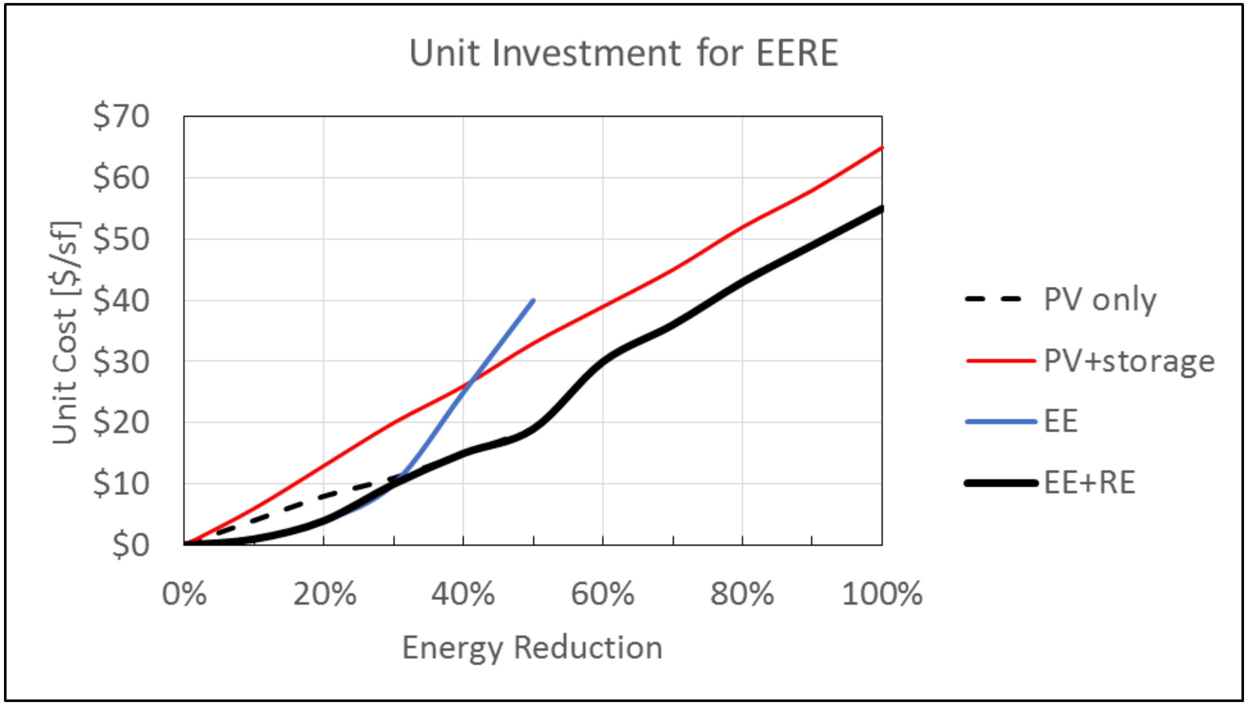
- ✓ Solar (PV and/or ST)
- ✓ Wind
- ✓ Tidal
- ✓ Wave
- ✓ Run of river
- ✓ OTEC
- ✓ Geothermal
- ✓ Pumped storage
- ✓ Ground source heat pumping
- ✓ Fuel cells (fuel source)

Characteristics

- ✓ First Capital Cost
- ✓ O&M
- ✓ Reliability
- ✓ Survivability
- ✓ Base load
- ✓ Dispatchable
- ✓ Visual impact
- ✓ Sound/noise
- ✓ Technical support
- ✓ Environmental impact

Development Feasibility of Renewable Energy and Energy Efficiency

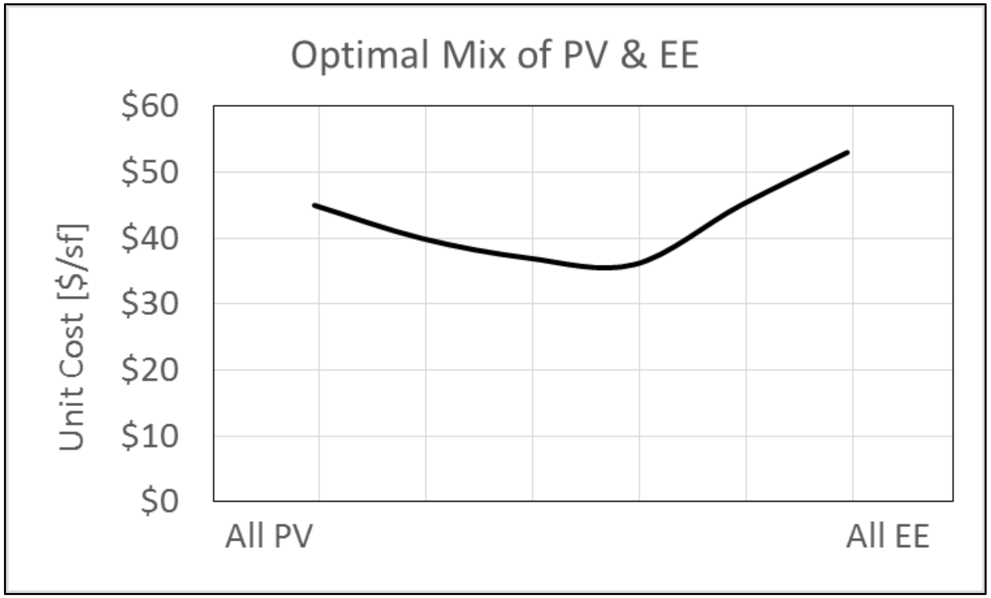
- LCOE from Renewable Energy ~ $0.15 to $0.25/kWh
- Energy Efficiency – highest returns < 50% reduction



Development Feasibility of Renewable Energy and Energy Efficiency

Best mix based on:

- Cost of power and energy, EE & RE options available
- How much storage (hours/days of autonomy)
- Construction cost
- Sunlight
- System design



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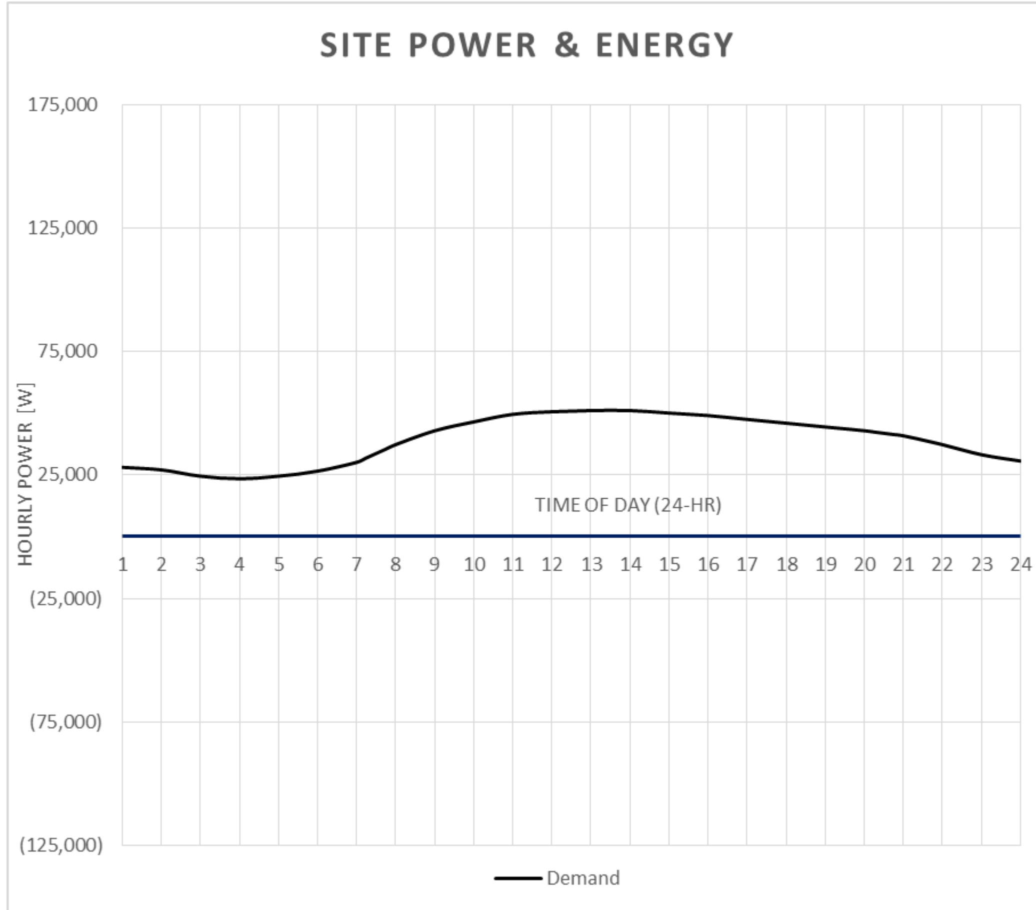
Phased Approach to Microgrid Implementation

Unknowns:

- How much EE reduction possible
  - Equipment tuning
  - Operational changes
  - Low-cost measures
  - Capital upgrades
- Construction risk (and cost)
- How much RE investment
  - What will EE provide?



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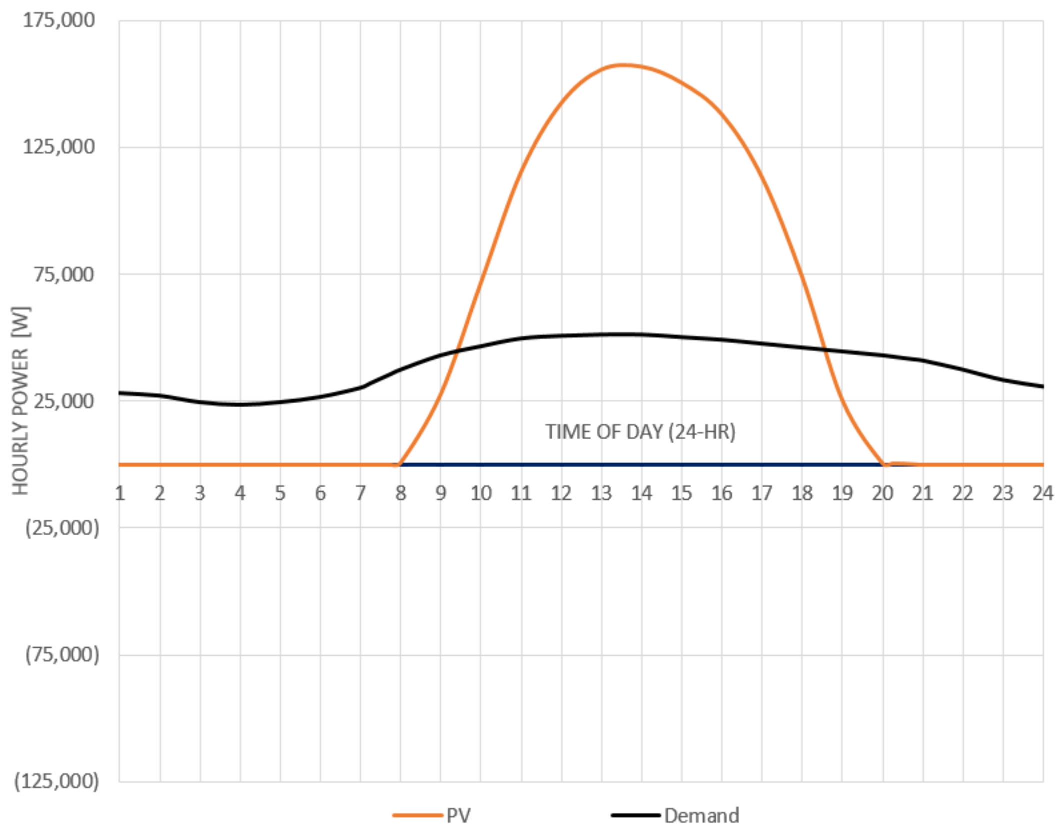
Phased Approach to Microgrid Implementation

100% offset PV array

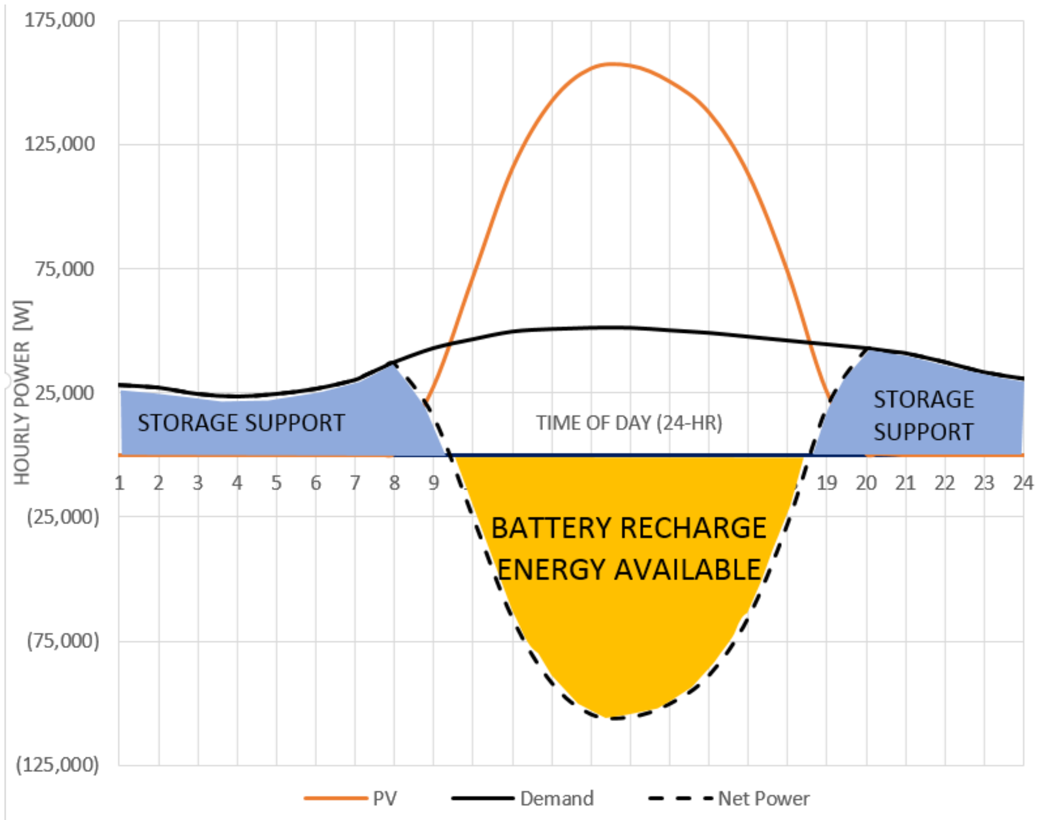
- Area under the curve
- More power than useable
- No sun, no energy



Phased Approach to Microgrid Implementation

100% offset PV array with storage

- Area under curves still the same
- Storage required, but how much?
- Wasted investment possible



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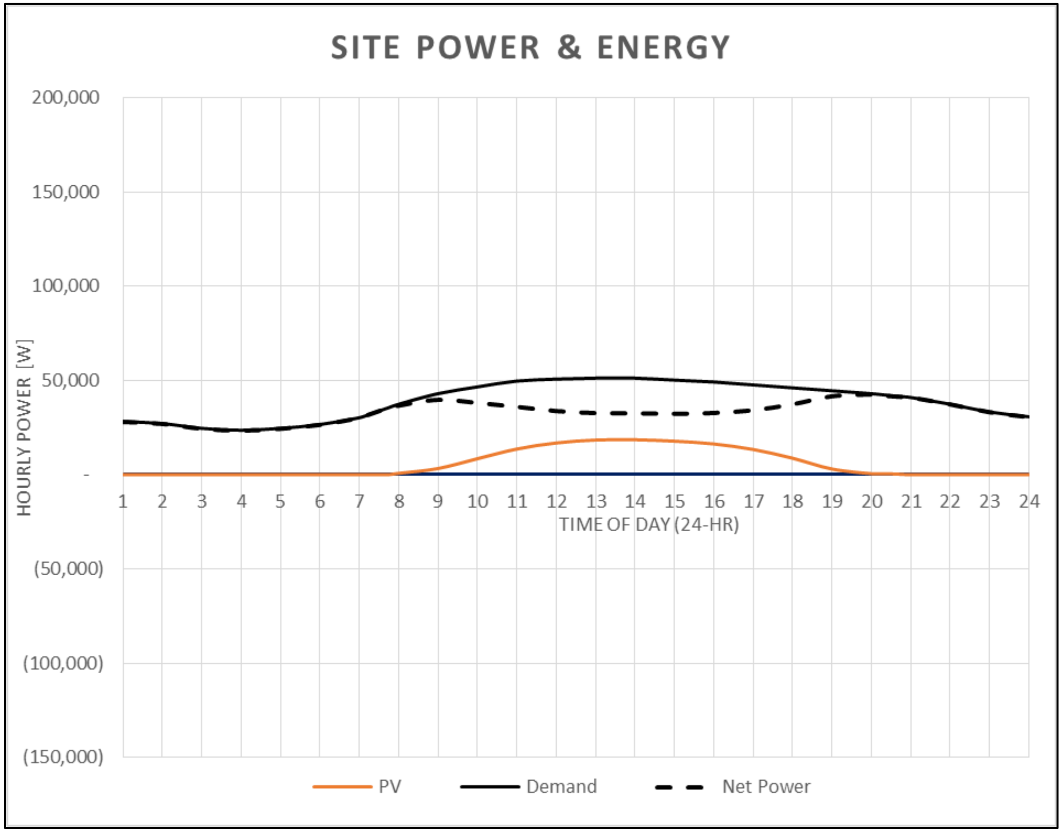
Phased Approach to Microgrid Implementation

PHASE 1: Max PV deployment without batteries or storage

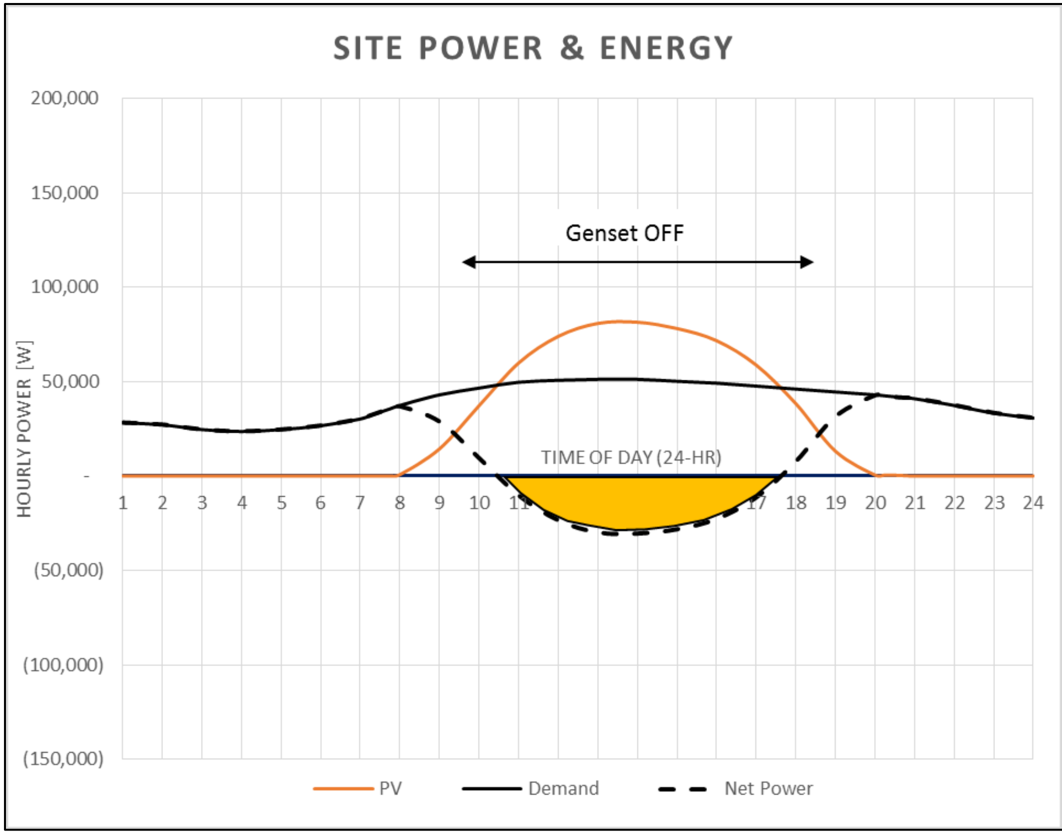
- Genset always on, fuel reduction
- Frequency & voltage stability
- Build out of key distribution
- Proof of concept
- Team vetting

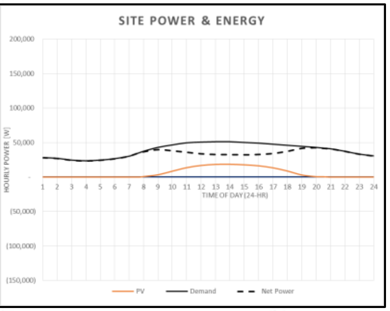


Phased Approach to Microgrid Implementation

PHASE 2: More PV, small battery plant

- Shoulder load on batteries
- Genset off period
- Size based on step functions
- Significant reduction in fuel usage

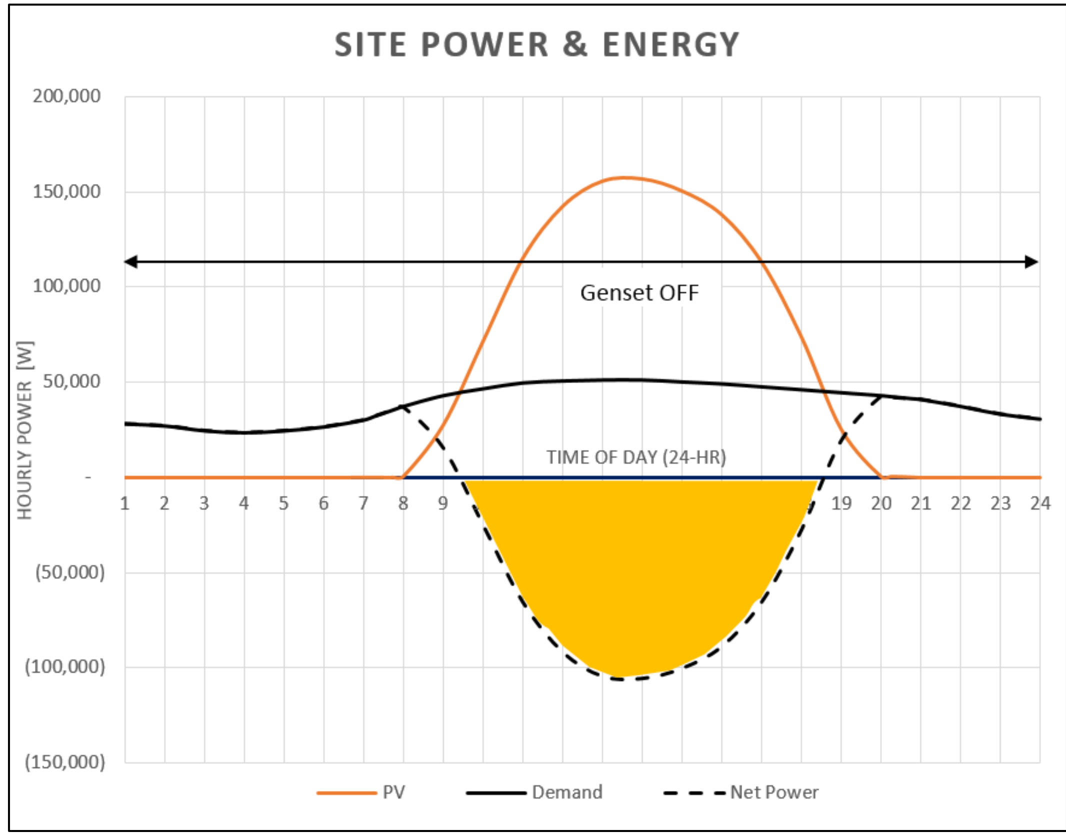


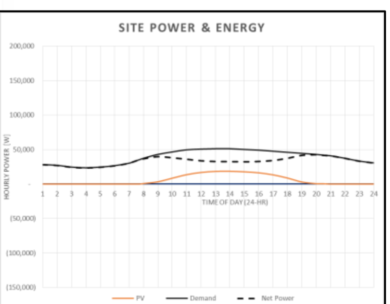


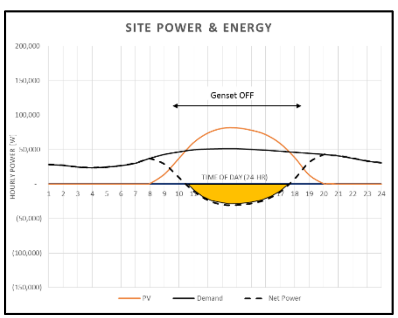
Phased Approach to Microgrid Implementation

PHASE 3: Total storage autonomy

- Elimination of fossil fuels for normal operations
- Lowest OpEx
- Lowest provisioning cost and risk
  - Removal of unknowns during earlier phases
  - Opportunity to employ efficiency during phasing
  - Better understanding of loads and needs







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