BARBARICUM

Expeditionary Hybrid Power System Sizing and Analysis Tool

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WHAT WE DO

- **Downrange Support**
- **Assessment & Evaluation**
- Communications Planning
- Data Analytics & Visualization
- Management
- Information Operations
- Interactive Web
- Marketing Communications
- Exercise Planning
- Media Monitoring
- **Modeling/Simulation**
- **Operational and Education/Training**
- **Operational Energy**
- Program/Curriculum Development
- OSINT for Irregular Warfare
- Technical Training
- Position & Concepts Papers
- Website Design, Development and Optimization
- Digital Engagement

Background

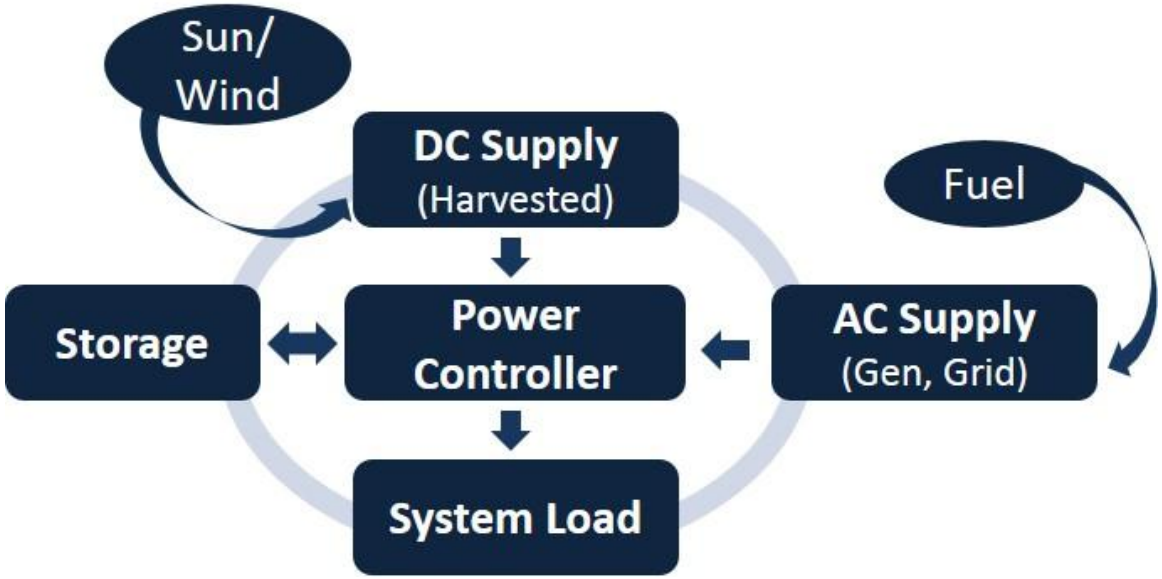
- Operational Energy Advisors/Trainers (REF/E2E)
- Barbaricum deployed over 200 systems 2011-2015
  - Middle East, Africa

Background

- Modular hybrid systems
- Systems configured on-site
- Extensive data was collected

Define

- Hybrid Power System:
  - Combination of energy sources
  - Generator operation only when needed
  - Generator provides “Power surety”



Problem

- Hybrid systems relatively new technology
  - What can it power?
  - How much benefit comes from PV?

Challenge

- Hybrid power systems have a large design space
  - More solar input = less fuel consumption
  - More energy storage = higher energy capture potential
- Is there a sweet spot?
  - Fuel minimization?
  - Cost minimization?
  - Cube, weight and/or foot print minimization?
- How to perform tradeoffs in a tactical environment

An expeditionary hybrid sizing tool is needed

Hybrid Tool Development

- Objectives
  - Visually based
  - Learning Tool
    - Enables end user
  - Low complexity
    - Minimal training required
  - Value added
  - Highly mobile
  - Tailored for 3kW – 10kW Hybrid Systems

Promote adoption of hybrid systems

Assumptions

- Law of averages
- All available solar (PV) energy is harvested
- Platform loads are sufficiently random
- Standard component efficiencies
- AC pass through power

Hybrid Tool Inputs/Outputs

System Inputs

Parameter	Value	Notes
Gen_W=	3000	3000, 5000 or 10000
AC_Charger_W=	2500	AC charger(s) output power (W)
Batt_Type (Li=0, LA=1)=	0	Impacts round trip efficiency and charging stages
Daily Irradiance=	5	Varies by season and location

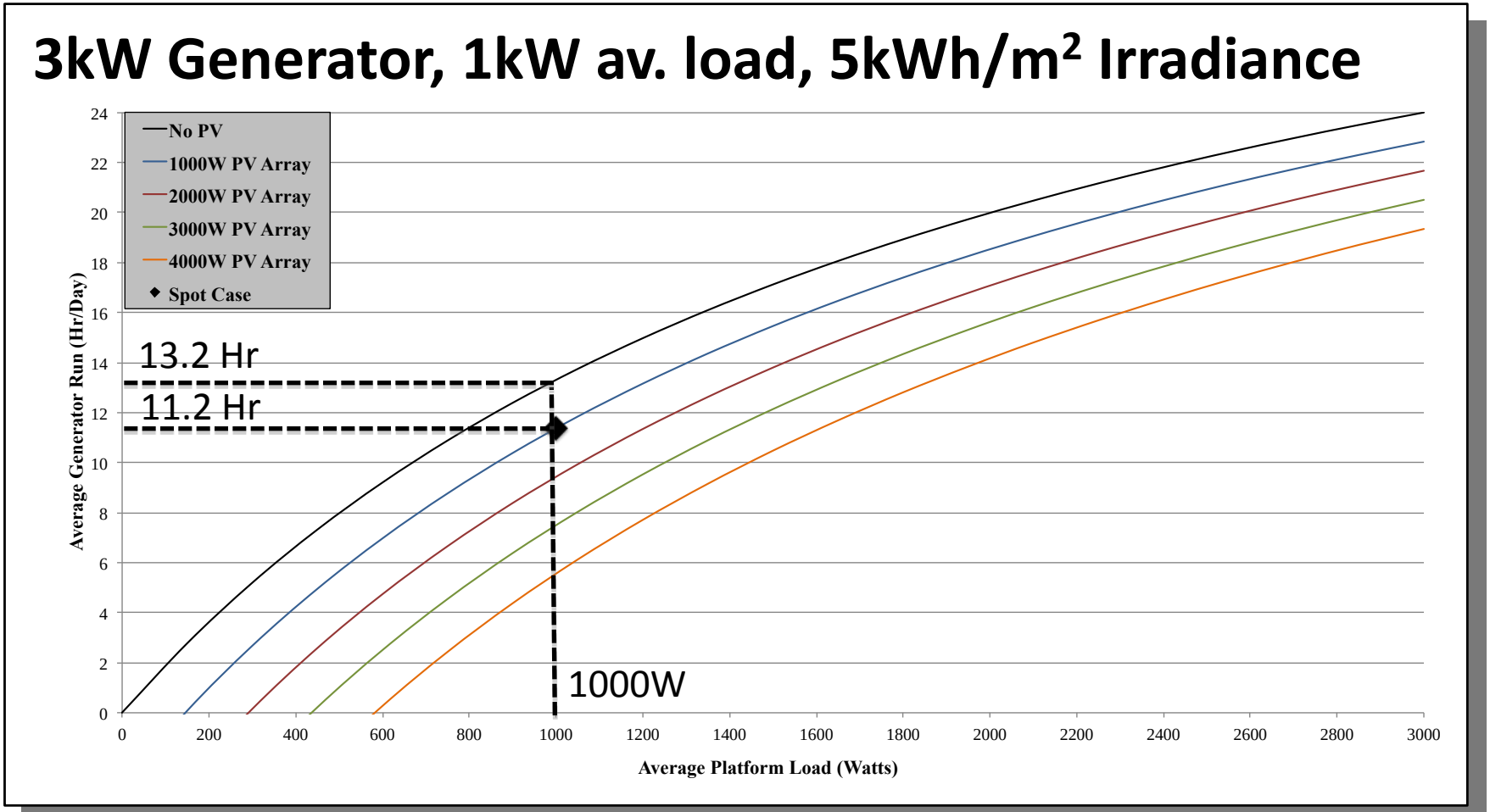
Spot Case Inputs

Parameter	Value
Ave_Platform_Load(W)=	1000
Array_Size(W)=	1000
Slient_Watch_Hours=	10

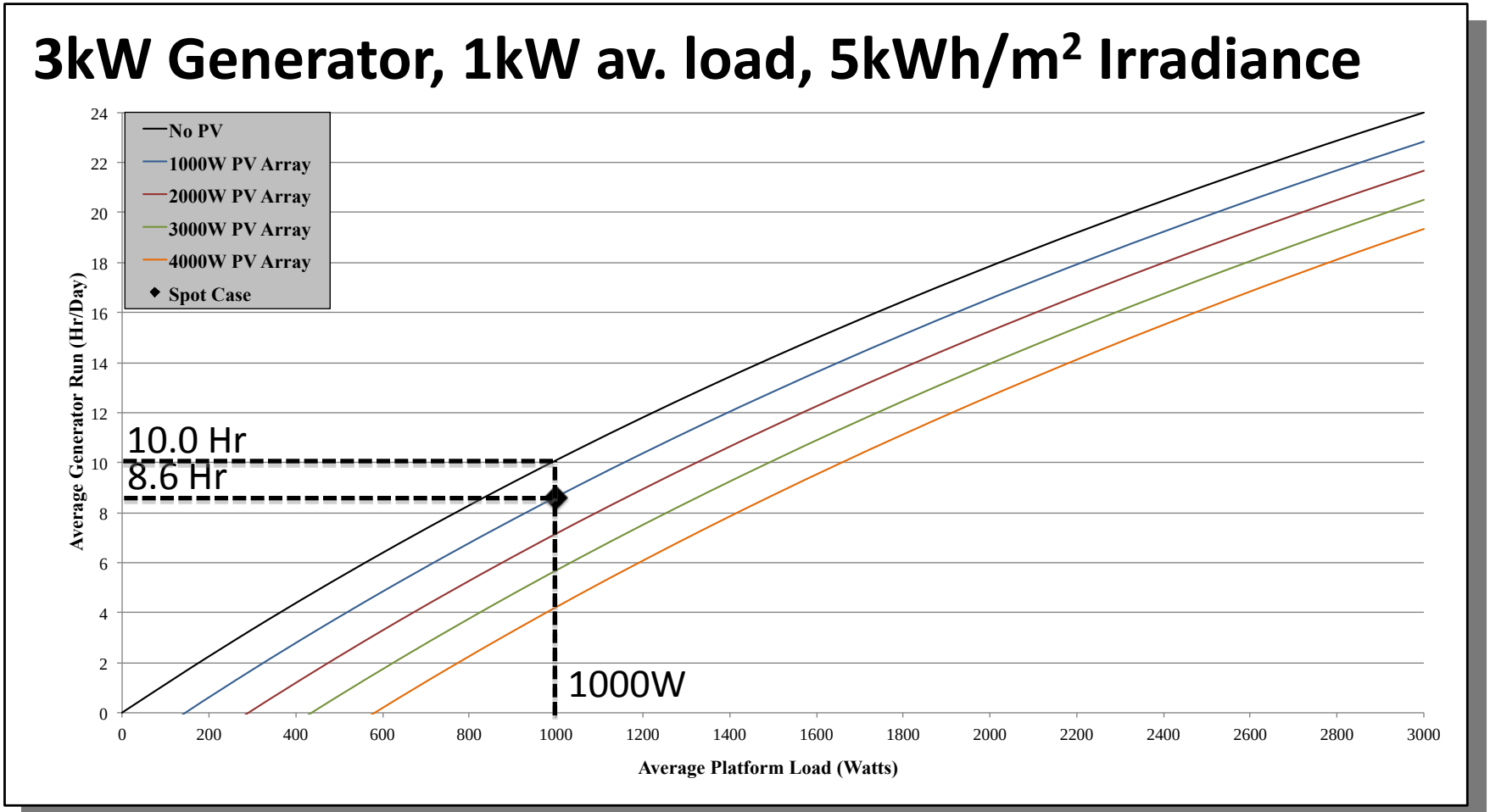
Spot Case Outputs

Parameter	Value	Parameter	Value
Gen Hours/Day=	8.63	Gen Only Fuel/Day=	5.77
Gen Output (kW)=	3.00	Fuel Savings/Day=	2.91
Gal of Fuel/Hour=	0.33	% Fuel Reduction=	50
Gal of Fuel/Day=	2.86	Min. Rec. ESM kWh=	13.9

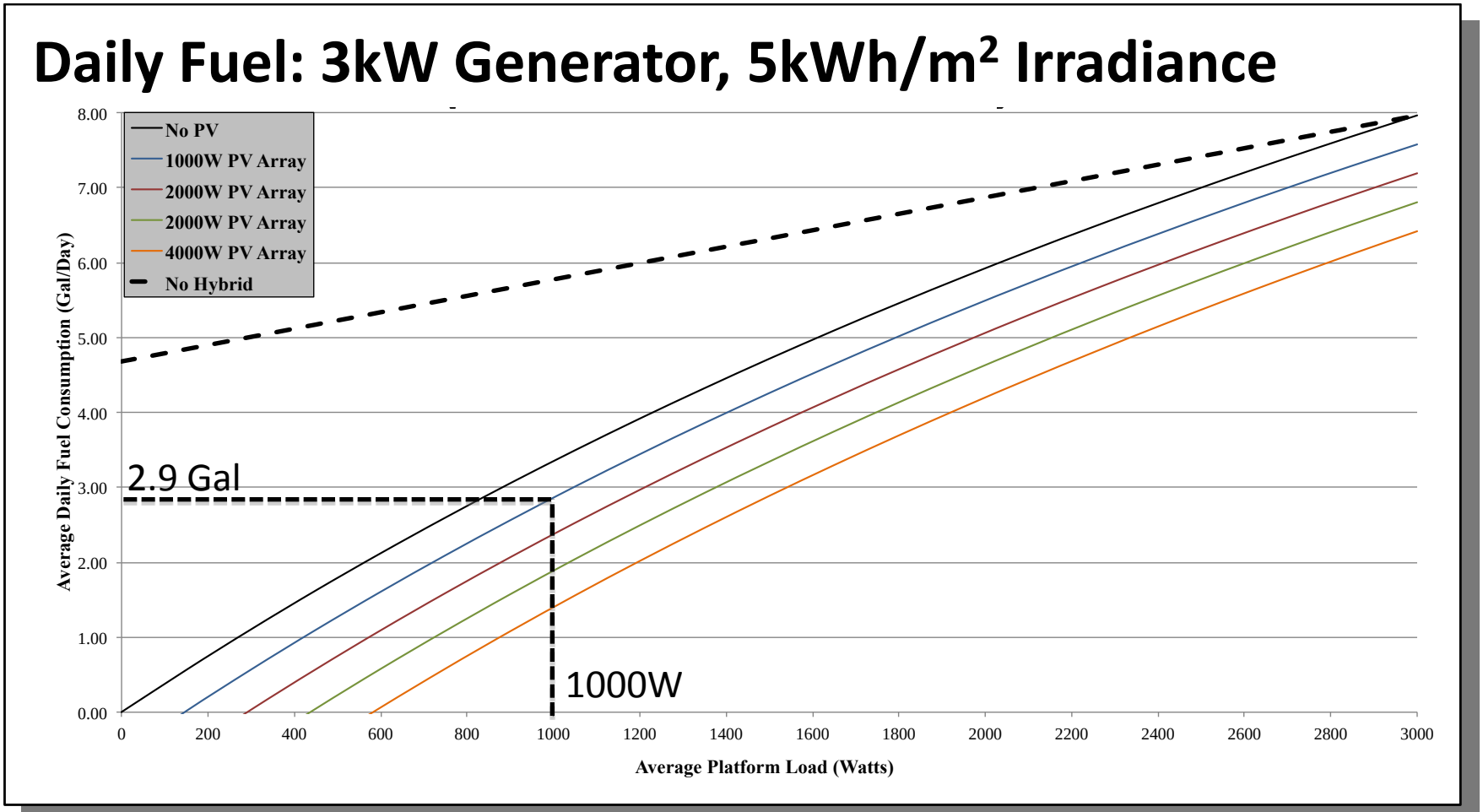
Example Hybrid System Gen Run(LA)



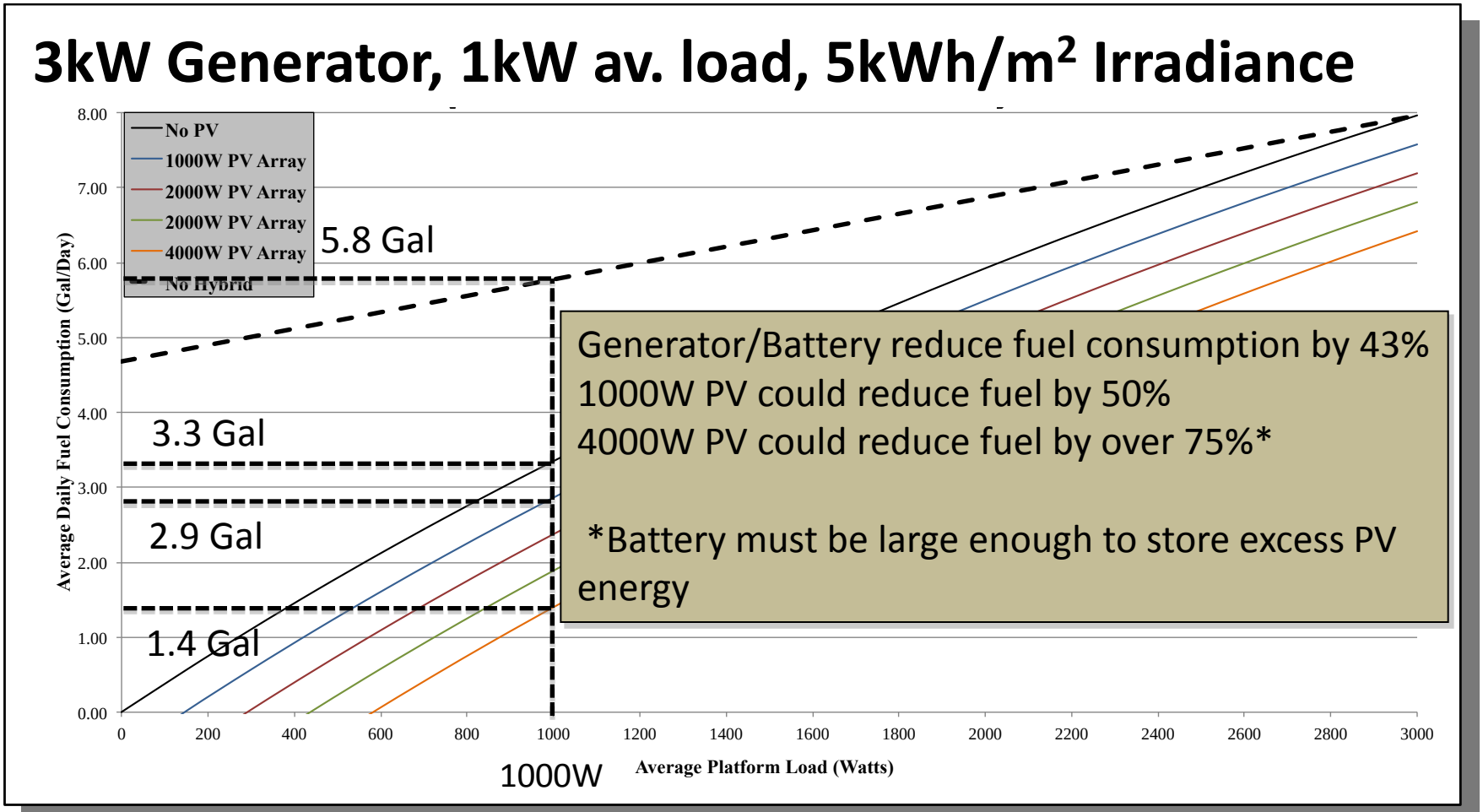
Example Hybrid System Gen Run (Li)



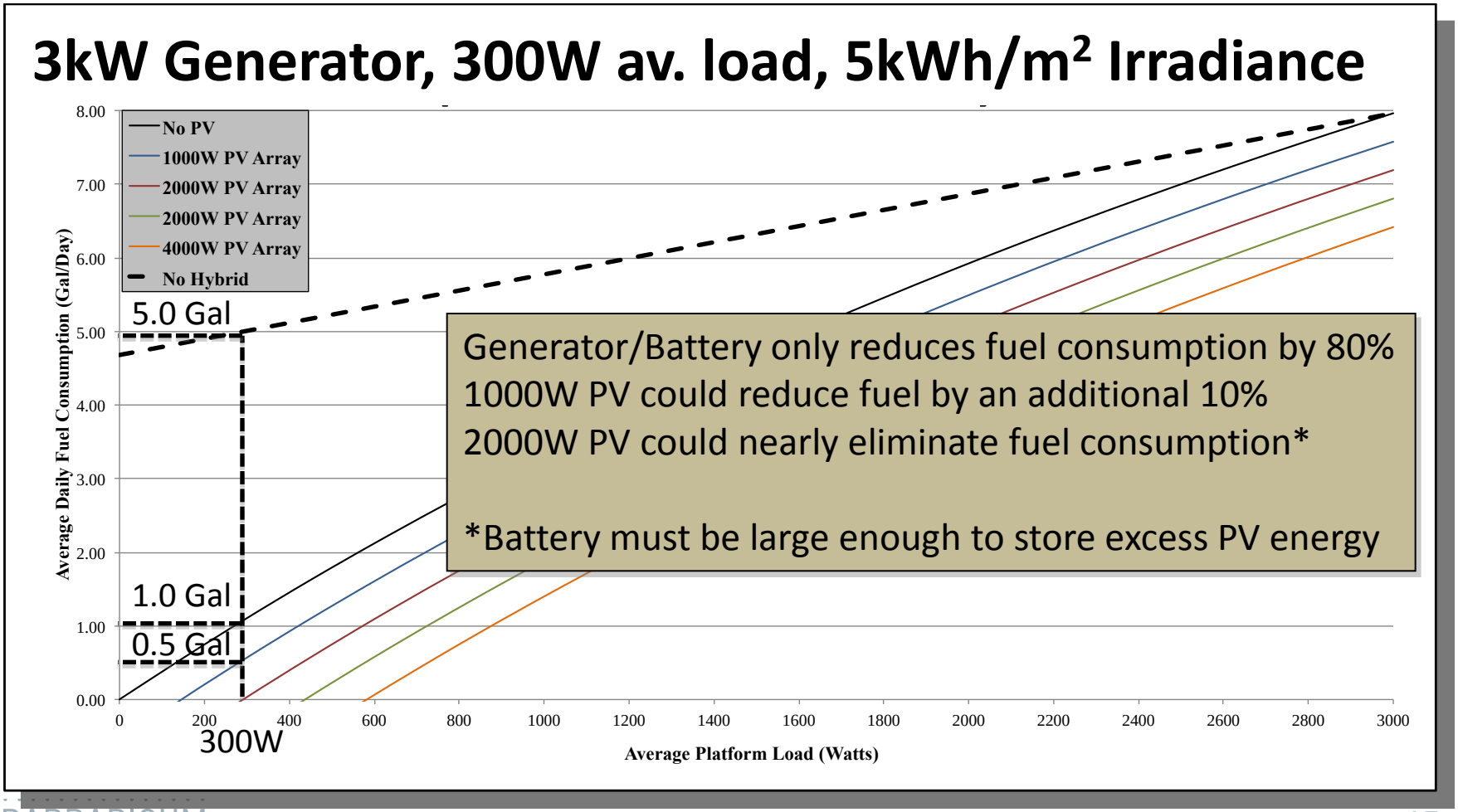
Example Hybrid System Fuel Use (Li)



Hybrid Tool Benefits Example 1



Hybrid Tool Benefits Example 2



What Tool Illustrates

- Largest gains are when generator is underutilized
  - Hybrid system makes sense when gen. < 50% cap.
- Large gains come from generator/battery configuration
  - Solar (PV) benefits may not out weigh size/weight/cost/complexity
- System component efficiency has significant impact
  - Lead Acid (LA) vs Lithium Ion (Li)
  - Power conversion losses
- Can be used for “Right Sizing” hybrid systems
  - Correctly match hybrid system with platform load
  - Shows diminishing returns

Applications

- Training Tool
  - Shows hybrid system potential benefits
  - Low cost
- Mission Planning Tool
  - Cost/Weight/Size tradeoffs
  - Enables Warfighter
- Decision Makers
  - ROM monetary ROI
  - Cost tradeoffs

Next Steps

- Identify interested end users
  - Create hybrid performance charts for specific systems
- Package tool in a smart phone app or browser
  - Link atmospheric database
- Database expansion
  - Develop platform load and hybrid system databases

Questions?

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