



**Brainheart**  
*Clean Energy makes good \$ents!*

**Practical Renovation and Innovation:  
Transform older, 600VDC PV systems into reliable, higher performing  
systems and add energy storage**

Presented By Allan Gregg

# Brainart Introduction

Brain & Heart of your system



An Inverter expert which is the heart of the system



A control software expert which is the brain of the system

Bringing together the experience of 25+ years in Renewable Energy

Brainart was created by renewable energy industry stalwarts with extensive experience in systems design, hardware, software, product/project development, and most importantly, service and support of renewable energy products for the past 18 years.

# What were the older PV systems like?

PV power systems installed between 2002 and 2010 used the following:

- Central PV inverters between 30kW and 500kW with a single MPPT and efficiencies (including transformer) ranging from 90% to 97%
- Leading inverter manufacturers were Satcon, Xantrex, SMA, Advanced Energy
- PV panels had capacities ranging from 120W to 200W
- PV string operating voltages between 300V and 450V
- No arc fault detection (AFD) or rapid shutdown requirements



# *Why do older systems need to be updated?*

- Ageing, 600VDC inverters failure rates have increased to the point where downtimes are excessive, leading to lost revenues.
- Most of the inverter manufacturers of that time are no longer in business.
- Converting to newer, 1000VDC, string inverters is impractical due to re-wiring and new, more restrictive, NEC requirements.
- PV panels from that era degraded unevenly at 0.5% to 0.75% per year
- String mismatch losses increase with age with total PV array losses increasing by about 1% to 1.5% per year
- There is a real need for cost-effective, energy storage that is driven by a list of factors, including frequent power outages, higher utility rates, and a move to zero export
- Brainart has developed a practical solution that brings more efficient technology together with an energy storage option that makes a “drop-in” package.

# How much can the performance be improved?

- Example System Assumptions:
  - System age = 12 years
  - Crystalline PV panels
  - Original Array capacity = 300kW
  - Inverter rating = 250kW
- Losses due to aging PV panels =  $0.5\% \times 12\text{yrs} \times 300\text{kW} = 18\text{kW}$
- Losses due to string mismatch =  $1\% \times 12\text{yrs} \times 300\text{kW} = 36\text{kW}$
- Total PV array peak output at the end of 12 years = 246kW
- Maximum inverter AC output power =  $95\% \times 246\text{kW} = 233.7\text{kW}$

# How much can the performance be improved? (Cont.)

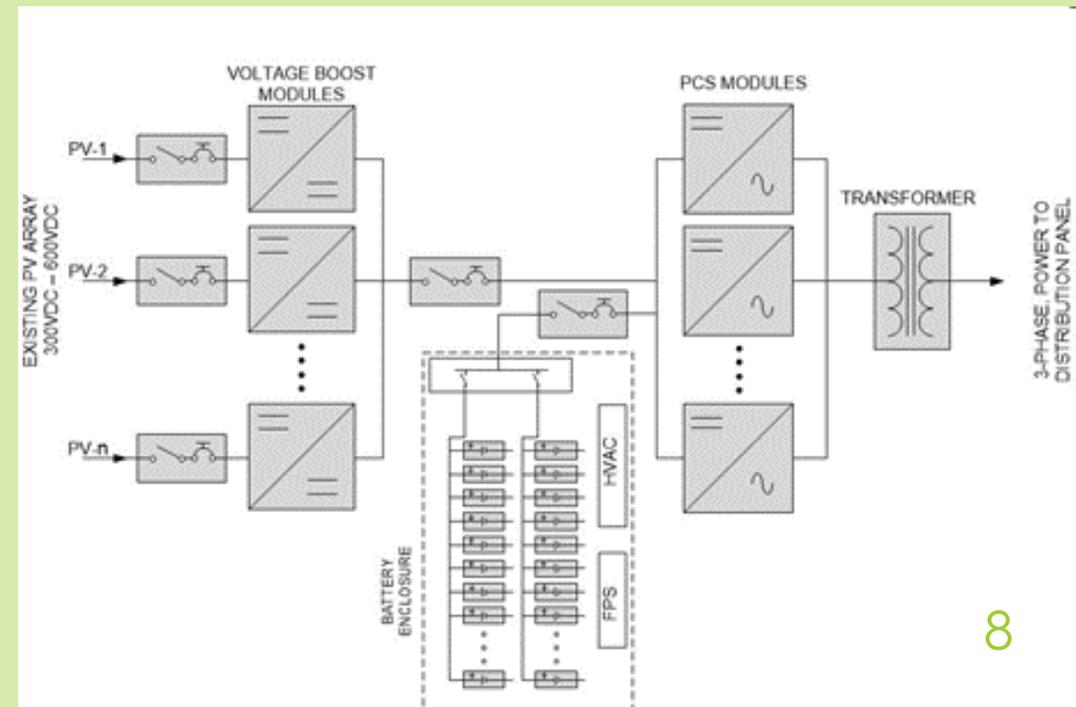
- Retrofit with **Brainart Microgrid 500** system:
  - New system has five MPPTs instead of one reducing mismatch losses by a factor of 5
  - No changes to PV strings or combiner box wiring
  - Existing PV inverter/transformer replaced with 98% efficient 250kW PCS
- Losses due to aging PV panels =  $0.5\% \times 12\text{yrs} \times 300\text{kW} = 18\text{kW}$
- Losses due to string mismatch =  $.2\% \times 12\text{yrs} \times 300\text{kW} = 7.2\text{kW}$
- Total PV array output at the end of 12 years = 274kW
- Maximum inverter AC output power =  $98\% \times 274\text{kW} = 268.5\text{kW}$
- Net improvement = 34.8kW
- Increase in annual energy production = 63,510kWh
- Estimated increase in uptime = 20%

# *Can energy storage be added?*

- Energy storage can be incorporated into the system design to add capabilities
  - Time of use controls/load management
  - Peak demand reduction
  - Off-grid operation (Resiliency)
- Capacity of energy storage matches the applications

# How are upgrades incorporated?

- **Brainart Microgrid 500** system includes the following:
  - Modularized voltage-boost system of rack-mounted, 50kW DC to DC converters
  - Modularized PCS in rack-mounted, 62.5kW units, up to 500kW
  - Modularized energy storage system (optional) between voltage booster cabinet and PCS cabinet
  - External, voltage-matching, transformer (208VAC or 480VAC)
  - Site controller (if energy storage is added)



# So what IS the BRAINART MICROGRID-500?

- “Drop-In” replacement for ageing or dead 600 Volt DC central inverters
- Pre-Integrated DC/DC Converter + Storage PCS + Microgrid Controller
- Comes with OpenEGrid Microgrid Controller
- Batteries can be added at a later date without any integration effort
- Enables compliance with Rule 21
- Ability to take advantage of emerging sources of revenue such as DR/DER/OpenADR/IEEE2030.5/IEEE1547 is already built-in



Outdoor Rated Cabinet<sup>9</sup>

# How are upgrades incorporated? (Cont.)

- Existing PV inverter/transformer is removed and the above equipment installed in its place, indoors or outdoors
- Certified/proven master controller (Energy Management System) optimizes the performance and maximizes the capabilities of the end to end system.



VOLTAGE BOOST  
MODULES



PCS MODULES<sup>10</sup>

# Steps for site evaluation

- Define the following:
  - Site location, roof or ground mounted PV array
  - Date of installation
  - Type of system (ex. PPA)
  - Array capacity/voltage/PV panel rating and manufacturer
  - Inverter(s) capacity and manufacturer
  - Any existing problems
  - Access issues (crane or forklift)
  - Union or non-union labor

# *Benefits of Brainart System Solutions*

- Designed to match applications and performance requirements
- Lowest downtime
- Power modules can be safely removed/replaced without having to shut down the system
- Highest up time
- Failed power modules are automatically isolated while system continues to operate at a reduced capacity
- Low time to repair = lower O&M costs
- PV array output is maximized through the inherent multiple MPPT circuits (five MPPTs compared to a single MPPT in competitor's systems)
- Indoor or outdoor configurations are available. Easy installation.
- Can supply power to more loads for a longer time during off grid operations



## **Brainart Energy Systems**

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