Microgrid Electronics

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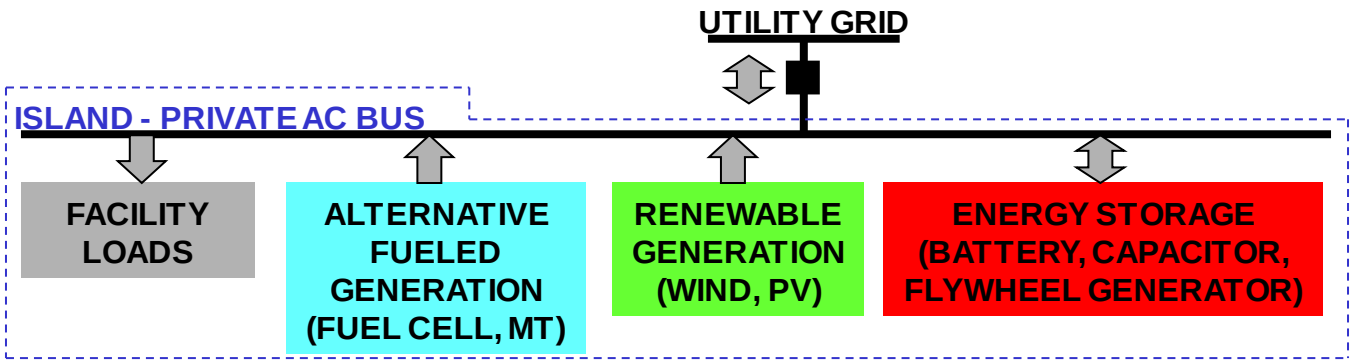
Some Performance and Cost Considerations of MicroGrid Electronics



- *Distributed Generation (DG) Resources Can Power Local Loads During Utility Outages*
- *Typically need storage to Load Follow (something to function as a swing generator)*
- *Electronics*
  - *Inverters*
  - *Grid Tie Switch(SDS, STS, or Electromechanical)*
  - *Controls*

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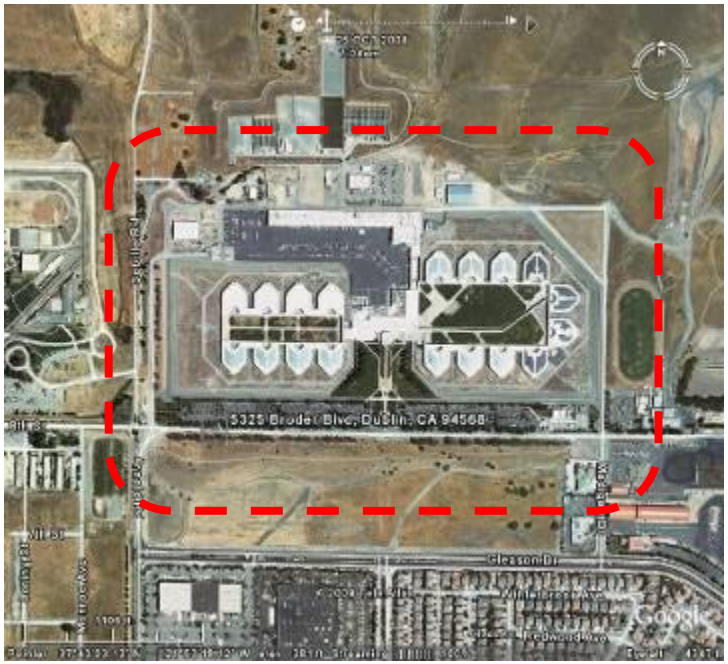
Santa Rita –"Load Following"

- Dynamic Balance of Load and Generation within Grid
- Needs Storage on some time scale (dynamic)

- Fuel Cell
- Battery
- PV
- SDS
- Certs Controls



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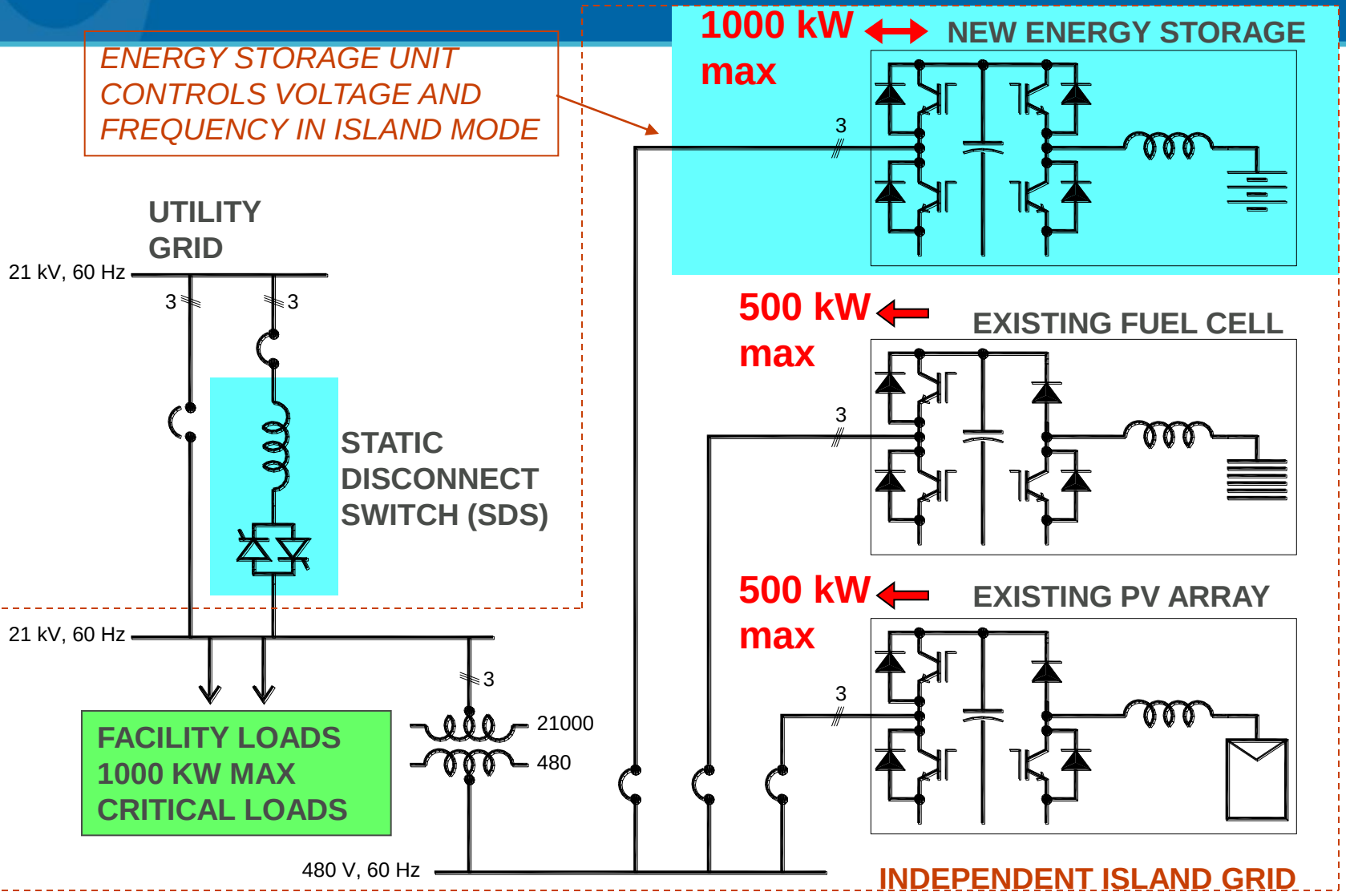
Adding Energy Storage and a SDS Allows Existing DG Units to Support an Island Grid



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Large Inverter Performance

- **Built-in DC & AC disconnect switches**
  - Integrated isolation transformer, or external transformer (typ MV)
- **DC inputs at full power, full MPPT range**
  - 305–320V DC to more than 600V DC, or 420V DC to 850V DC
- **CEC efficiency rating**
  - 97.5% to 98.5% (without transformer), 96.5% to 97.5% (with transformer)
- **CE efficiency rating**
  - 97% to 98% (without transformer)
- **Ambient temperature range (standard)**
  - -20º C (-4º F) to 50º C (122º F)
- **Warranty plans**
  - Standard (five years, ten CA), Extended warranty (20 years)
- **Service**
  - Remote diagnostics, Modular components.

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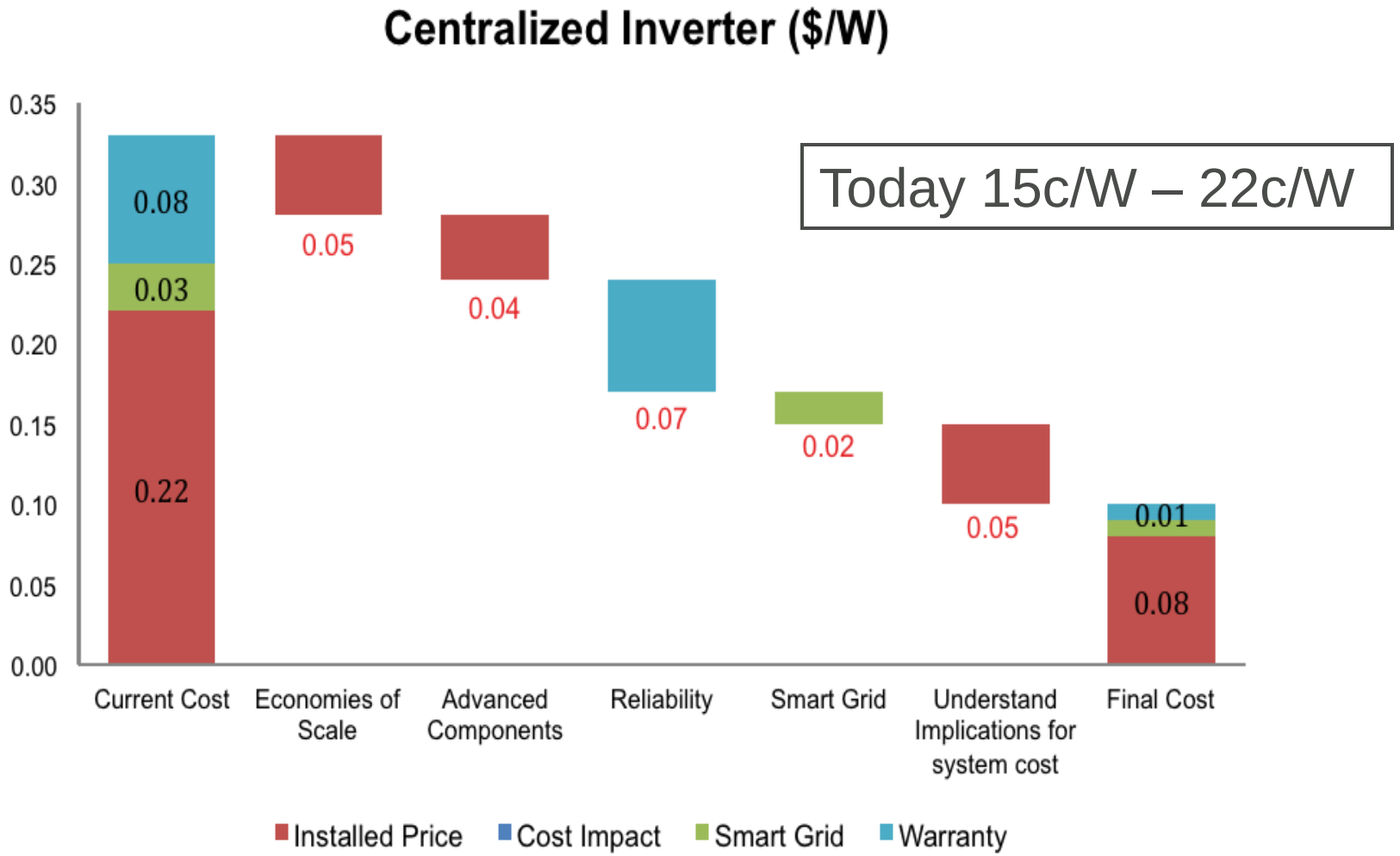
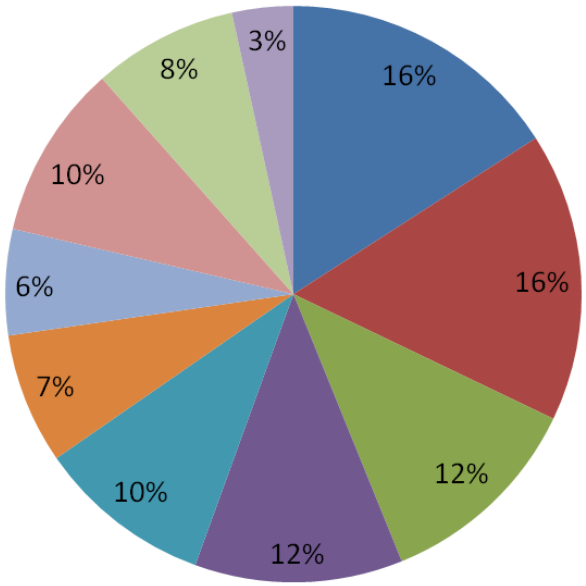
DOE's Projected PV Power Electronics Cost Goals – $0.10/W Installed



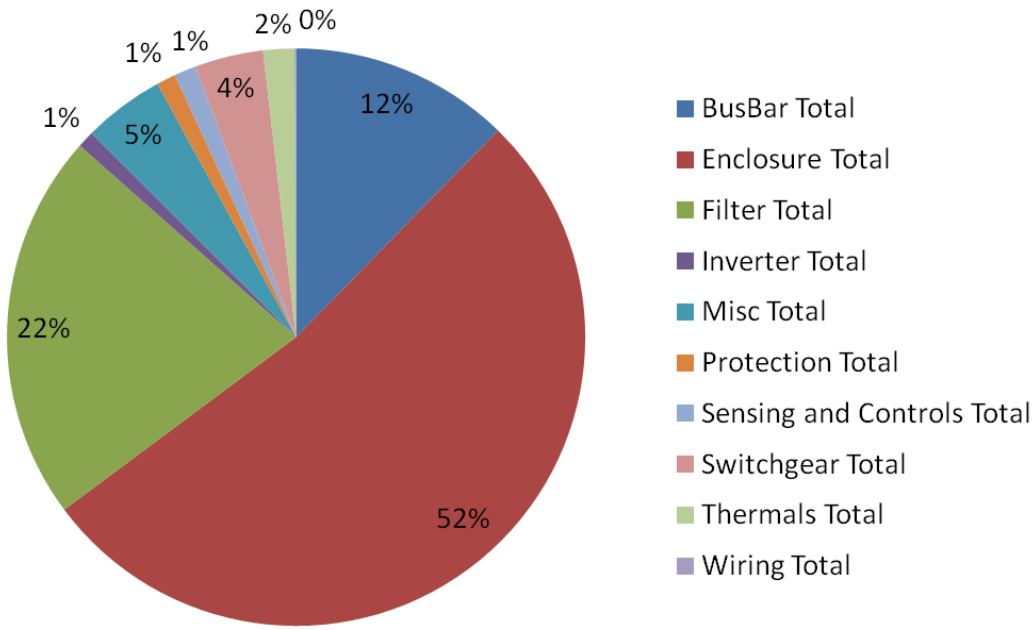
Large PV Power Electronics Cost and Weight - Today

500 kW PV Inverter Cost and Weight Breakout

Cost Breakdown



Weight Breakdown



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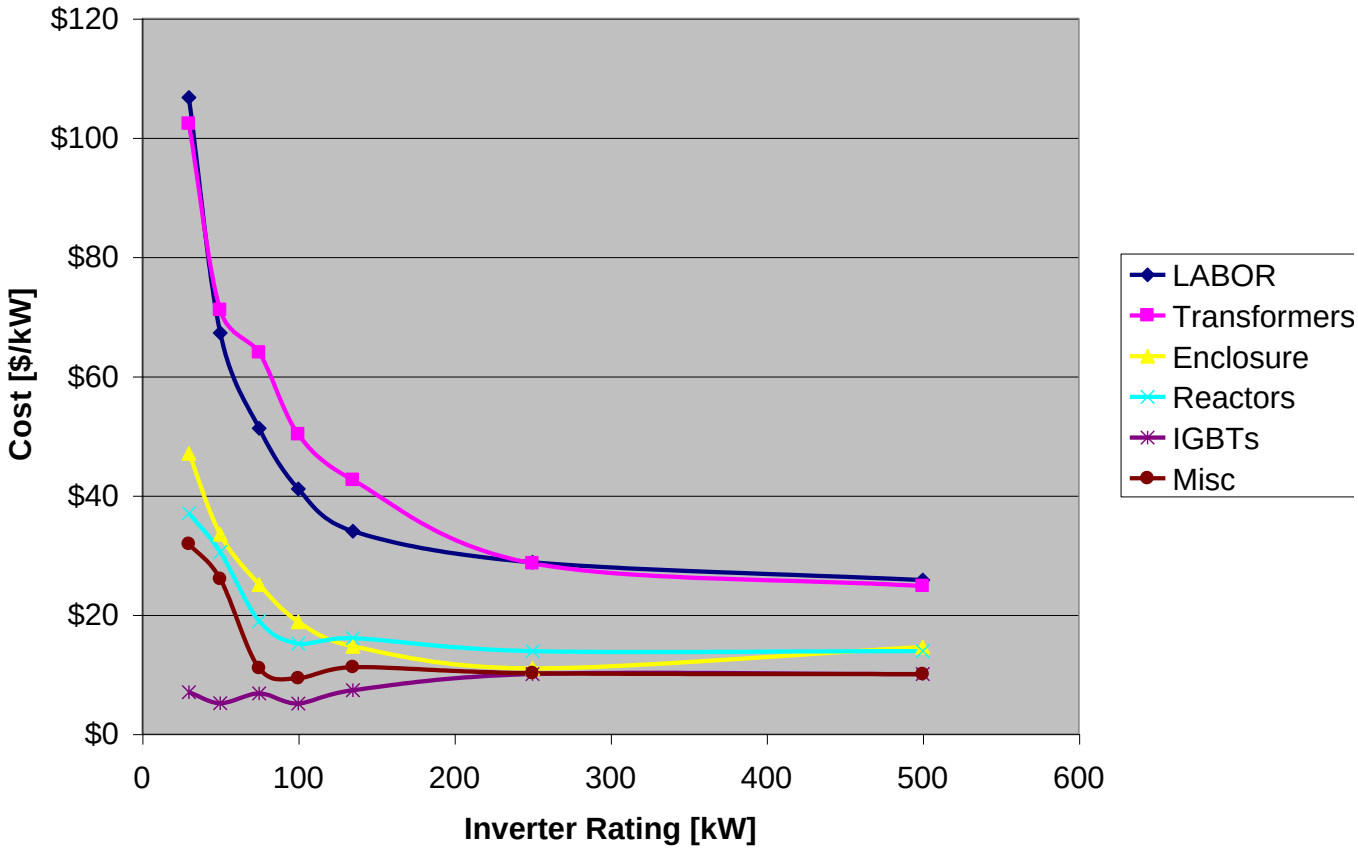
Inverter Normalized Cost of Top 6 Items (>60% of Total Unit Cost)



$/kW relatively flat at 135kW and above

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Static Disconnect Switch Minimizes the Impact of Utility Grid Faults on Island Grid Voltage

Medium Voltage Sub-cycle Disconnect Switches (MV SDS)

- *Sub-cycle* voltage sag sense & disconnect times, half-cycle, or 8ms max,
- *Solid-state* (thyristor valve based) switching, up to 35kV system voltage and 25kA fault isolation rating,
- *Static*, wear & tear-free, including *switching parts*,
- Equipped with conventional *service isolation and bypass disconnects*.

~ Inverter Costs, tradeoffs for no-break

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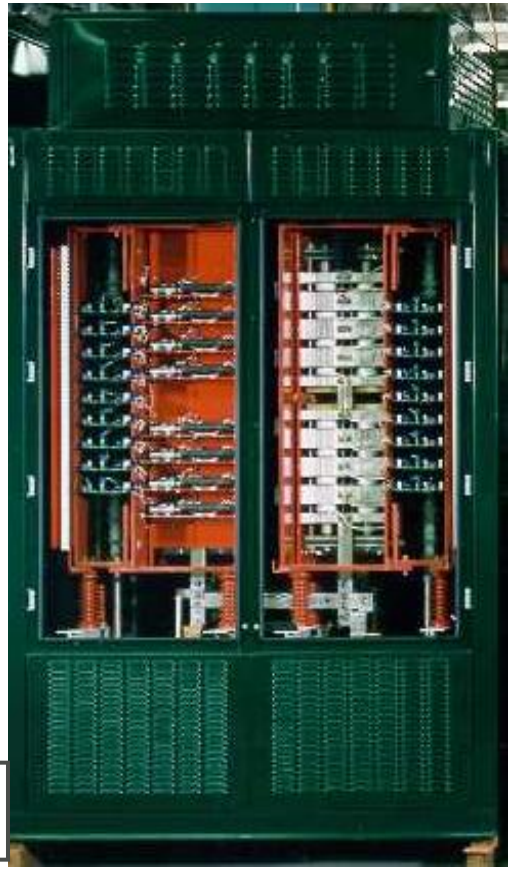

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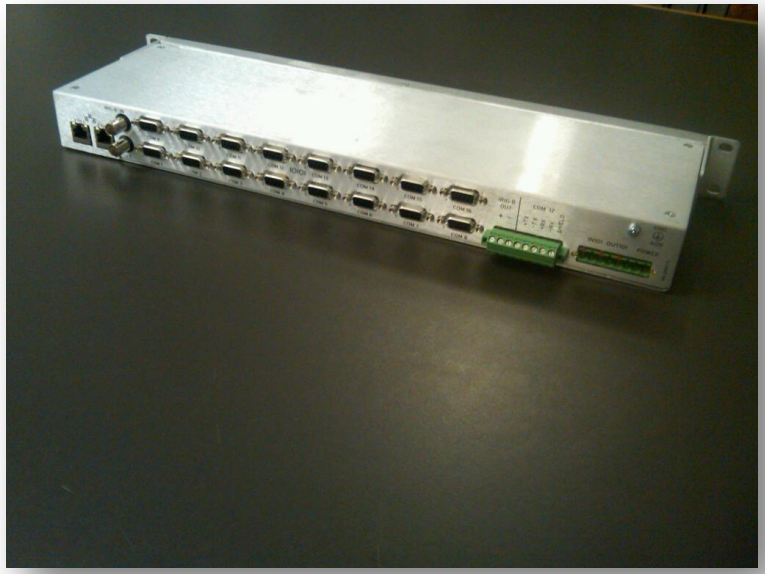
Typical Site Controller



Site Controller ties together

- SCADA, Inverters, Metering at the PCC, Disconnect devices, …
- Aggregates performance and control of individual components

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Site Controller-Implementation Details

- Real Power Curtailment/ Shutdown
- Direct VAR/P.F. control
- Schedule/Load Based VAR/P.F.
- Automatic Voltage Regulation

Typically
- MV metering
- $10-15k hardware
- ~50-75k integration

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Electronic Developments

- Operational Inverter Improvements
  - Harsh Environments
  - Remote Reprogramming, Parameterization
  - More rugged, reliable, improved overload
  - Remote diagnostics, prognostics (wear-out)
- Next Gen Inverter
  - Volume, weight, cost, efficiency (WBG, improved thermals, …)
- Advanced Inverters as System Elements (SEGIS - GRID SMART INVERTER)
- System Yields
  - Ultra efficient DC/DC (micro and mini converter)
- Advanced Concepts
  - Direct MV Inverter
  - Integrated storage Inverter
  - DC microgrid subsystems