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Photovoltaic Inverter Needs

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To Inverter R&D

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AstroPower

Photovoltaic Inverter - Status

- Shift has been towards high input voltage (up to 600V)
- Systems have become easier to install with higher DC voltage inputs
- Efficiencies ("average" or European) currently 89 – 94%
- Maximum power-point tracking (MPPT) now standard for grid-tied applications
- Single-unit cost ~$0.60 – $1.00/Watt

Photovoltaic Inverter - Market

- On-grid applications (without UPS) driving domestic market growth
- (Currently ~95% of AstroPower domestic residential business)
- Residential system sizes range from 1.6 - 9.6 kW
- “Favorite” sizes (2.4, 3.6, 4.8, 7.2 kW) depend on customer type and limitation of roof area/orientation
- Wide variety of commercial system sizes (10 - 300 kW or more)

What We Want from Tomorrow's Inverters? *Electrical/Mechanical/Soft Characteristics*

- Need both utility-interactive and stand-alone capability
- Capacity
  - 2.5-5 kW nominal for residential
  - 10, 30, 50, 100 kW… nominal for commercial (or multiple string-inverter solution)
  - Surge 1.5-2X of nominal (for UPS only)
- >94% "average" efficiency (with flat load curve)
- Reliability
  - Life expectancy comparable to PV modules (~25 years)
  - MTBF ~ 10 years
  - Low infancy failure/service rate (<<1%) Right now >5%

What We Want from Tomorrow's Inverters? *Electrical/Mechanical/Soft Characteristics*

- Communications
  - Extensive local communication for diagnostics
  - Remote communications
    - required for commercial
    - option on residential a plus
- Low sensitivity to perturbation (environment)
  - No fan/thermal de-rate issues
- Dimensions
  - Smaller/Lighter = Better (one-person install)
  - Low profile (minimize depth)
- Standard Warranty > 5 years (w/option of 10 or more)
- Cost <$0.50/W

What We Want from Tomorrow's Inverters? *Electrical/Mechanical/Soft Characteristics*

- Flexibility (an "all-in-one" residential box)
  - A universal or modular inverter solution to maximize flexibility for system size (voltage/power window)
    - DC input voltage: 48 – 600V
    - Power input: 1 – 5 kW
  - Ability to easily integrate UPS as an option
  - Indoor or outdoor installation (NEMA 4)
  - BIG PLUS: 3-4 separate string inputs (each with own MPPT) allowing for several different module orientations
- Can Reliability Trade Off with Cost? *Not much. Reliability currently more important.*

What We Want from Tomorrow's Inverters? *Electrical/Mechanical/Soft Characteristics*

- Input from the field (residential):
  - Failure rates comparable to TV's & Microwaves!
  - Easy installation
  - Quiet (no fan or "hum")
  - Neutral color for enclosure
  - 240V output
  - Flush-mounted (cabinet inside stud bay)
  - DC/AC disconnects external to inverter

PV Inverter Issues

- Performance
  - Expected inverter lifetimes still a fraction of expected system lifetime.
  - Growth in market compounds problem of high service rates and could be a barrier to widespread appeal.
- Cost
  - Inverter currently comprises 10-20% of system cost.
  - Important to drive cost down as PV cost falls, however, not priority #1 for PV industry.

PV Inverter Issues

- Market share
  - On-grid market is currently strongest area of growth.
  - Need "bullet proof" systems (that feel like appliances) for PV to cross-over into the main-stream residential consumer market.
- Priorities
  1) Reliability
  2) Flexibility
  3) Cost
  4) Efficiency