ROOFTOP

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Breakout Session

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1. For roof-top PV, what are target operating voltages and power levels for a commercial installation? For a residential installation?

- Commercial (10kW – 1-2MW)
  - Impacting NEC – have a safe product to begin with
  - Bipolar +/- 500 V to ground
  - 1000 VDC on module connection
  - Interconnection point (voltage) is important to consider
    - 240 V, 480 V, 208 V (three phase) are practical

- Residential (10 kW and less)
  - Safety guys (firefighters) want lower voltage
  - <100 V input voltage

2. What properties of the inverter contribute to the overall installation cost for roof-top PV systems? How much?

- Weight
  - >70 lbs - 2 guys to install by law when over 70 lbs
  - Lighter weight – 1 guy
- Footprint/Efficiency – not a significant cost driver
  - Not an issue for commercial – plenty of unusable space
- Input DC Voltage
  - <48 V for residential (safety)
  - Commercial – NEC
- Output Voltage. 480V-AC?
  - N/A
- Power level
  - AC module definitely reduces cost on residential level (no specialized electrician)

3. What is the state-of-the-art power density for a PV inverter for 20-500kW systems?

- Not really important for large rooftop inverters
- More relevant for microinverter implementations
  - 20-30 W per cubic inch

4. Consider circuit architectures that can drive to dramatic reductions in weight, size, and cost.

- Break down to 3 market sizes
  - Residential (10kW and under)
  - Big rooftop systems (10-50 kW)
    - Microinverters go up to this point
  - 50 kW and above
    - Central inverters more beneficial
- AC modules would have a huge impact in the residential market
  - Plug and play
  - Lower safety concern

- Microinverters cost about $0.4-$1 per Watt
  - Design costs for roof systems are lower
  - LCOE is better even though capital costs may be slightly higher

- Need to fix efficiency issue of microinverters – need to go up to 99% (heat dissipation)
- Have to have a match between the warranties of the inverters and panel
- Large systems – topology changes? Distributed MPPT might make more sense, maybe not at each module – string size is about right

5. What is the switching frequency employed in today's state-of-the-art inverters for roof-top PV?

- Residential (up to 100 kW)
  - Between 60-20 kHz, use a standard transformer
  - Microinverters need higher, but lose efficiency -200-300 kHz
- Commercial
  - Frequency comes down

6. Consider the components required to dramatically increase power density while reducing the cost of the inverter.

- High frequency switches. Wide-bandgap semiconductors. GaN/Si?
  - 20-30V GaN switches (one-polarity device only)
  - At high voltage SiC is better than GaN/Si
- High frequency, high-flux magnetics
  - Need for magnetics goes away if you implement wide-bandgap semiconductors and high frequency switches
  - High freq inverters reliability needs improvement
  - Reduces capital cost, but not necessarily LCOE
- Packaging technology.
  - Not going to drive the cost down that much
  - Important for microinverters
  - Drives reliability (including thermal dissipation)
  - What needs to be addressed
    - Thermal management
    - Integration of active and passive components
  - Don't want to all logic on same substrate as power IC, but some basic functions can go there
    - Can integrate some controls and communications
- Weight and density are not as critical, it's performance
  - This is not really an ARPA-E play anyway

7. Address issues related to isolation and grounding?

- We can use transformerless inverters
  - DC injection is a main concern of utilities
- Bipolar arrays may get around some issues

8. What methodology can be used to evaluate first cost of the power electronics? How can progress against cost metrics be evaluated?

- LCOE is the metric to use
- How this impacts other costs of the system, efficiency, long term reliability
- A lot of the improvements are not drop-in replacements, it's a new system
- Use NREL/SAM as the baseline/benchmark
  - Need models for new technologies