SAND2013-4328C

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Sandia National Laboratories

2013 Inverter Reliability Workshop Survey Results

May 1, 2013

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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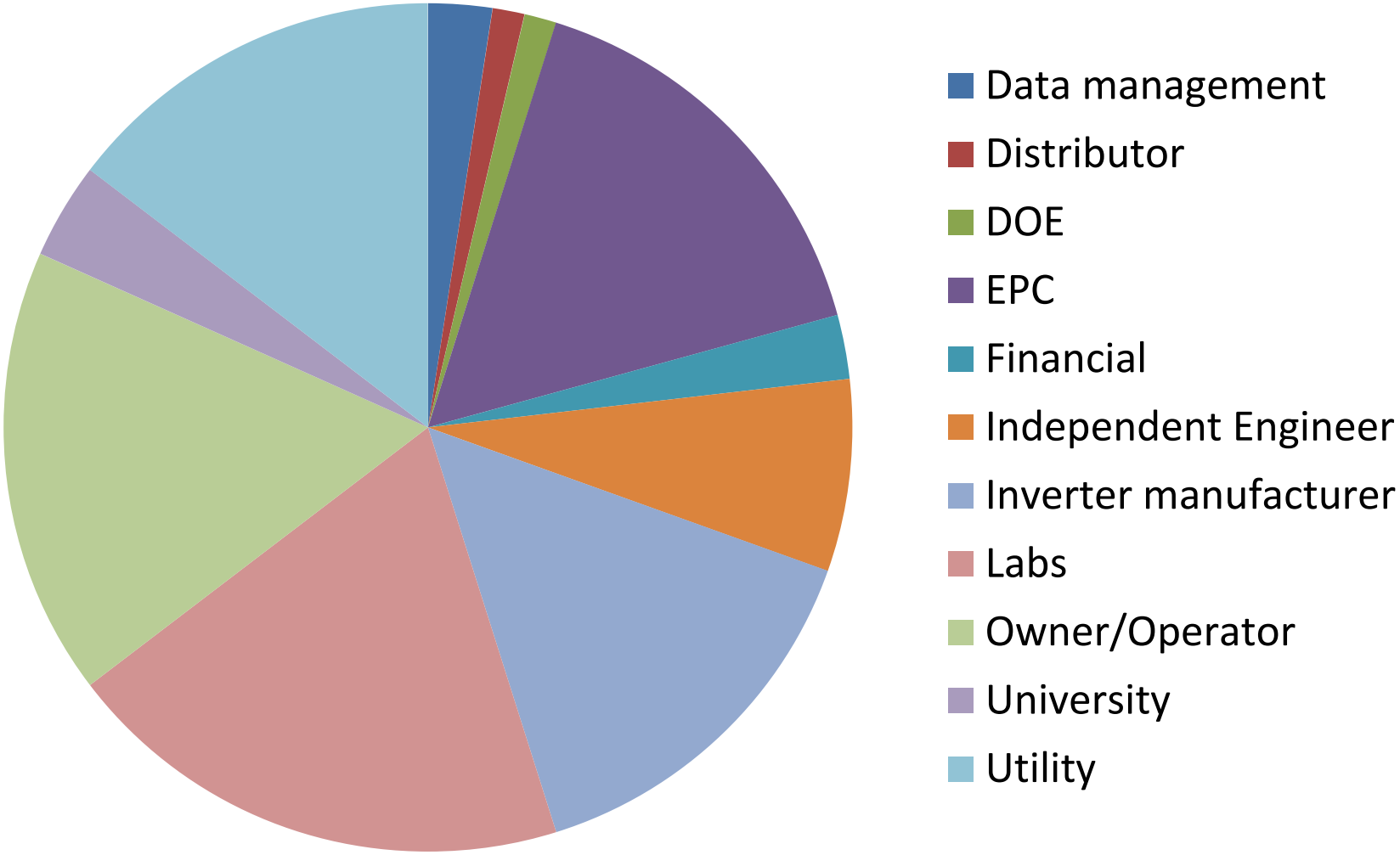
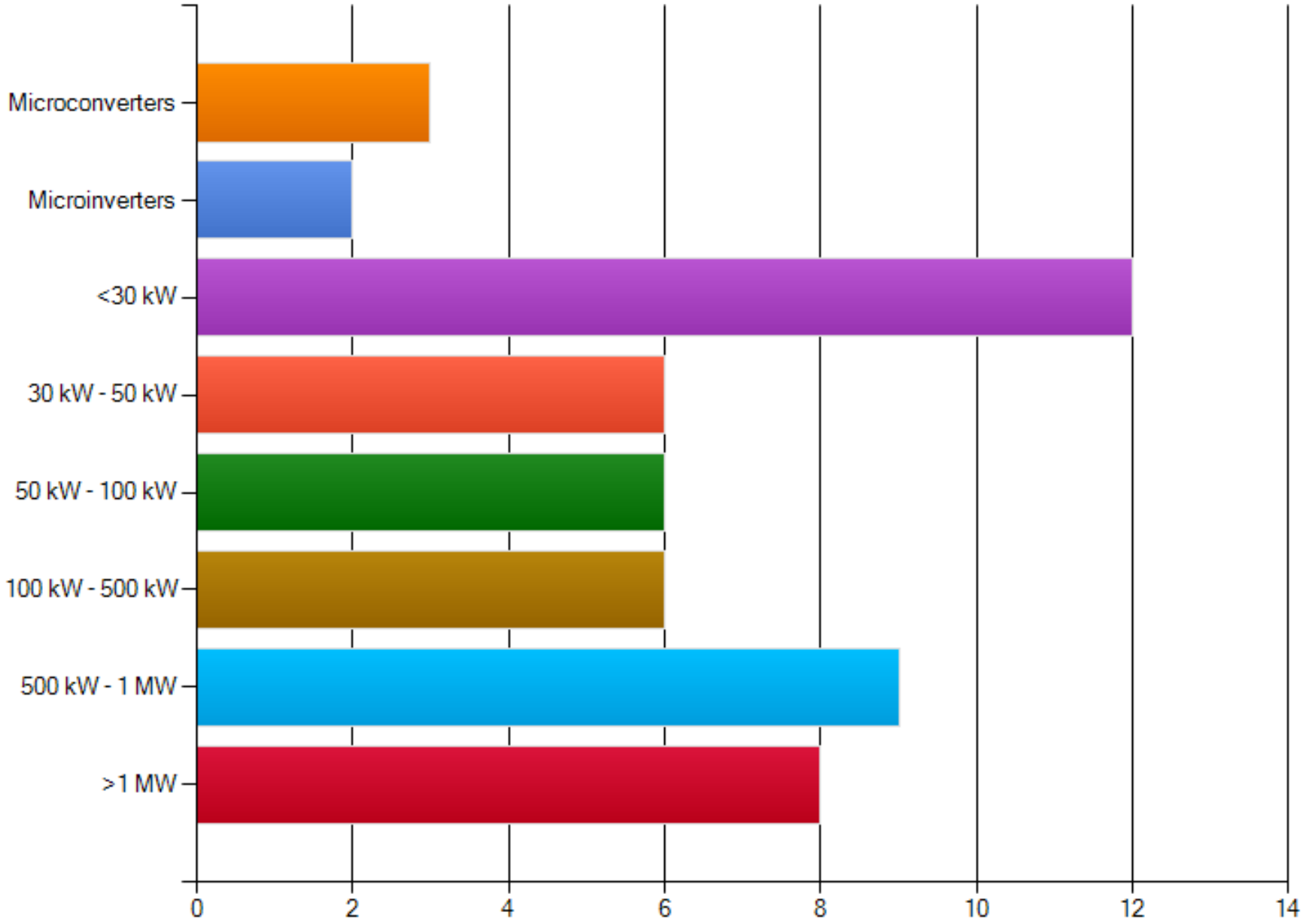
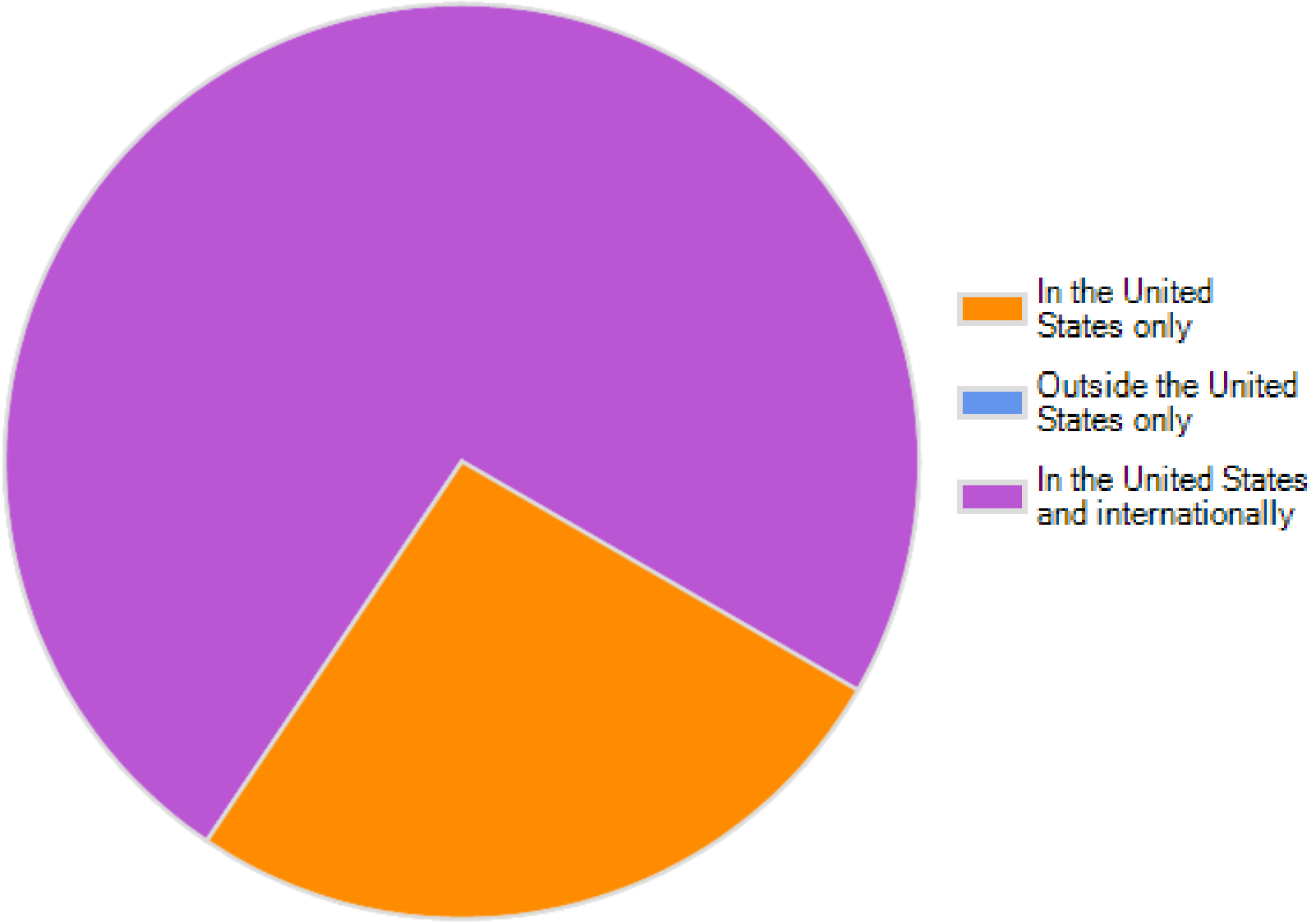
Participants: 82



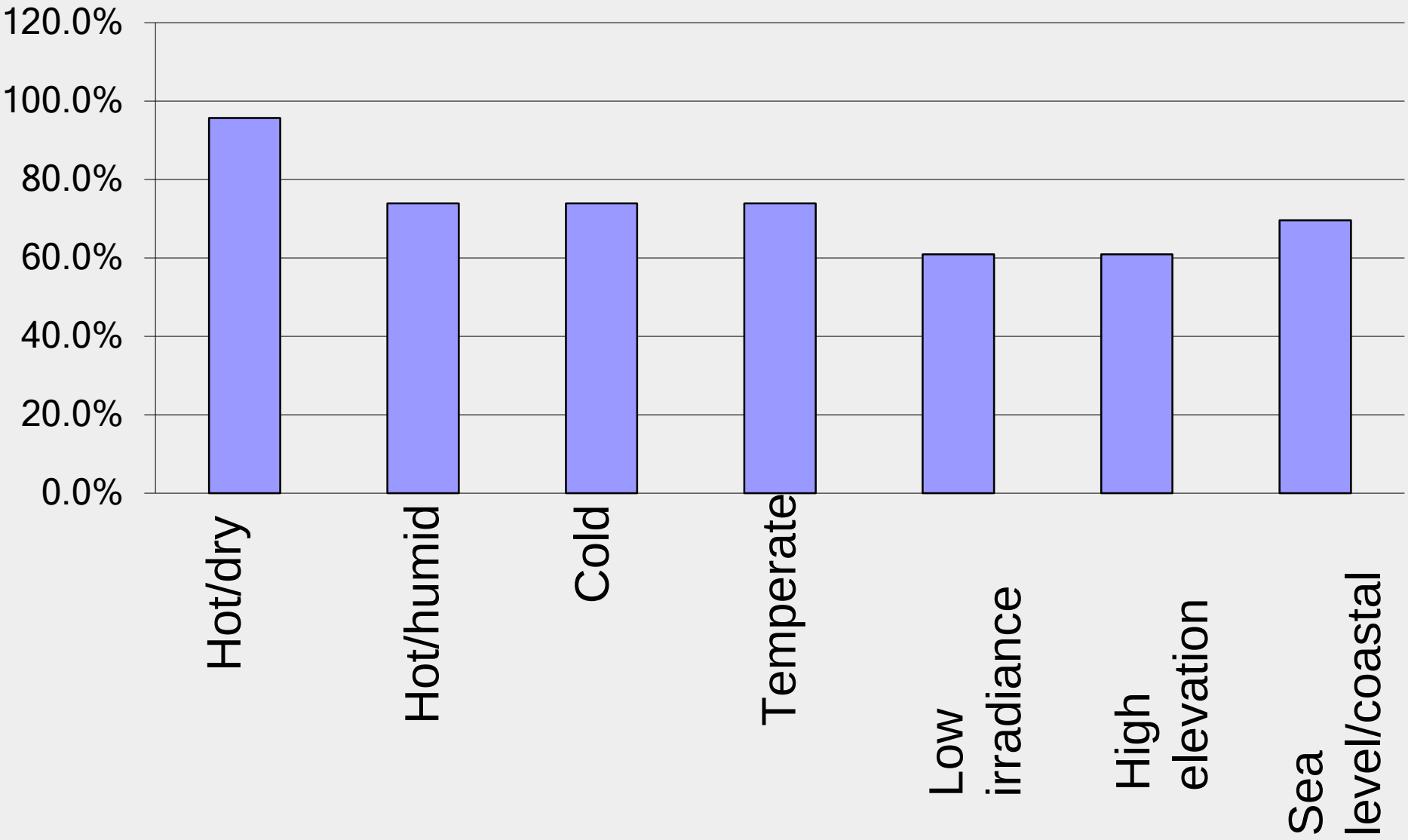
What size inverters does your company produce? Please check all that apply.



Where has your company sold inverters for PV systems?



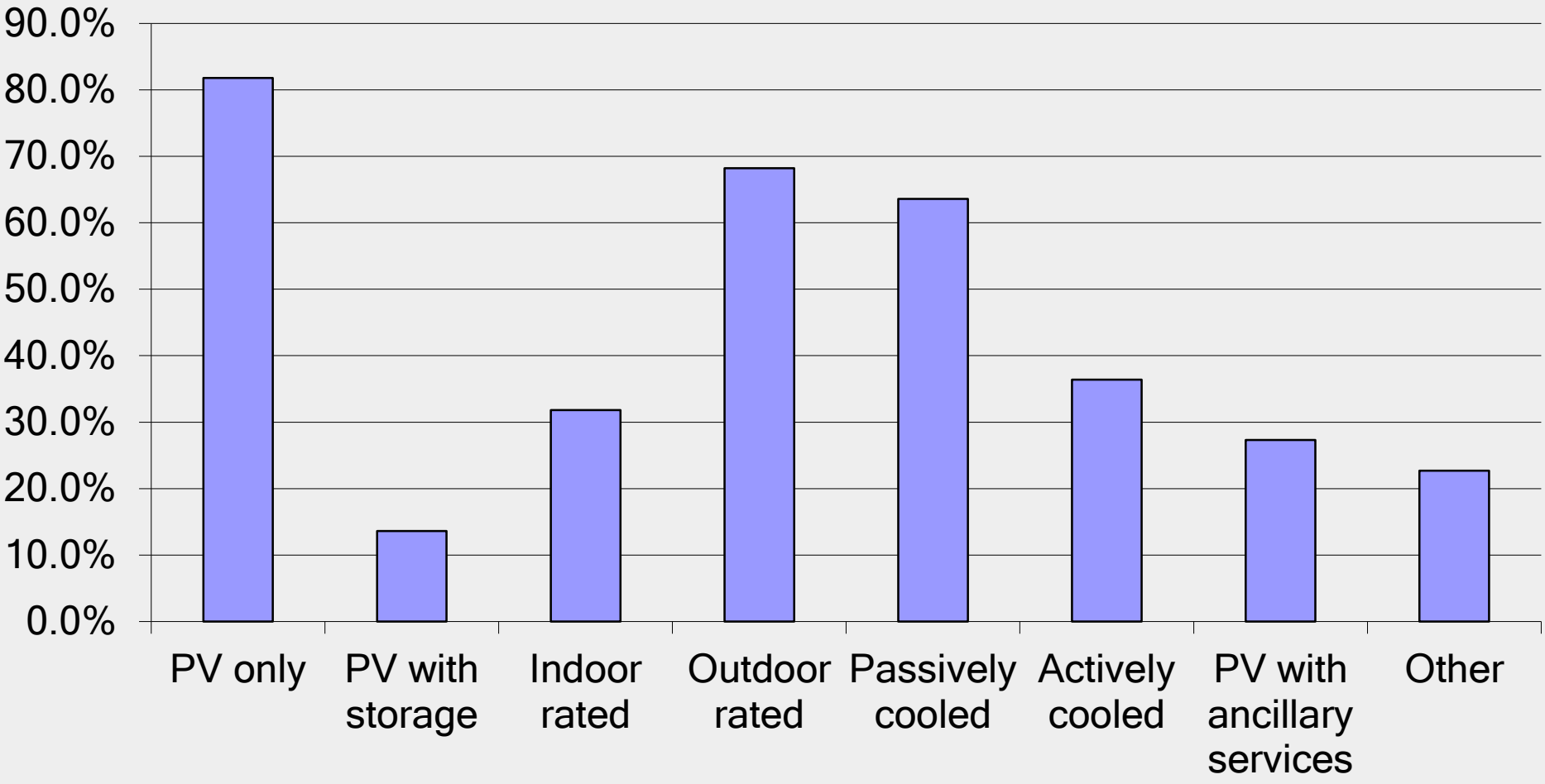
In which climate zones are your inverters working (to your knowledge)? Check all that apply.



How many years has your company been in the PV inverter business

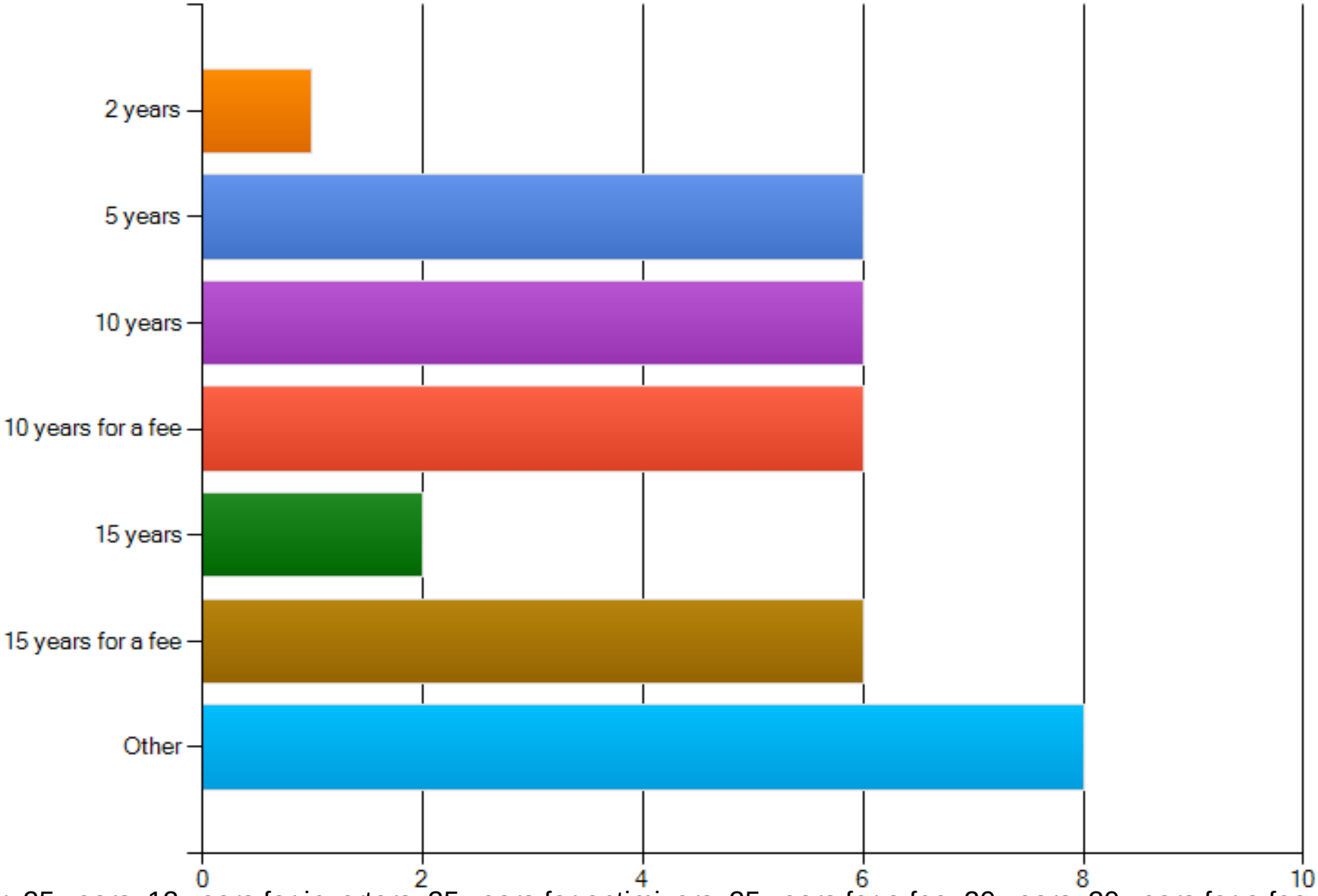
- 0 (3)
- 2
- 4
- 5 (6)
- 6 (4)
- 7
- 10 (4)
- 20

What different types of inverters has/does your company design and market?

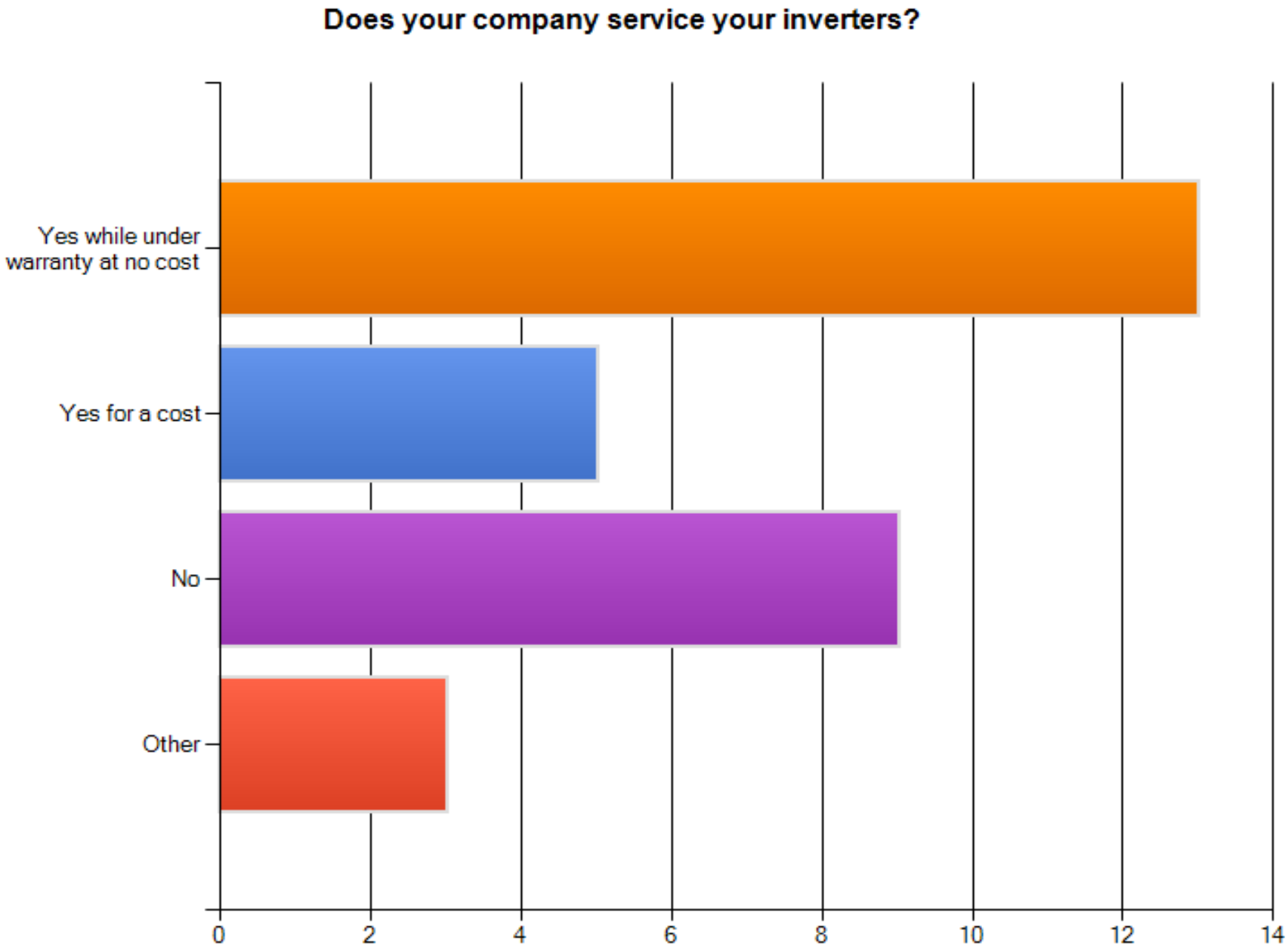


Other: DC Optimizers and inverters

What is the warranty offered by your company? Check all that apply.



Other: 25 years; 12 years for inverters, 25 years for optimizers; 25 years for a fee; 20 years; 20 years for a fee



Other: preventative maintenance after certified training from inverter companies; rely on 3rd parties

How long do you believe your inverter will last in the field (expected lifetime vs. warranty)?

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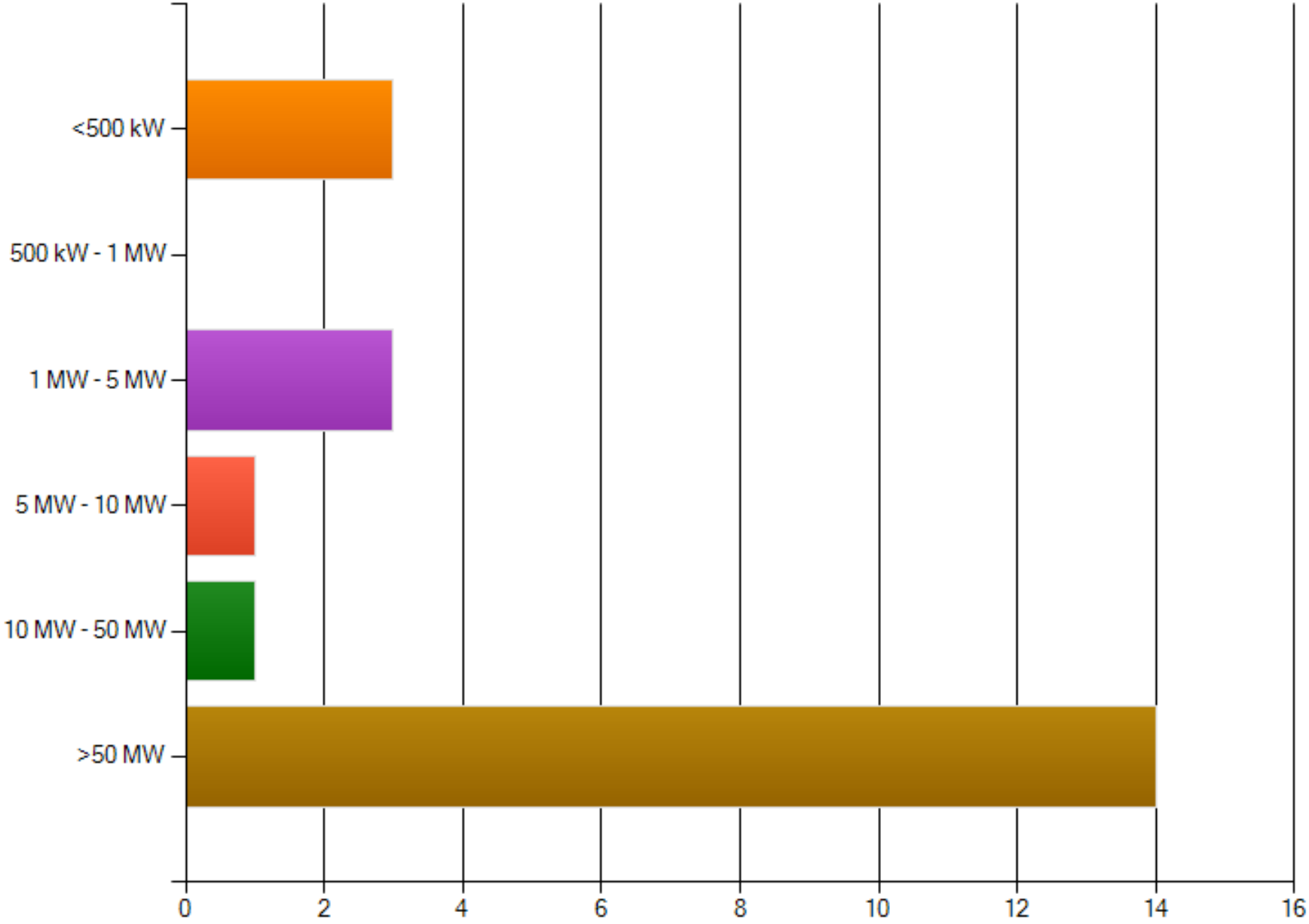
- Unknown
- A required percentage will survive warranty period
- 10 years (4)
- 12-15 years (3)
- 15 years (5)
- 20 years (8)
- 25 years (4)
- 30 years or greater (2)
- Unconcerned about average, only distribution

To date, what is your company's cumulative capacity of PV inverters sold?



How does your company define inverter failure? (e.g. % efficiency loss, communication loss, no power output)

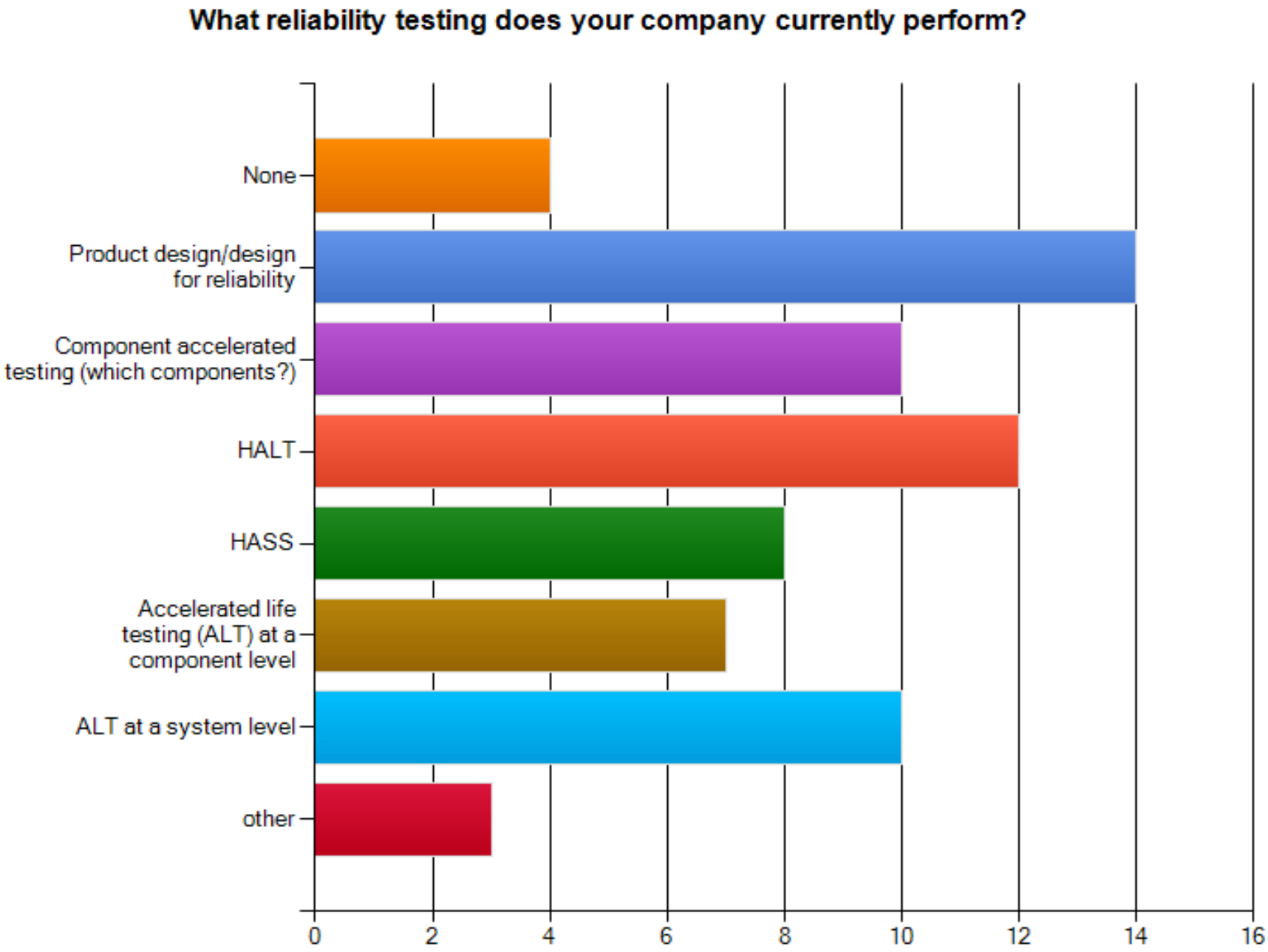
- Power Output/Efficiency (14)
- Loss of Grid Integration
- Requires AC/DC power cycling on 2 or more occasions
- Failure to meet minimum specs (2)
- Tripping
- Alarms (2)
- No LCD display/Communication Loss (4)
- All of the above

How does your company define inverter availability?

- Active to possible working hours ratio (6)
- No loss of communication (2)
- Time power output is within % of spec (4)
- Daylight uptime including planned maintenance (3)
- Power output compared to site peer inverters (2)

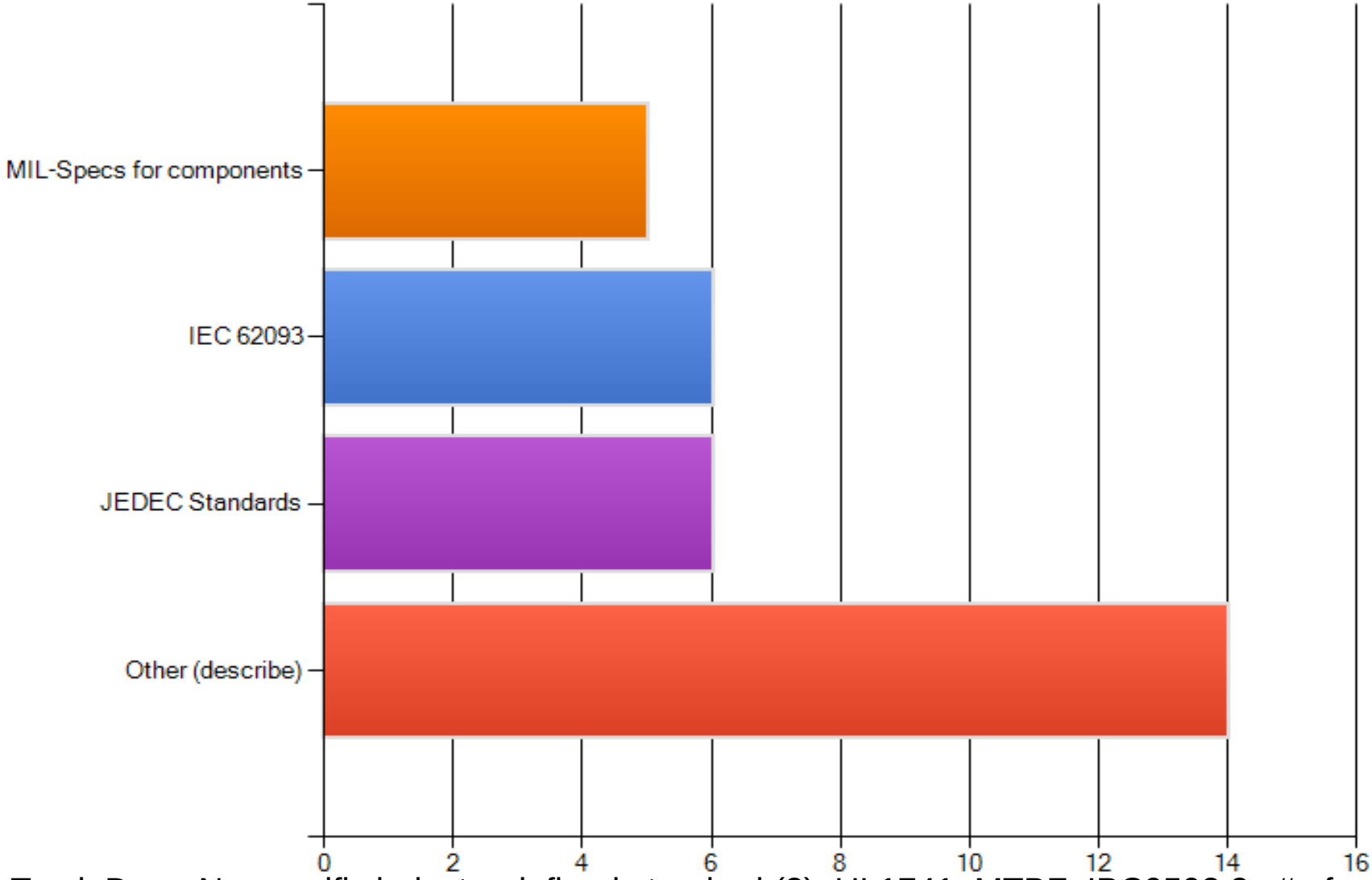
How does your company define inverter reliability?

- Number of failures to working hours ratio (6)
- Inverter able to perform at specified performance level (4)
- Fielded hours without any failure (2)
- % lost generation opportunity
- Daylight uptime after planned maintenance
- Based on frequency of O&M required maintenance
- No definition yet/under construction (3)



Other: Physics of failure; Stress testing

What reliability-related standards or guidelines does your company currently use? Check all that apply.



Other: Truck Drop; No specific industry-defined standard (2); UL1741; MTBF; IPC9592;2x # of cycles for IEC module reliability

What are your top three vulnerabilities or reliability issues for your inverters?

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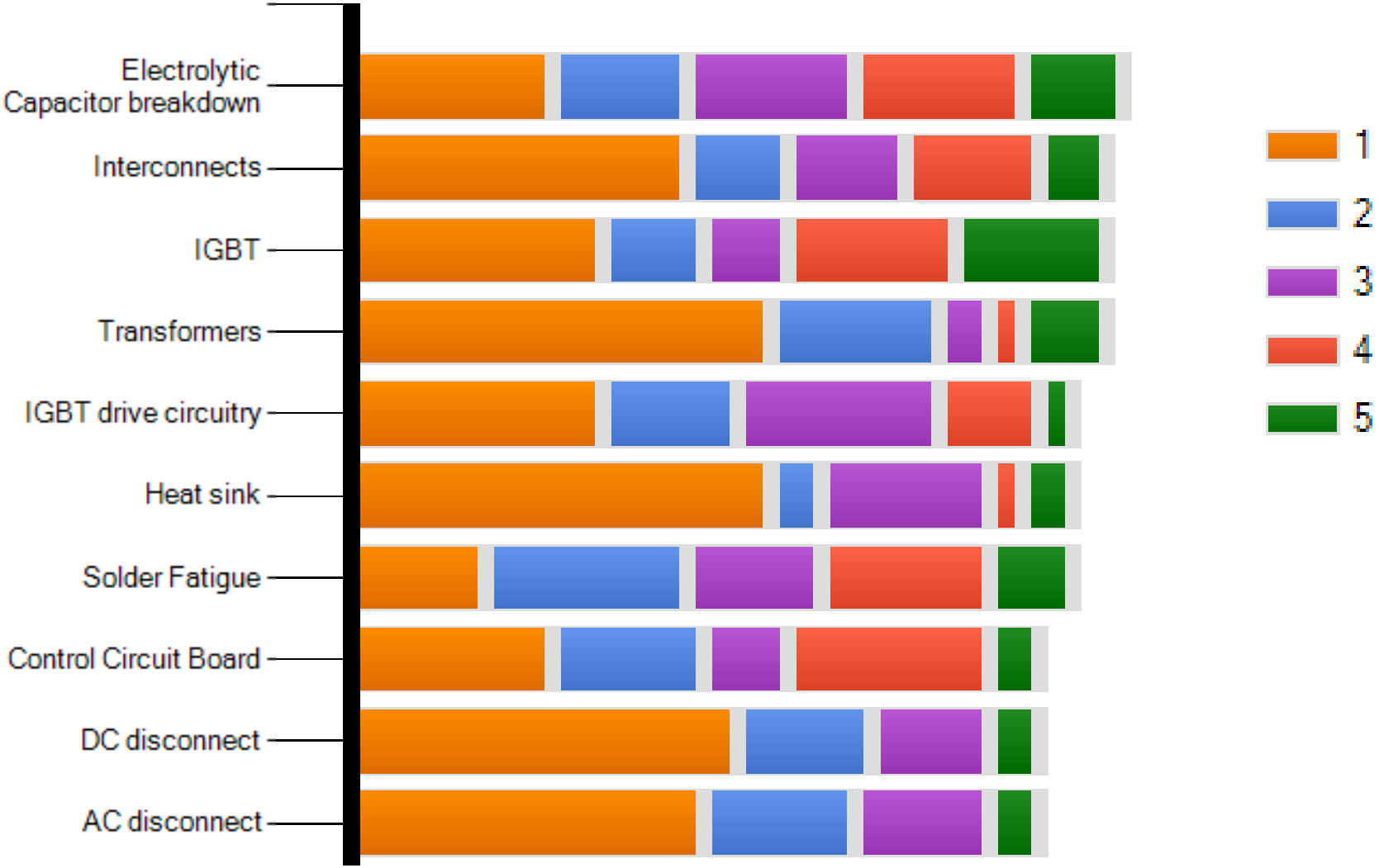
- Component degradation (14)
- Grid Transients/Events/Excursions (11)
- Communications (9)
- Dust/Water/Environment (8)
- Workmanship/installation (4)
- Temperature (4)
- Firmware (2)
- Interconnects (2)
- Fans/blowers
- Warranty survivability
- Customers

Where on the list of main sources of critical failures of inverters do you believe each of the following inverter components lie? (1) bottom 50%, (2) top 50%, (3) top 25%, (4) top 10%, (5) top 5%. Consider this question across the industry.



What are your top three reliability drivers you worry about for your company and the industry?

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- Component degradation/reliability (16)
- Warranty (12)
- Active cooling/thermal management (10)
- Environmental/Dust/Humidity (5)
- Firmware/Control/Condition Response (5)
- Lack of long-term reliability data/metrics and/or standards (5)
- Inverter design (3)
- Workmanship (2)
- Interconnects (2)
- Unknown root cause of failure
- Communications
- Field Support
- High DC/AC ratio
- MPPT
- Grid issues
- Manufacturer going out of business
- Lack of field and office OEM personnel understanding
- Ability to accurately stress test
- Compatibility of centralized inverters with distributed optimizing technologies

From OEM Perspective, what would you like DOE, national labs, standard development orgs, and utilities do to help increase inverter reliability?

- Common reliability standards/definitions (10)
- Studies/data collection related to inverter reliability (8)
- Nothing/don’t know (3)
- Correlation of field failure to accelerated life testing (2)
- Stakeholder outreach
- Case studies of energy impacts of failure and recovery
- Research into thermal stress and design improvements
- Conditions-based monitoring

What do you hope to get out of participating in this workshop?

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- Connecting with other in industry (6)
- Understanding of reliability, standards, and metrics (5)
- O&M requirements/mitigation strategies (5)
- Learn current/future areas of research (4)
- Roadmap/standards creation (2)
- Understanding of component failures
- New perspective towards inverter selection
- Learn of existing reliability certification
- Learn about inverter design
- Modeling of inverter performance/failure
- Learn reliability prediction in inverters