



Survey #1 Results

Utility Scale PV Inverter Reliability Workshop January 27-28, 2011

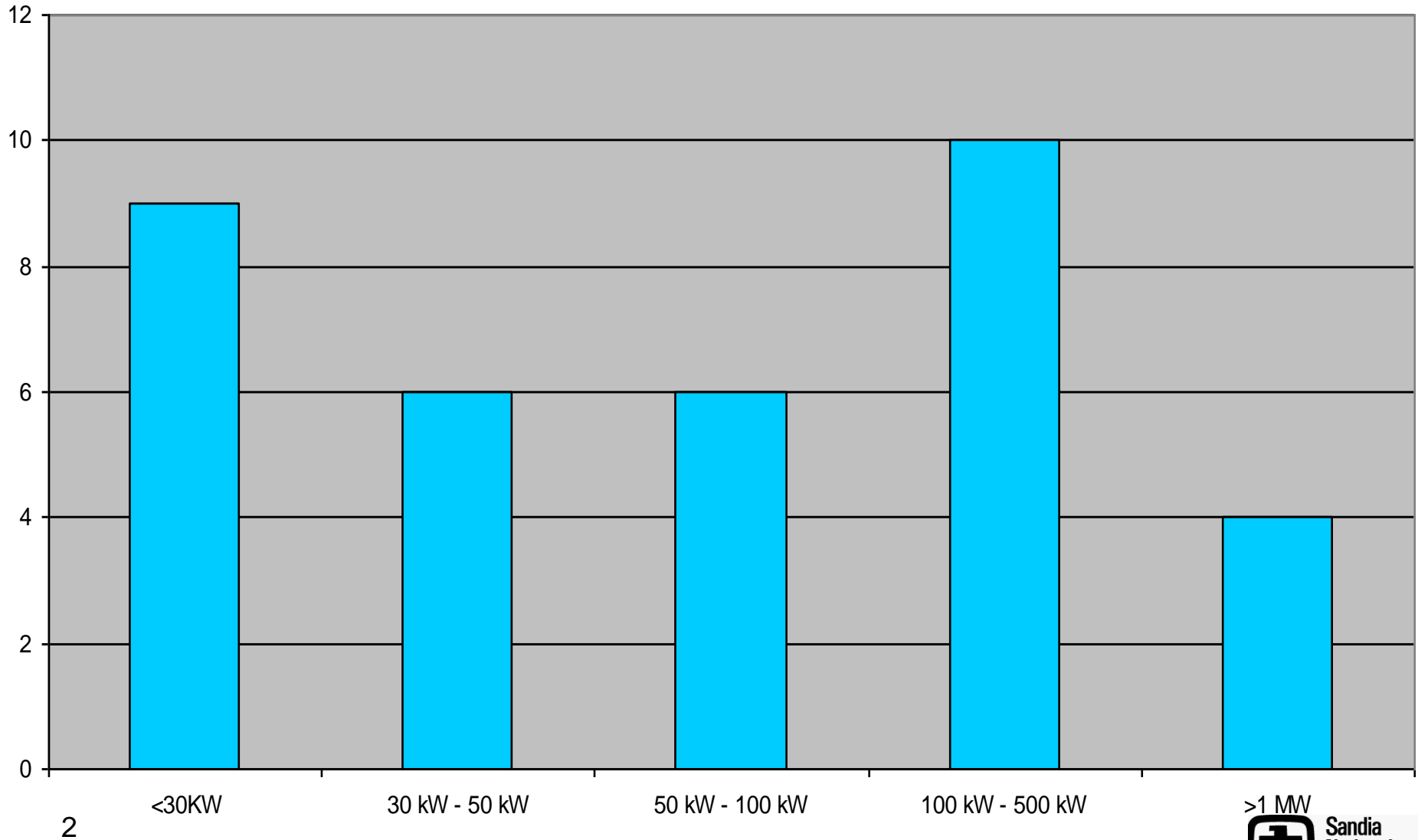
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Sandia acknowledges the support of the DOE Solar Energy Technologies Program in particular for the work presented here.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

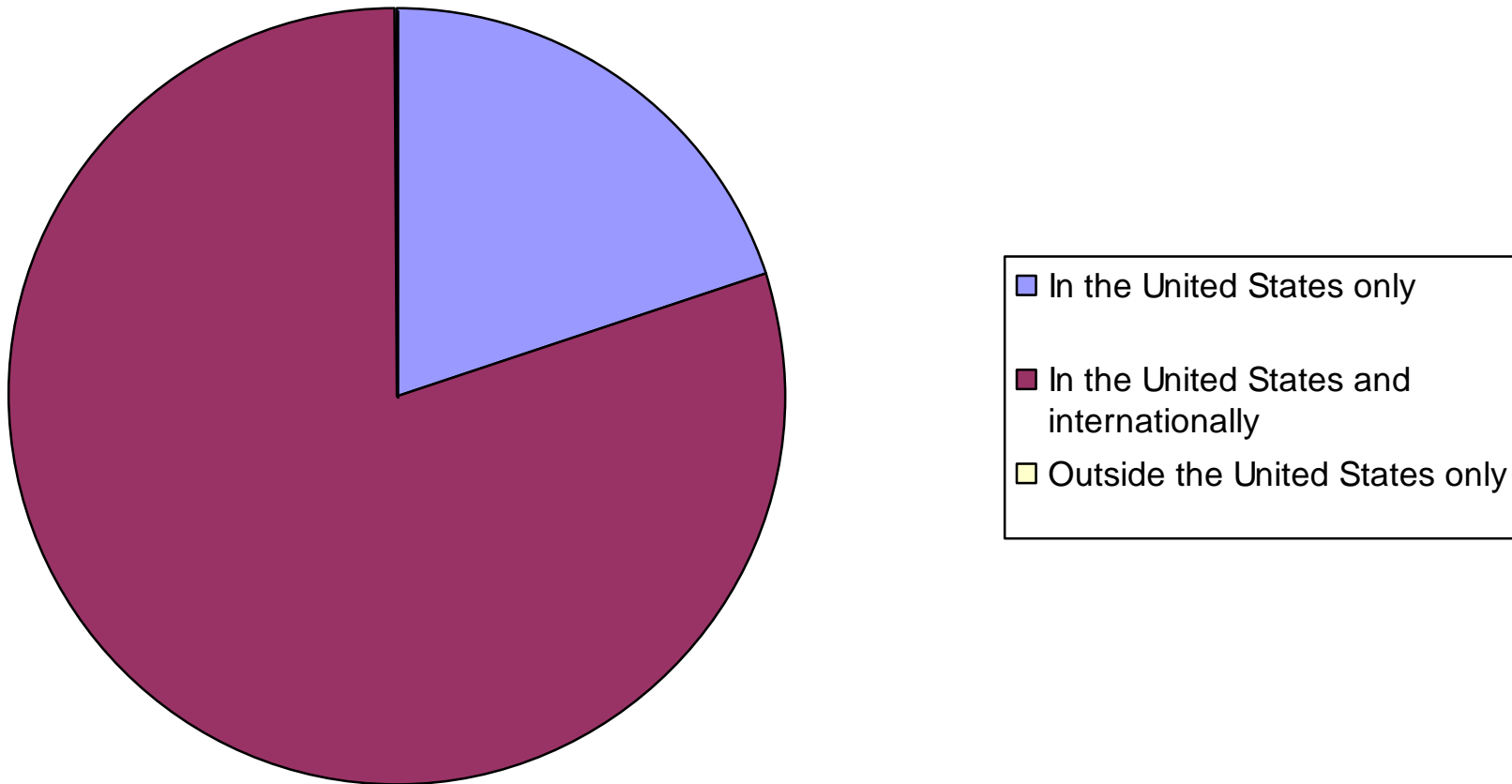


#1 What size inverters does your company produce?



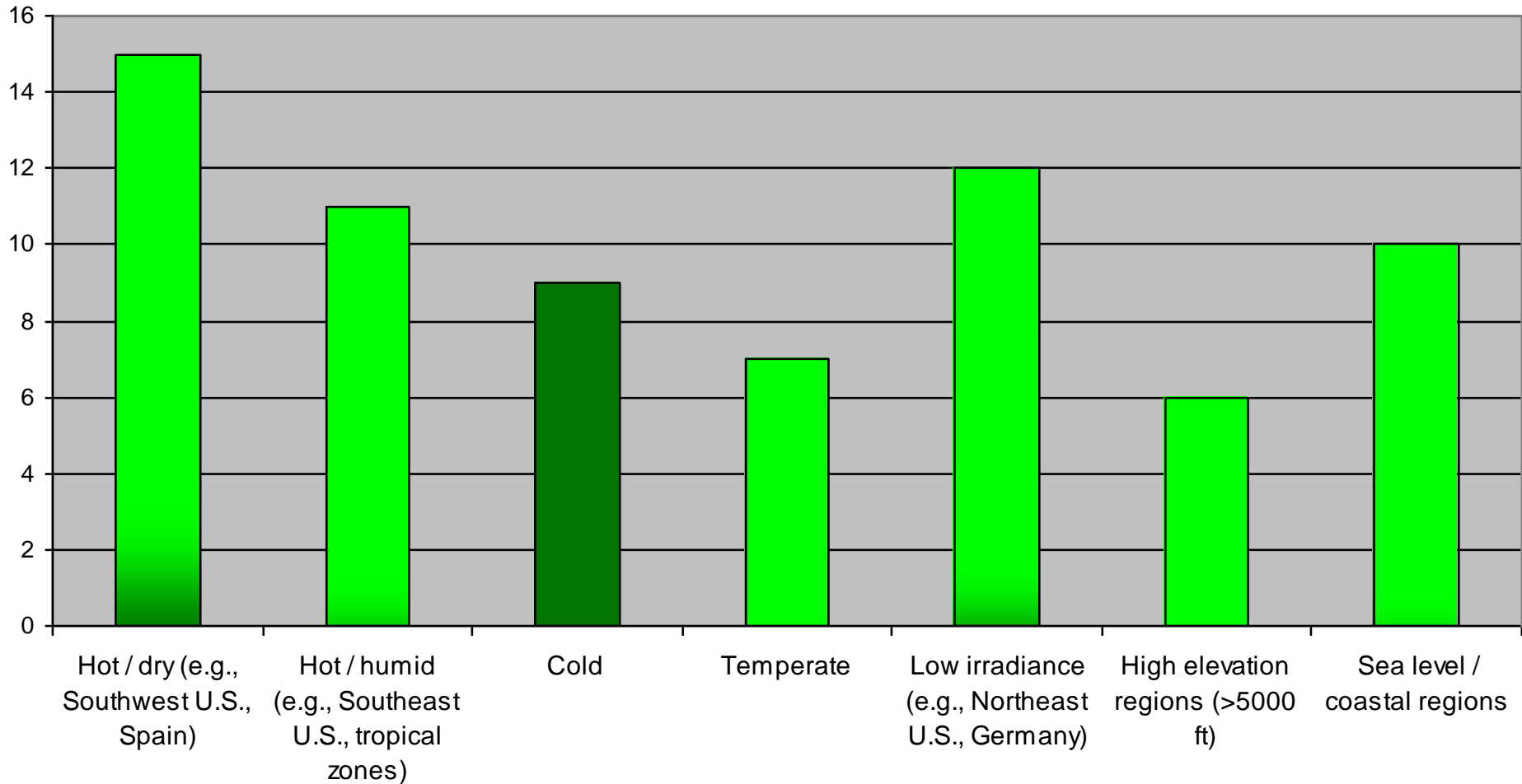


#2 Where has your company sold Inverters for PV systems?

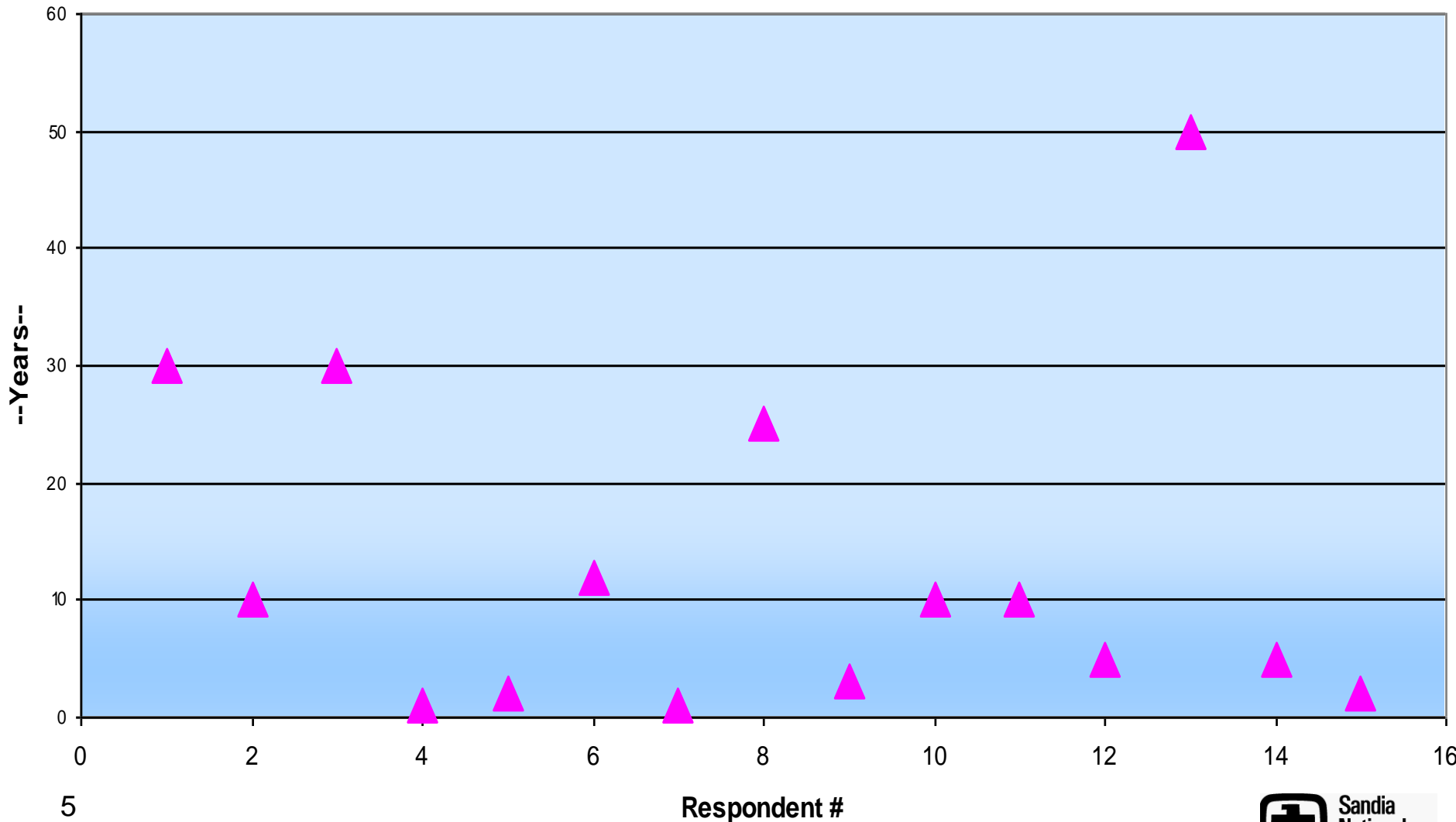




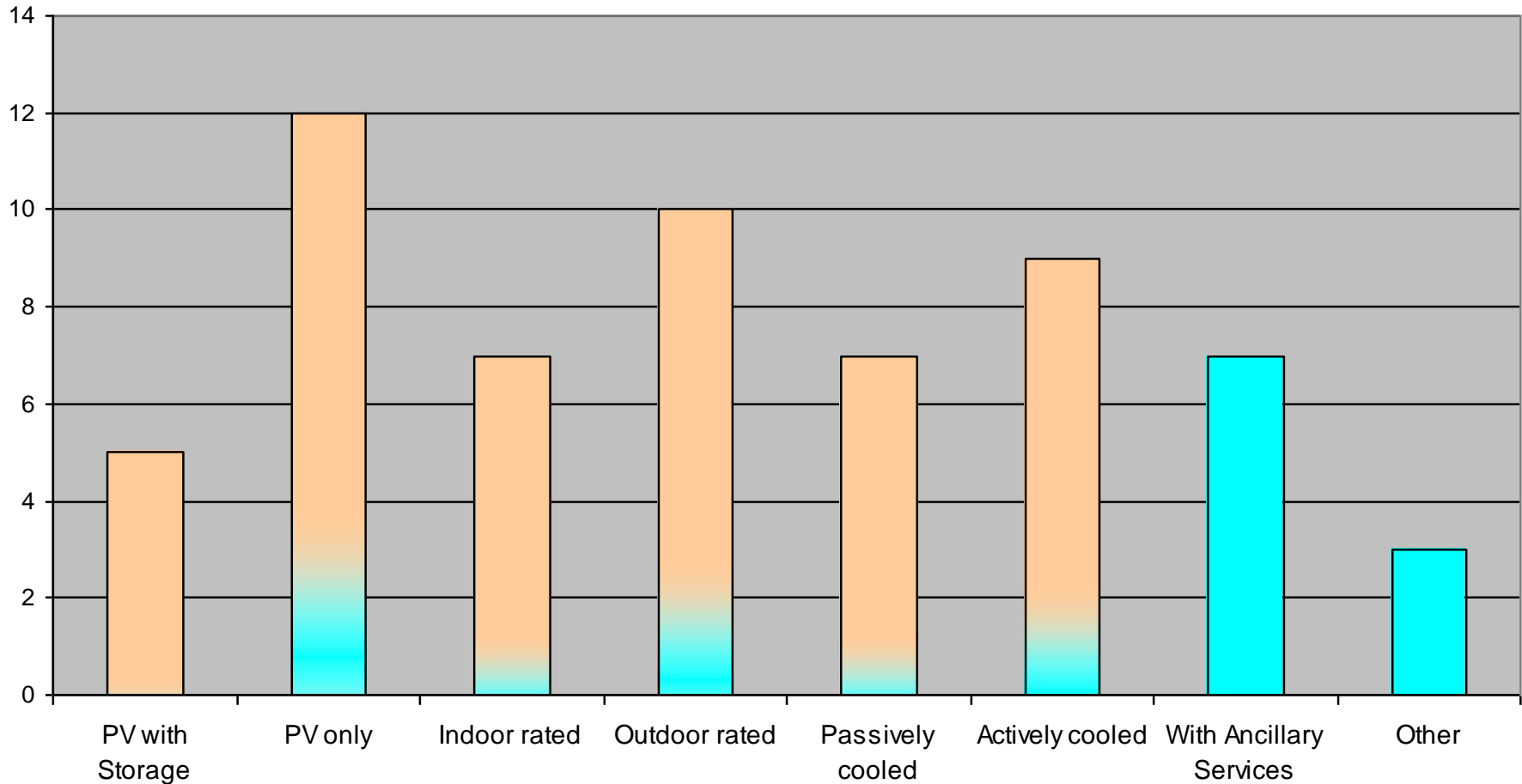
#3 In which climate zones are your inverters working (to your knowledge)?



#4 How many years has your company been in the PV Inverter business?



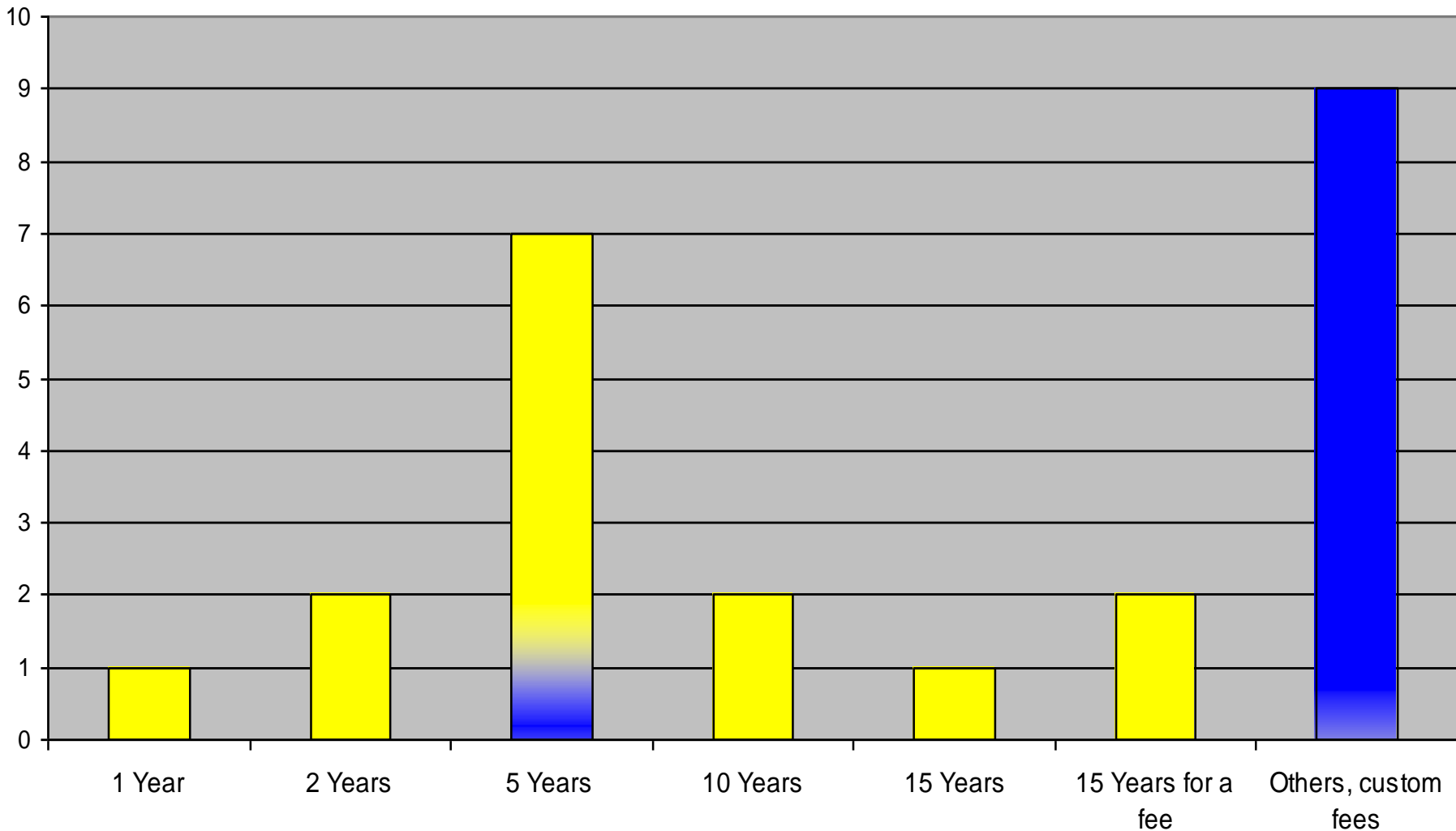
#5 What different types of inverters has/does your company design and market?



Other: Wind Turbine, Distributed Module Level Power Electronics



#6 What is the warranty offered by your company?



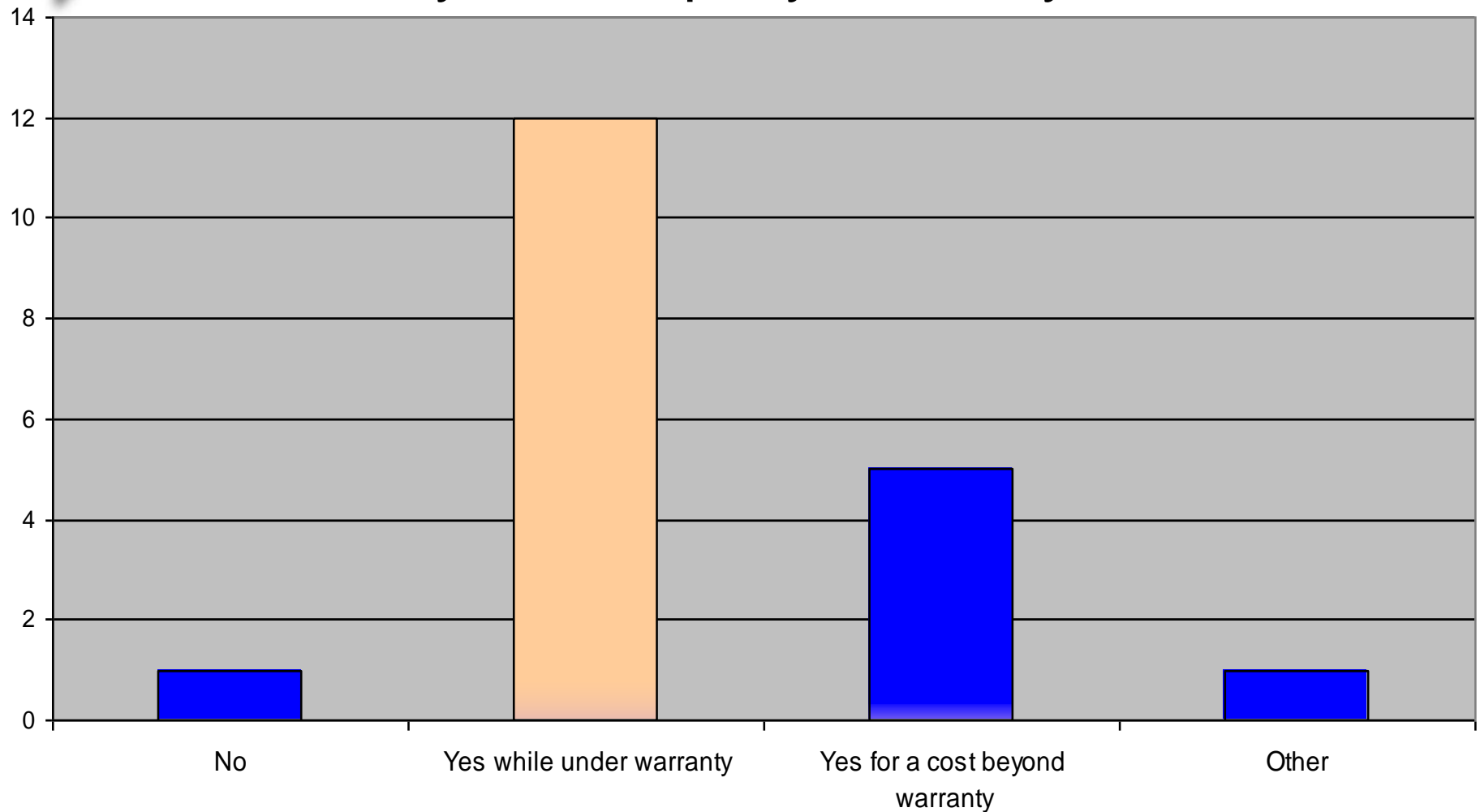


#6 What is the warranty offered by your company?

Other:

- 1 Year
- Extended service offerings beyond 10 years
- It can be extended up to 20 years
- 20 year for a fee
- 20 & 25 years
- For the life of the Power Purchase Agreement
- 12 Inverters,(20 with fee), 25 Power Boxes

#7 Does your company service your inverters?

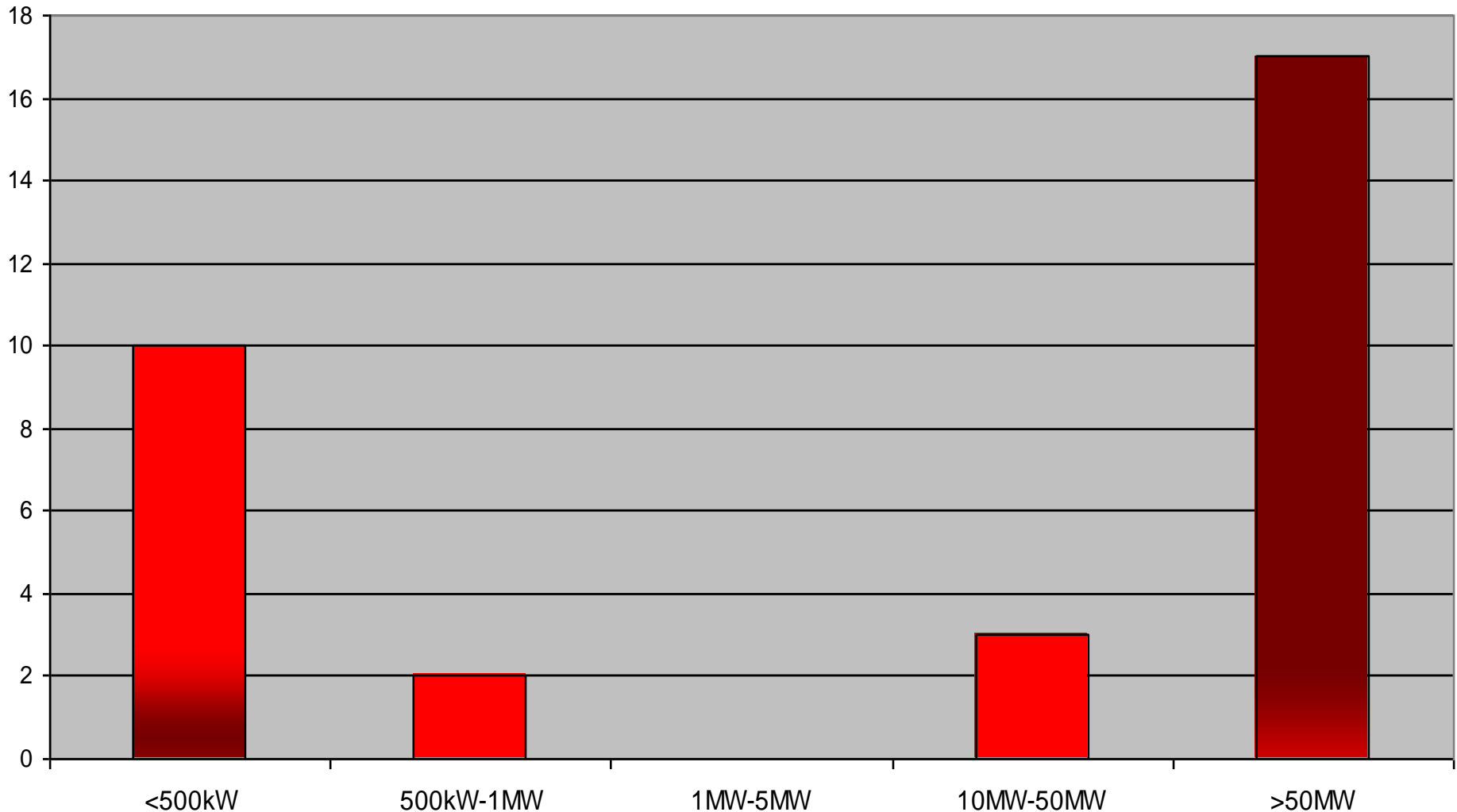


Other: - Enable more efficient warranty servicing by predictive maintenance

- If they are part of our plant service contract, then we will service the inverters on a limited basis. Complex repairs are left to the inverter manufacturer

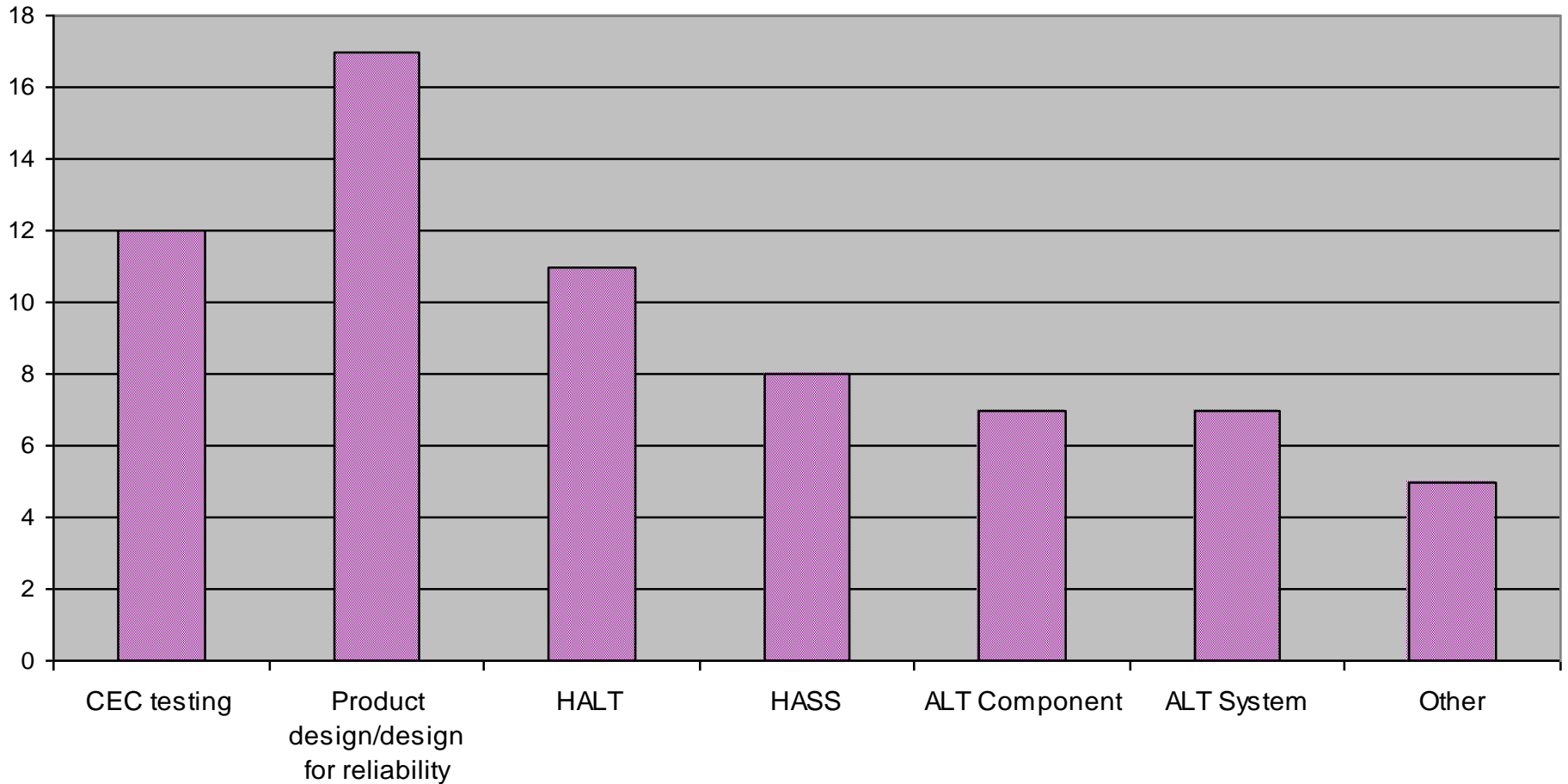
- Depends on model and country

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





#9 What reliability testing does your company currently perform?



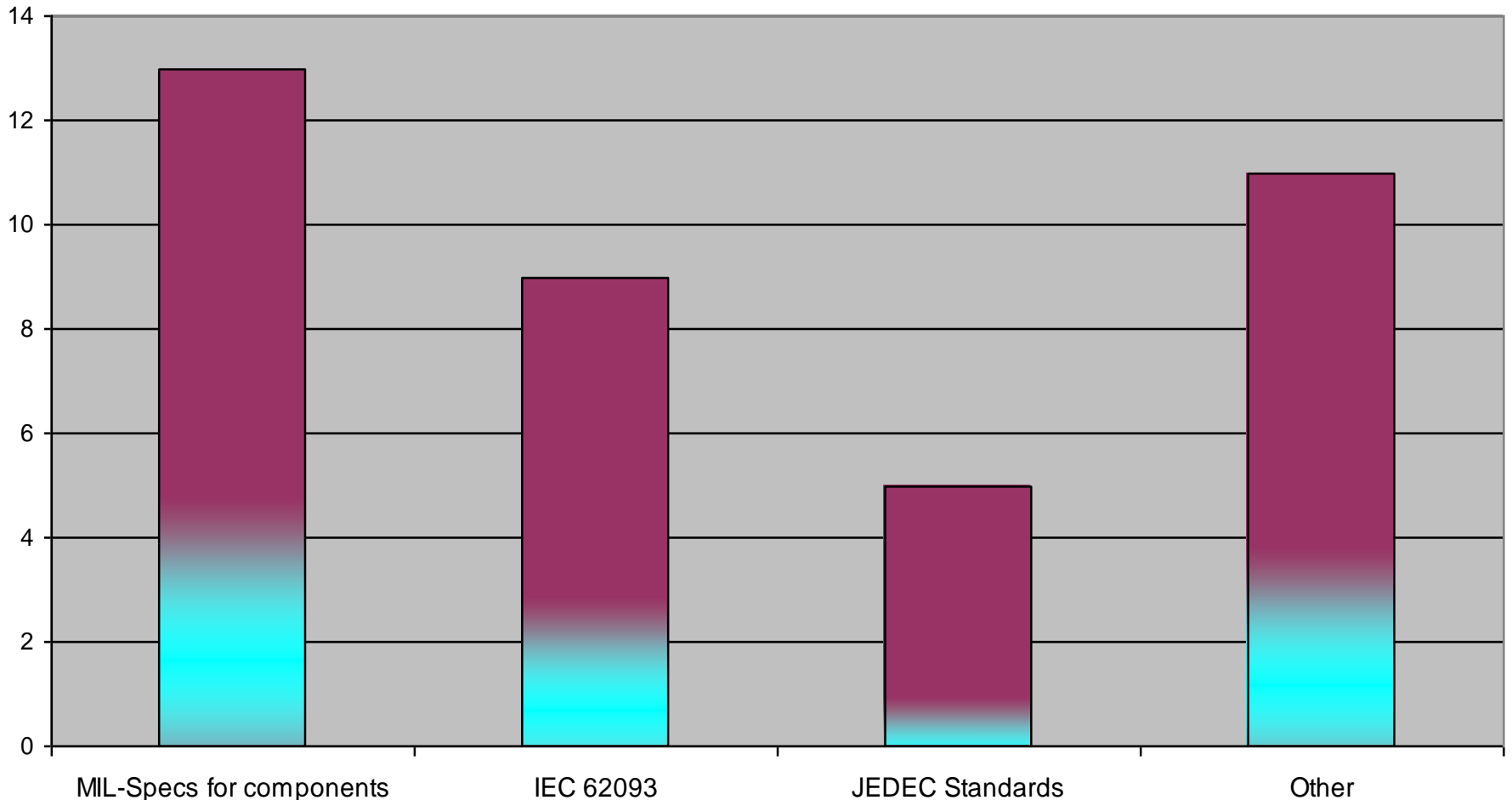


#9 What reliability testing does your company currently perform?

Other:

- Test to failure (2)
- UL 1741
- National Lab, compliance testing for 1547
- Grid interface tests covering the range of conditions expected in the field, including system faults and surges.
- Control boards
- We are a System Integrator and therefore specify that all/some of these tests be executed on products we purchase.
- As a system integrator we don't factory test inverters but we do track reliability.
- The testing is performed at our request by the inverter manufacturer.

#10 What reliability testing does your company currently perform?






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Other:

- IEC 62109
- IEC 50178 IEC 62109 UL 1741
- NERC
- EN 60068
- IEEE Orange Book
- Proprietary deratings
- Custom specs depending on study
- Reliability-Centered Maintenance
- Internal component testing / qualification (HALT/HASS).
Largest effort to date is on Capacitors.



#11 What are your top three(3) vulnerabilities or reliability issues for your inverters?

Responses (#):

1. Thermal Management (19)

a. excursions, ranges, ratings, hot, cold

2. Grid issues (18)

a. transients, overvoltage, surge protection

3. Component degradation/failure (17)

a. plastics, circuit boards, capacitors, contactors, fans, IGBT's

4. Environment (5)

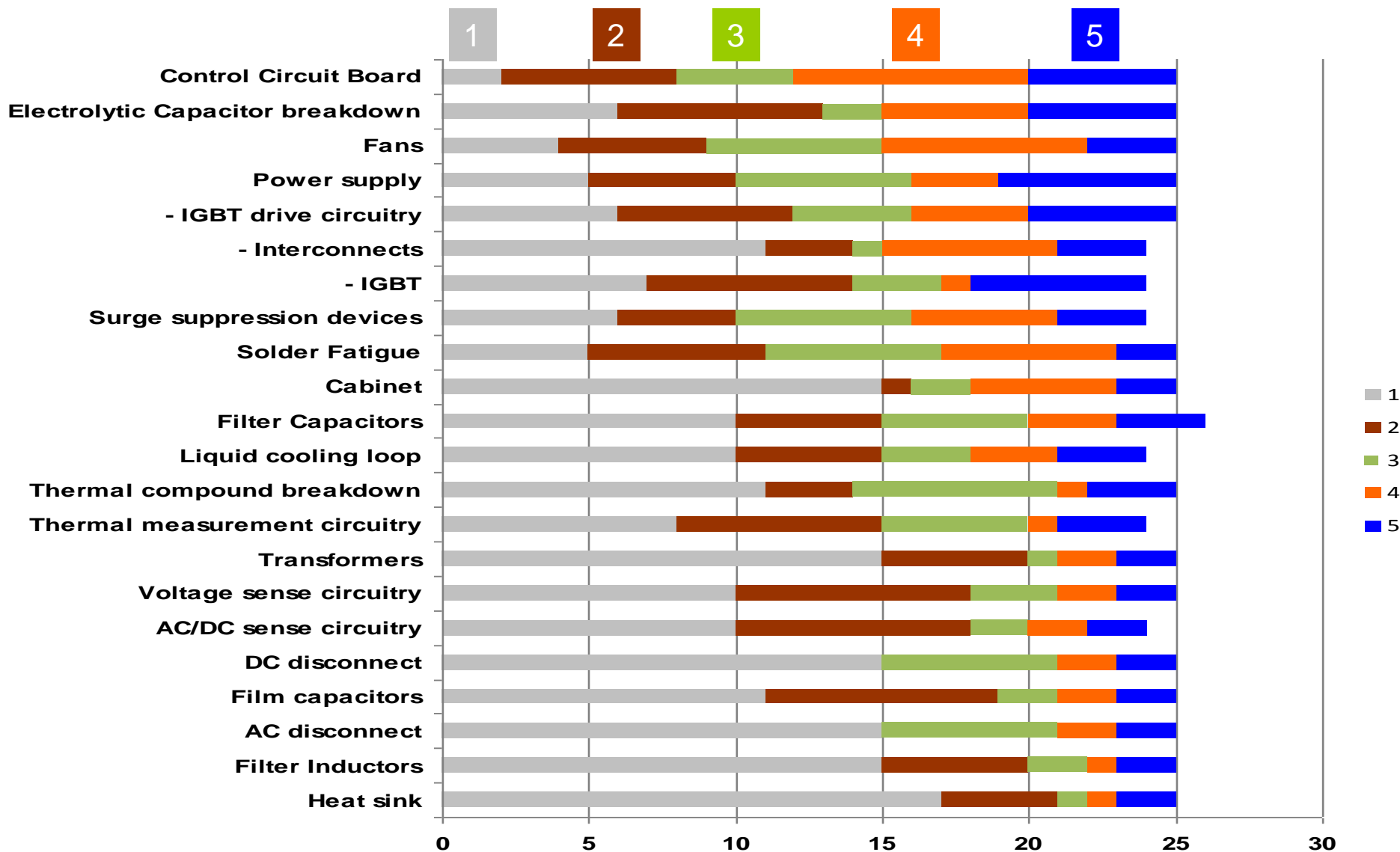
5. Communications (5)


a. standards, integration, expectations

6. Other (6) - software, safety, transport, install



#12 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% (Sorted 4+5)






#13 What are your top three (3) reliability drivers you worry about for your company and the industry as a whole?

Responses (#)

1. Components (28)
 - a. Capacitors (7)
 - b. IGBT (4)
 - c. Connectors
 - d. Fans
 - e. Fuse Holders
 - f. Communications
 - g. Materials (packaging)

Types of component concerns:


- Component application
- System design
- Derating
- Lifetime and Wearout
- Testing (especially new products)
- Failure (analysis and documentation)



#13 What are your top three (3) reliability drivers you worry about for your company and the industry as a whole?

Responses (#)

2. Business Practices as they relate to reliability
 - a. Cost and time constraints (5)
 - b. Supply chain management – QC (5)
 - c. Warranty and service (4)
3. Reliability Practices and assessment
 - a. Design for Reliability (5)
 - b. Reliability metrics (4)
 - c. Operation & Maintenance (2)
 - d. Certification & Standards (1)
4. Grid excursions (3)
5. Thermal management (3)
6. Others (11)



#14 What do you hope to get out of participating in a reliability workshop?

- Help industry improve; identify areas of improvement
- Professional development, gain experience
- Network with industry professionals; share information and ideas
- Identify, prioritize and quantify reliability issues by cost impact and time-to-remedy
 - Contribute to the understanding of IGBT reliability
- Benchmark what others are doing; update on trends related to reliability
- Express the needs of consumers
- Gain an understanding of Standards trends
 - Design Standards
 - Testing Standards
- How to collaborate with DOE/Sandia

Summary

- Your expectations are our expectations-
 - look for reliability improvement opportunities while learning from each other
- Component reliability is a big concern
 - Capacitors, IGBT's, drive circuitry, power supplies, circuit boards
- Reliability methodologies and best practices are a big concern
 - Design for Reliability
 - Reliability Metrics
 - Certification, Codes, Standards
 - Failure identification, Failure Analysis
 - Testing; function, safety, ALT's
- Vulnerabilities
 - Thermal management
 - Grid issues
 - Components
 - Environment
 - Communications