



# Solar Operations and Maintenance Training

Curriculum Development Support from Wisconsin  
Distributed Resources Collaborative

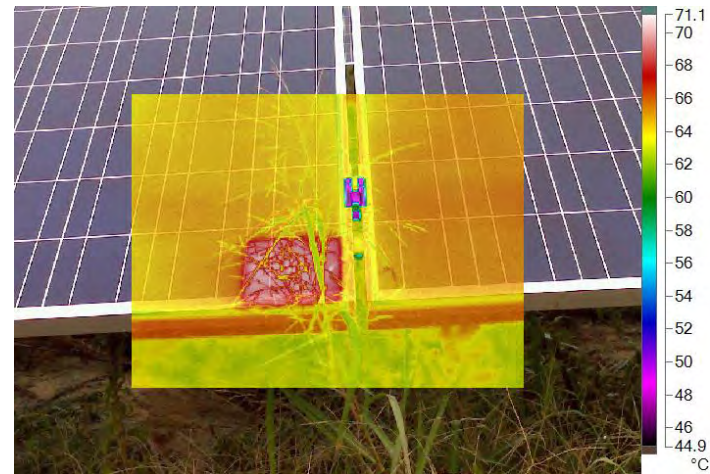
Presented by Julie Brazeau (MREA)

1/19/18

# Solar Operations and Maintenance (O&M) Training

## Project Goals:

Develop and deliver advanced Solar Operations and Maintenance (O&M) training to municipalities, facility owners and solar contractors in Wisconsin with the objective of ensuring that new and existing PV systems in Wisconsin are properly maintained throughout their expected lifetimes of 25 or more years.



# PV Operations and Maintenance

## Subject Matter Expert: Cari Helberg

Cari Helberg is the Asset Manager for Ecos Energy, based in Minneapolis, MN. She is responsible for the operation of more than 30 MW of utility-scale solar plants throughout the US. She is a licensed master electrician and IAEI certified electrical inspector. When not in the field, she teaches classes in code calculations, code updates and Article 690 (solar PV).



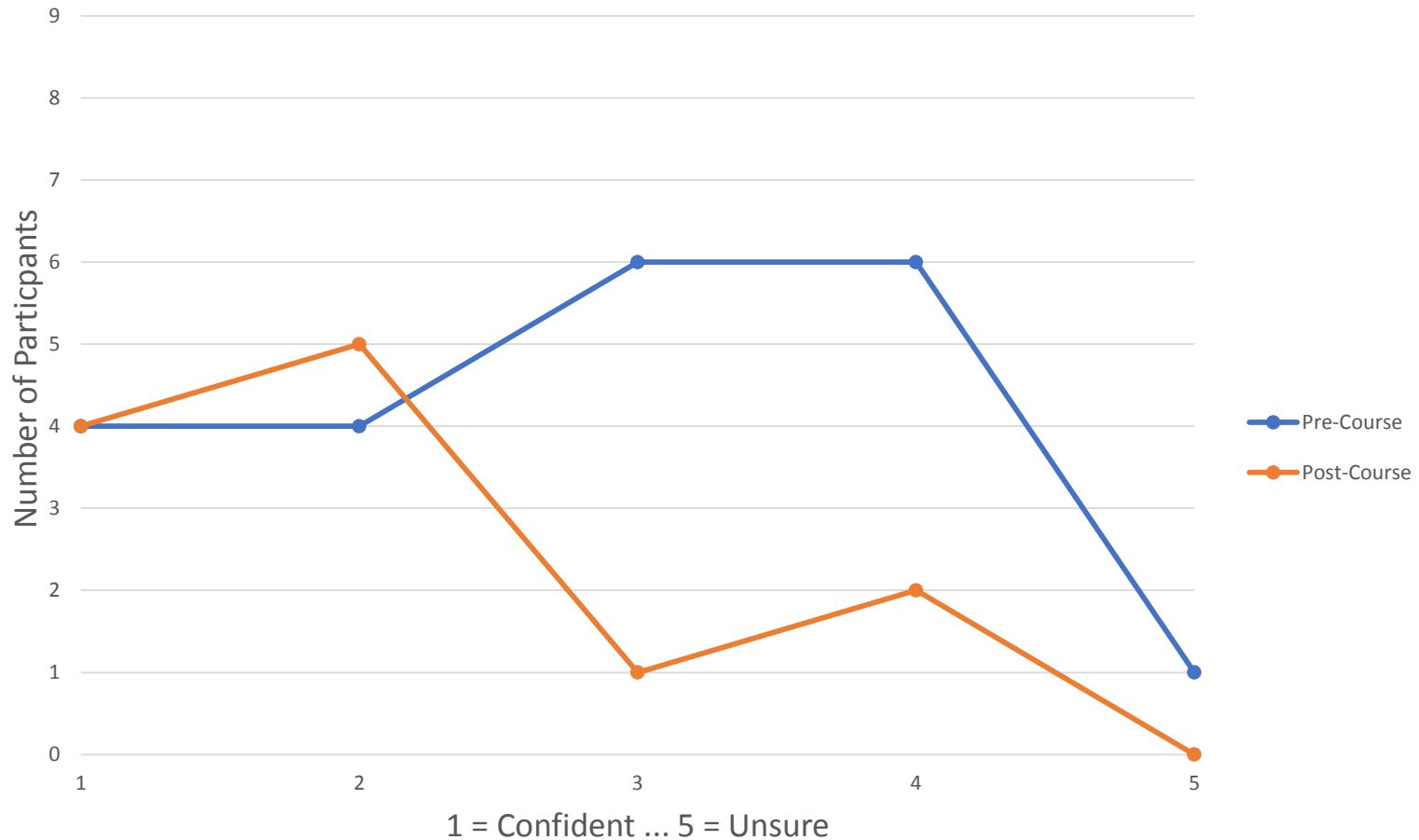
# PV Operations and Maintenance

## Course Development

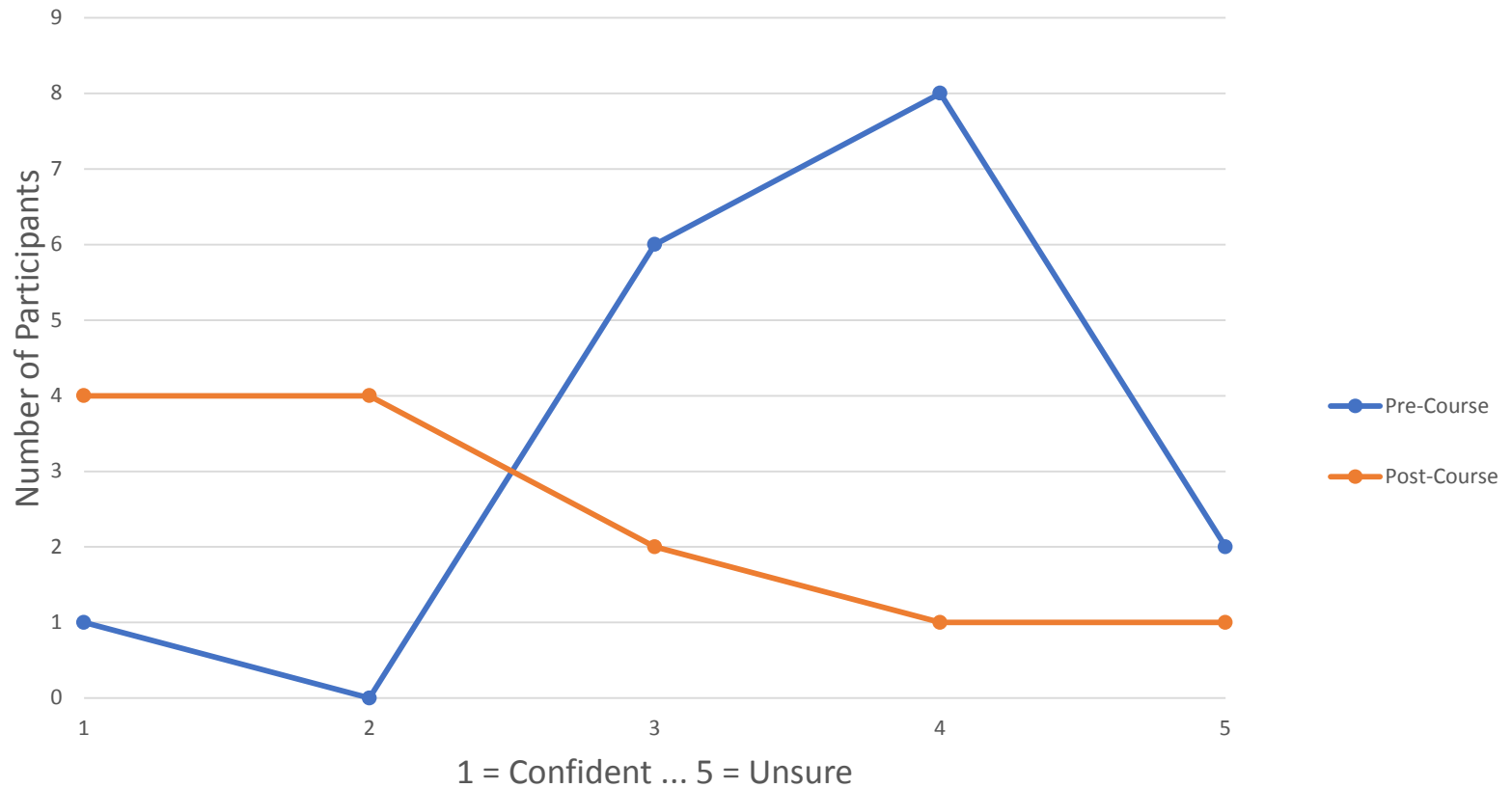
### **Establish Learning Objectives:**

1. Recognize hazards related to working with PV systems
2. Describe steps necessary for performing visual PV inspection
3. Identify and remove obstructions to the solar window
4. Identify improperly installed PV components
5. Calculate expected PV system energy output
6. Compare expected PV system output with system monitoring data
7. Identify equipment required for taking safe field measurements
8. Measure system output (voltage, current, power and energy)
9. Verify and interpret field measurements
10. Recognize common PV system malfunctions
11. Follow logical troubleshooting procedures
12. Identify proper protocols in re-commissioning PV system

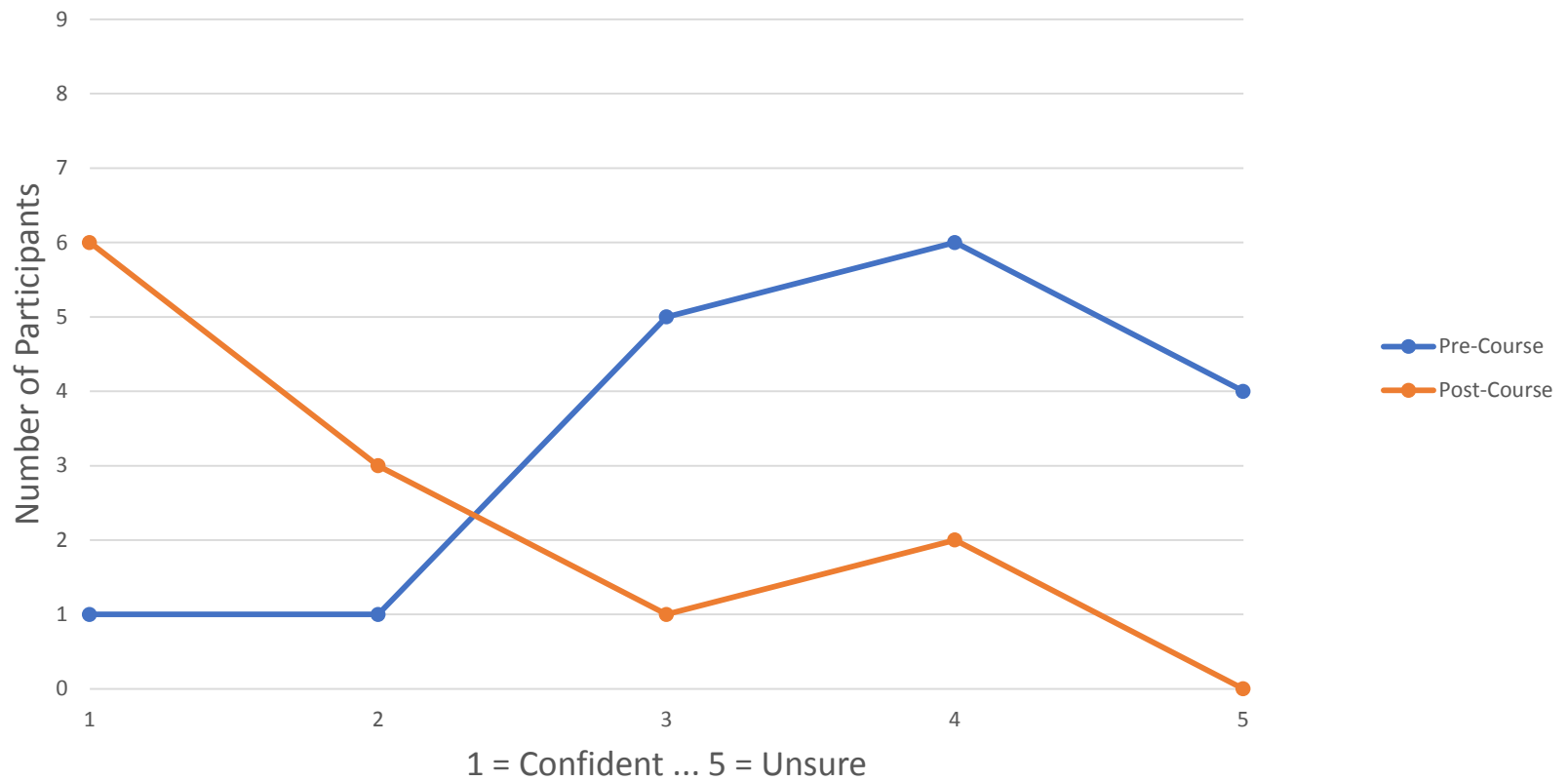
# 1) Recognize Safety Hazards Related to Working with PV systems



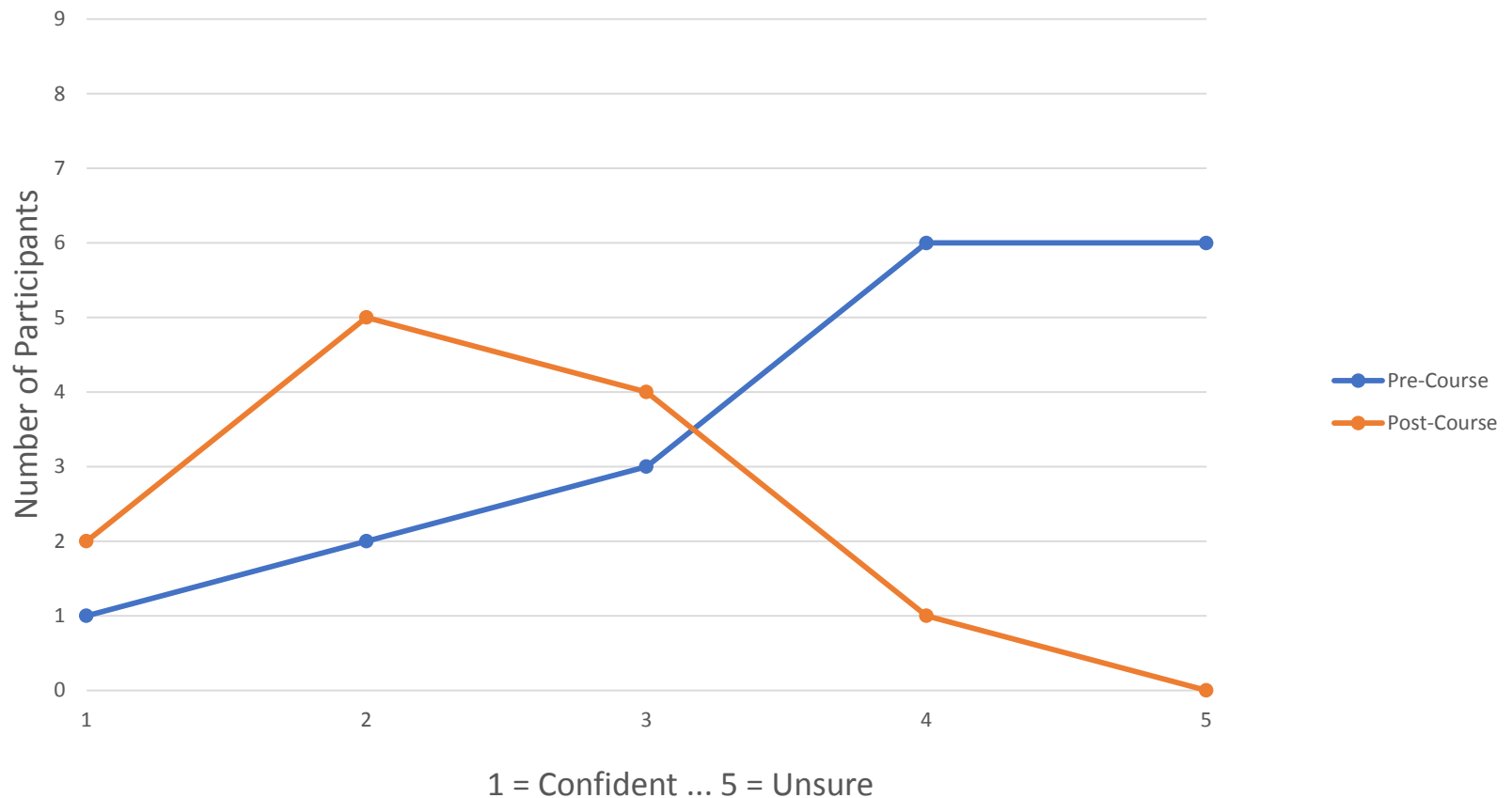
## 2) Describe Steps Necessary for Performing Visual PV Inspection



### 3) Identify and Remove Obstructions to the Solar Window

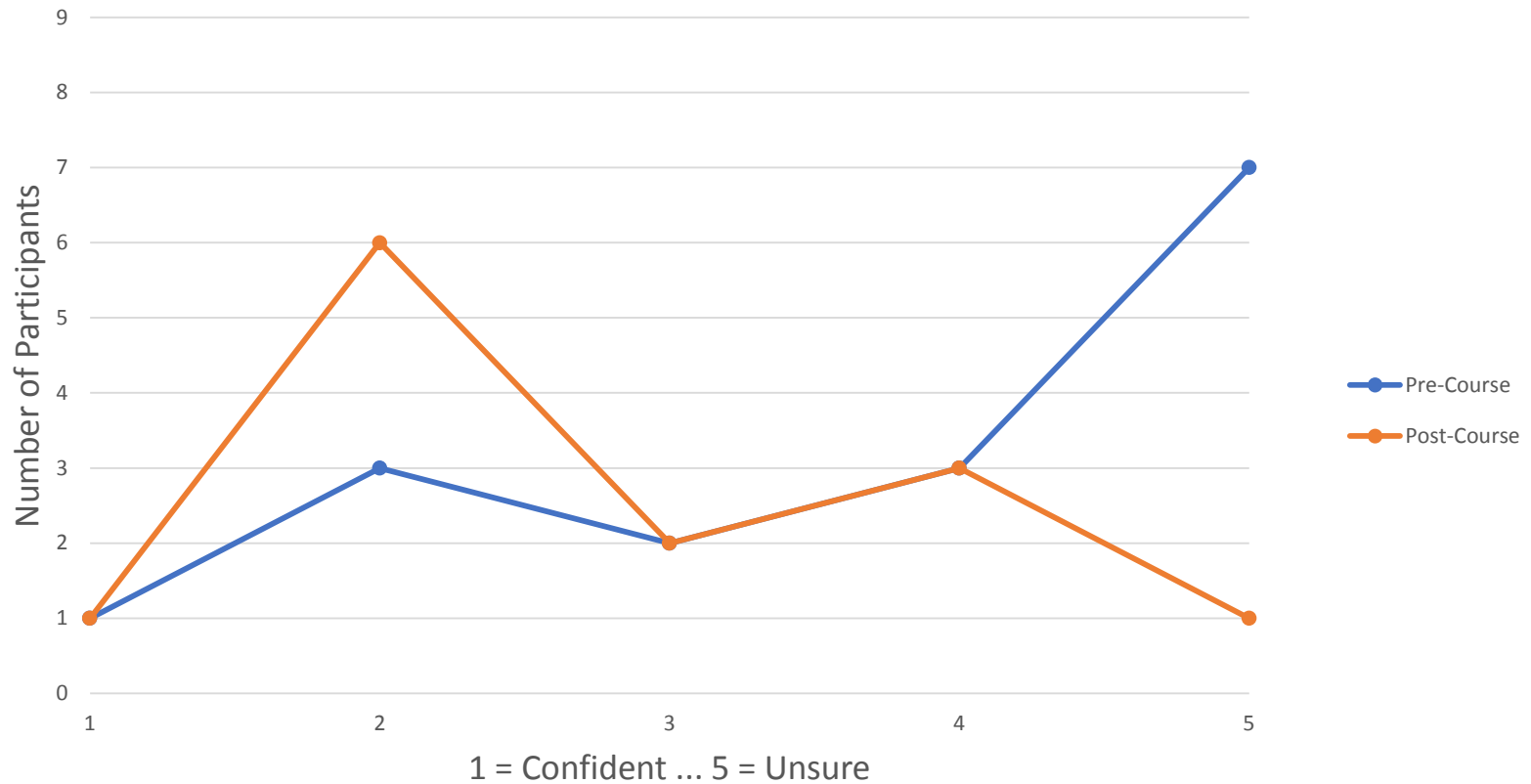


## 4) Identify Improperly Installed PV Components

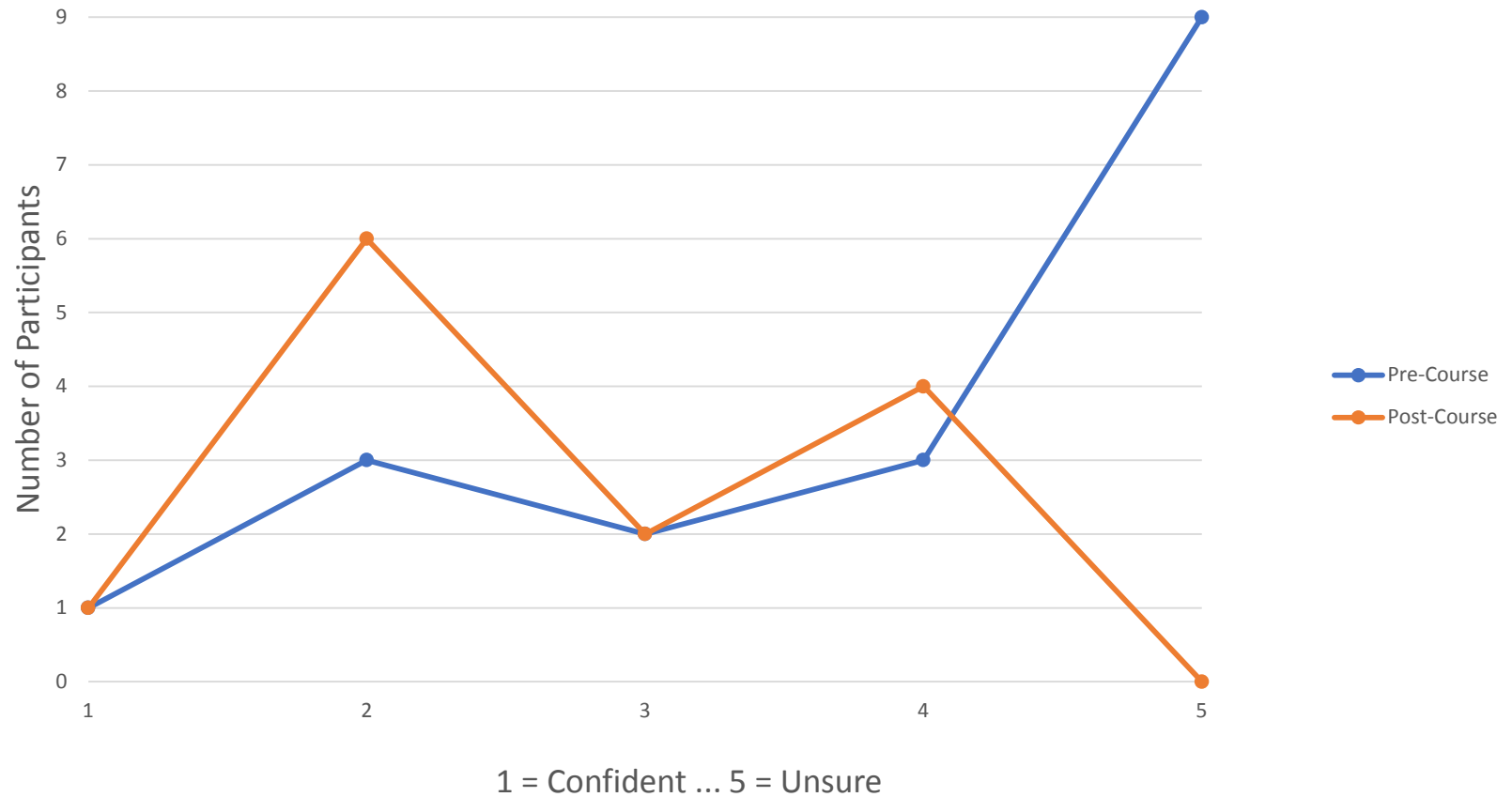




# 5) Calculate Expected PV System Energy Output



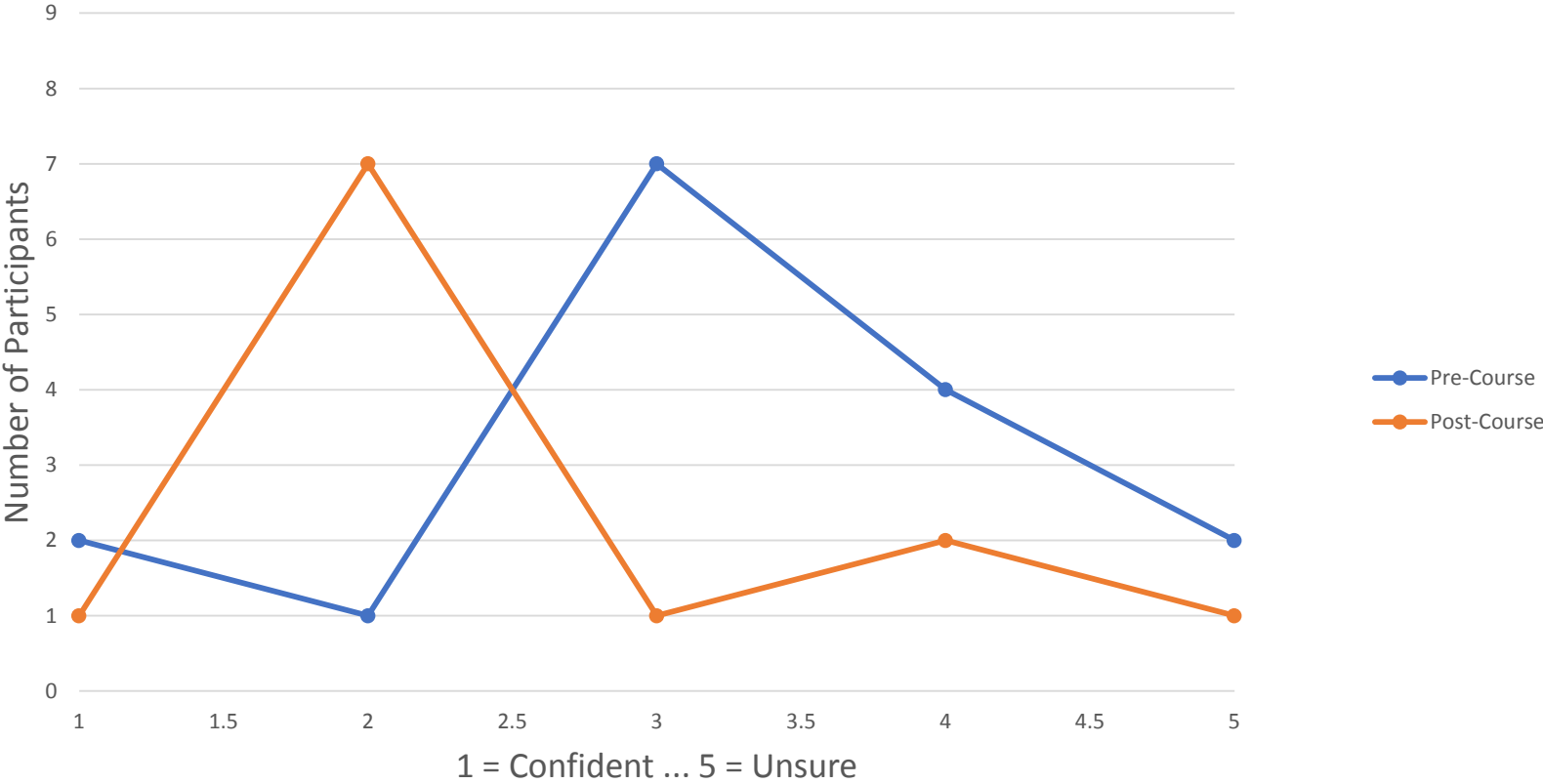
## 6) Compare expected PV system output with system monitoring data



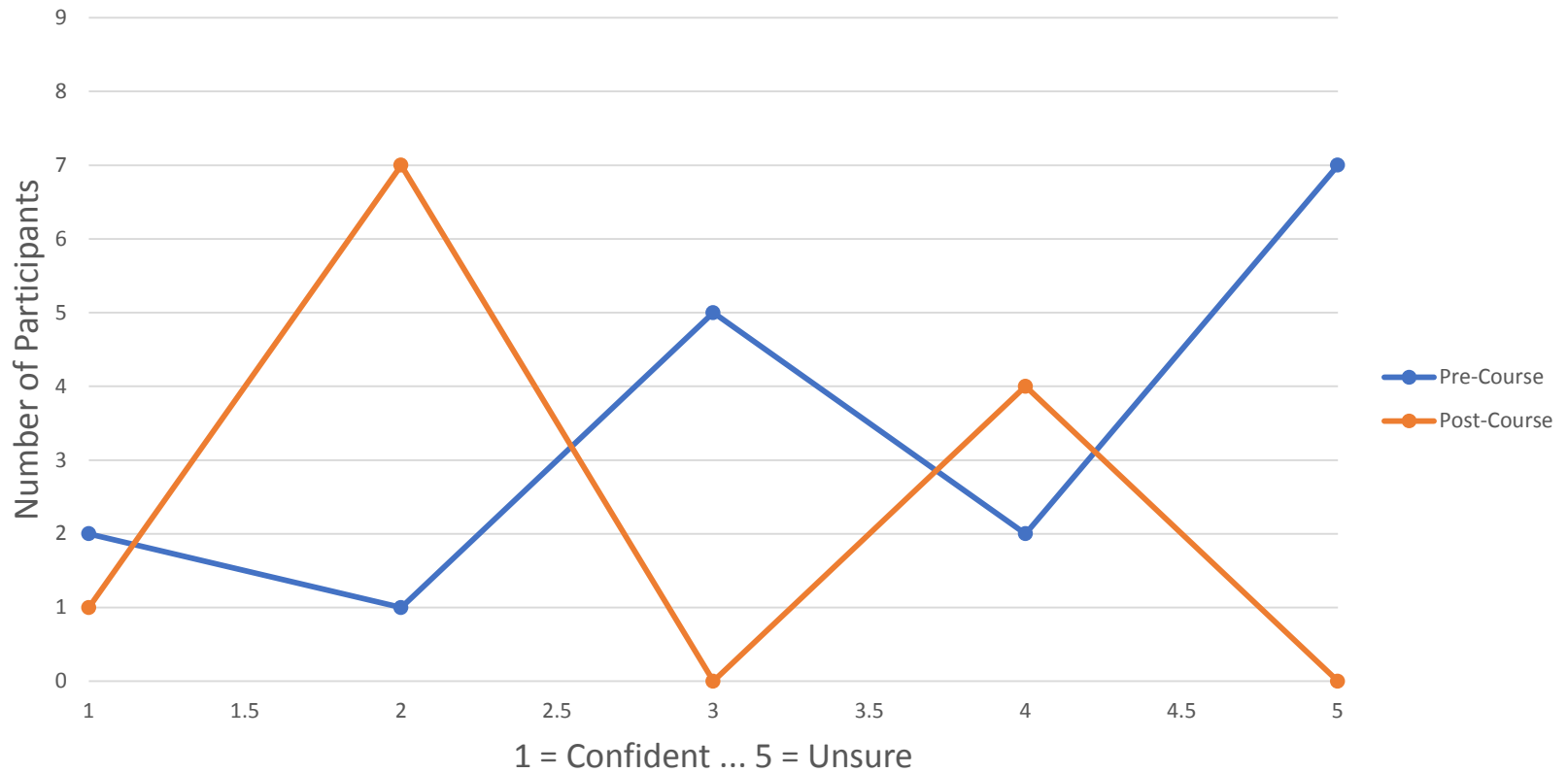
# 7) Identify equipment required for taking safe field measurements



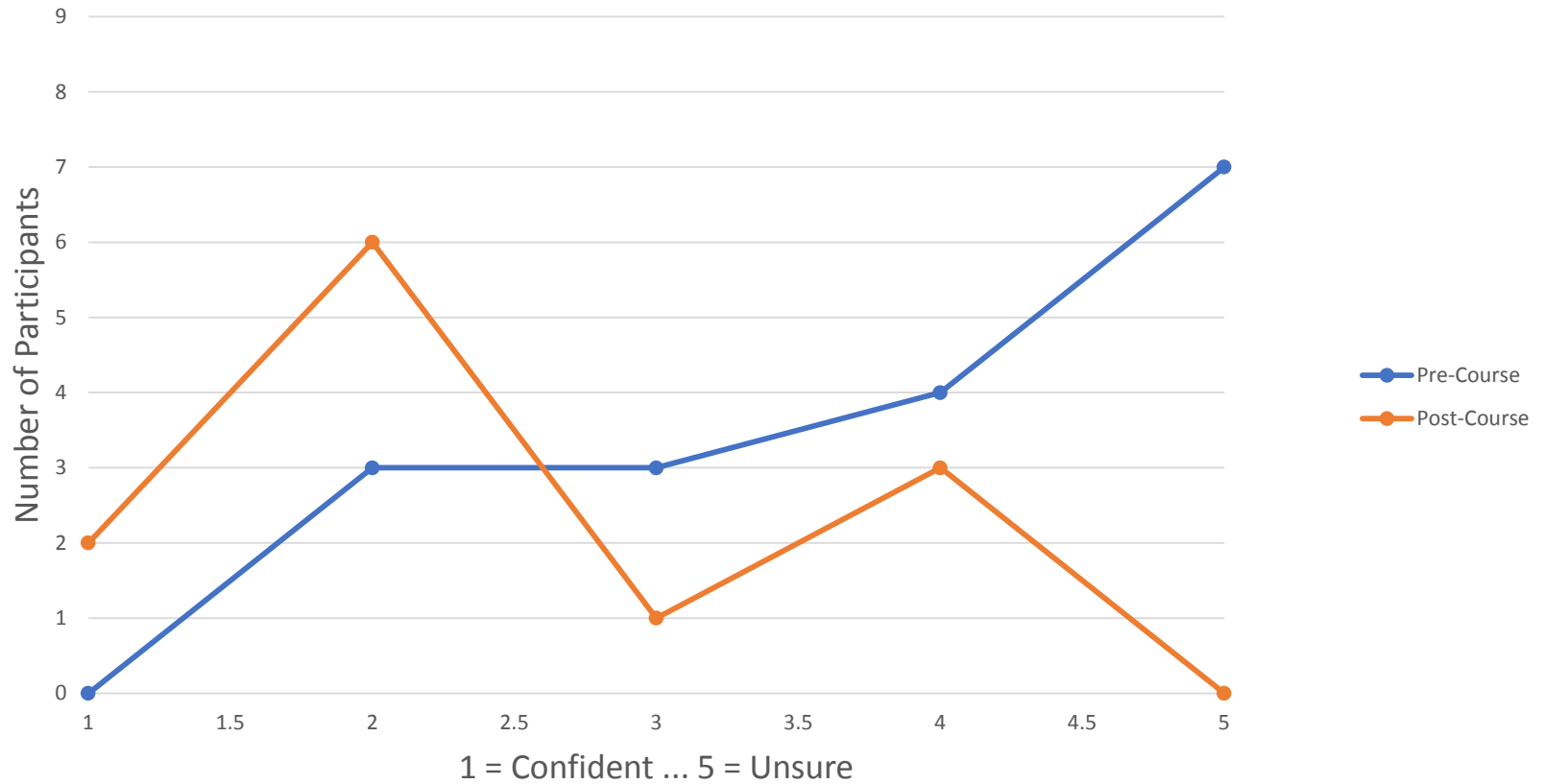
# 8) Measure System Output (Voltage, Current, Power and Energy)



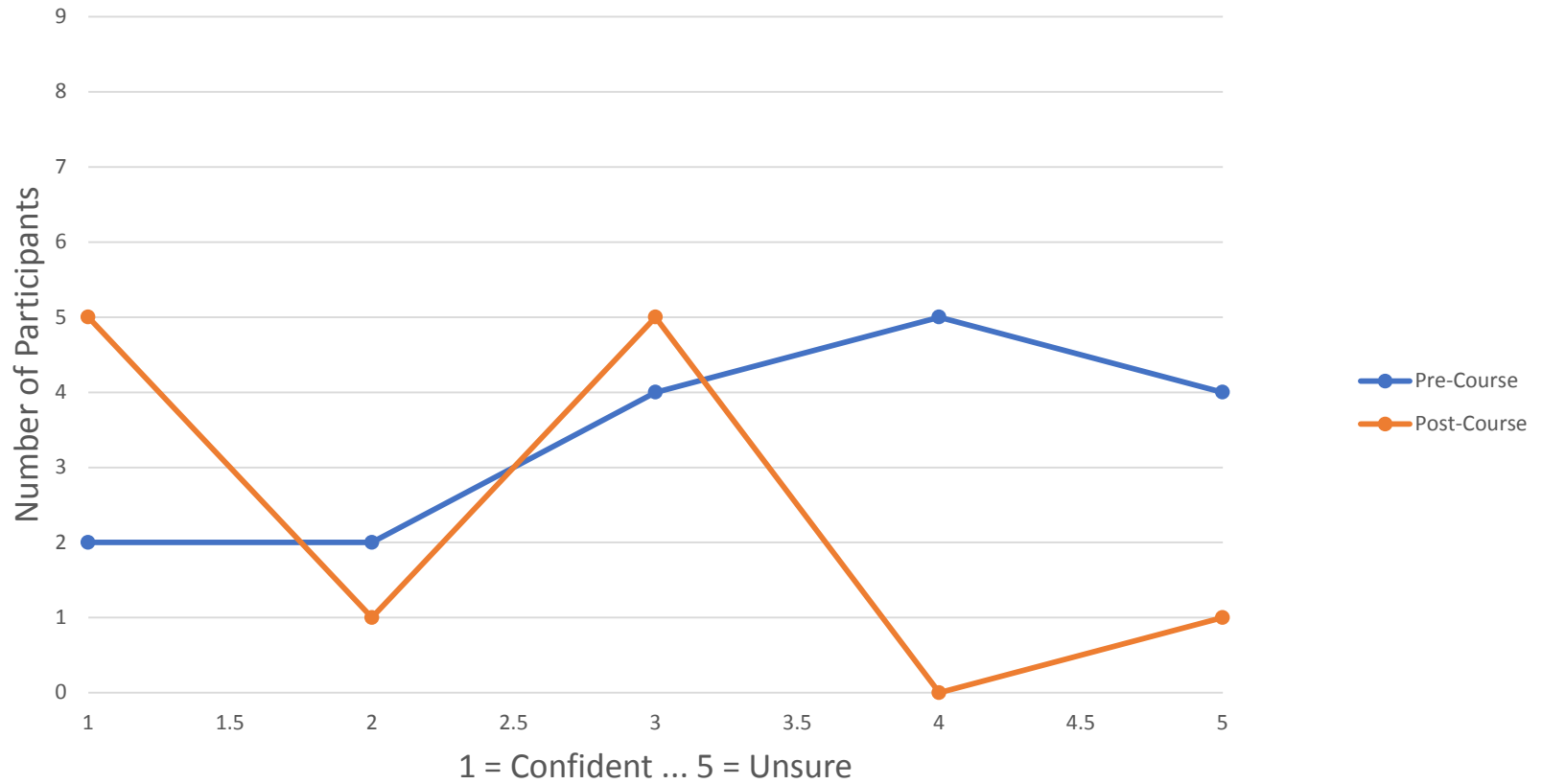
# 9) Verify and Interpret Field Measurements



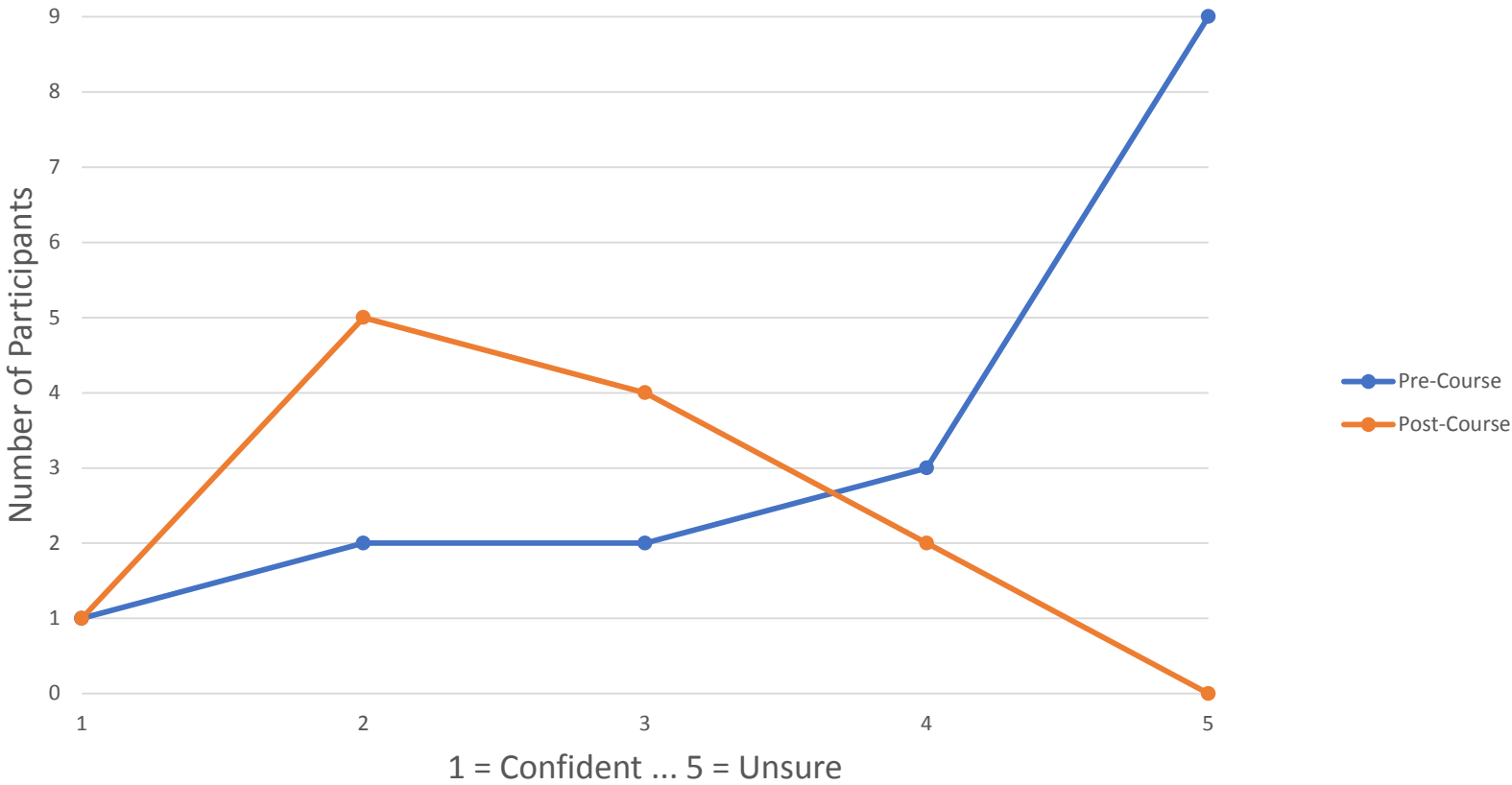
# 10) Recognize Common PV System Malfunctions



# 11) Follow Logical Troubleshooting Procedures



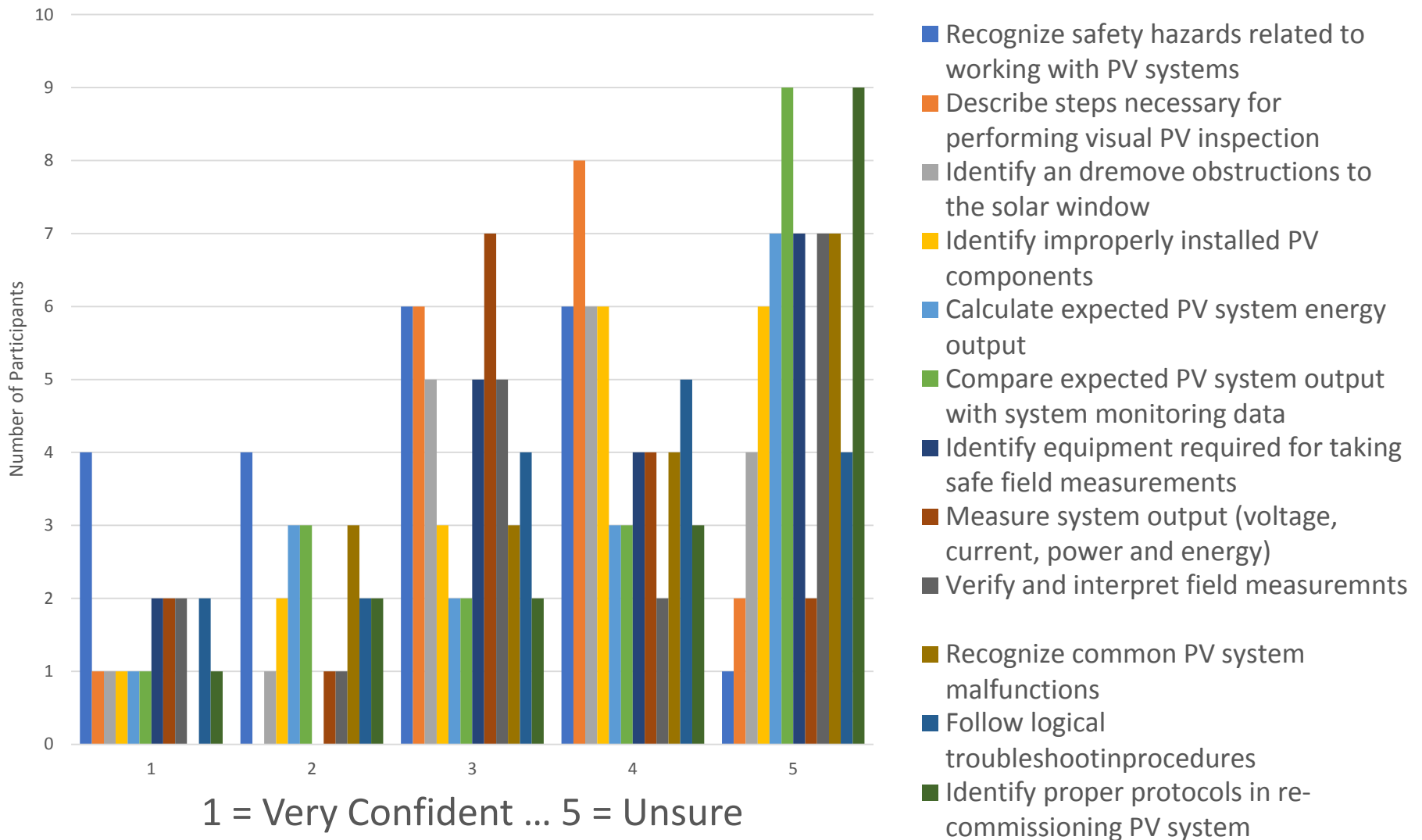
# 12) Identify proper protocols in re-commissioning PV system



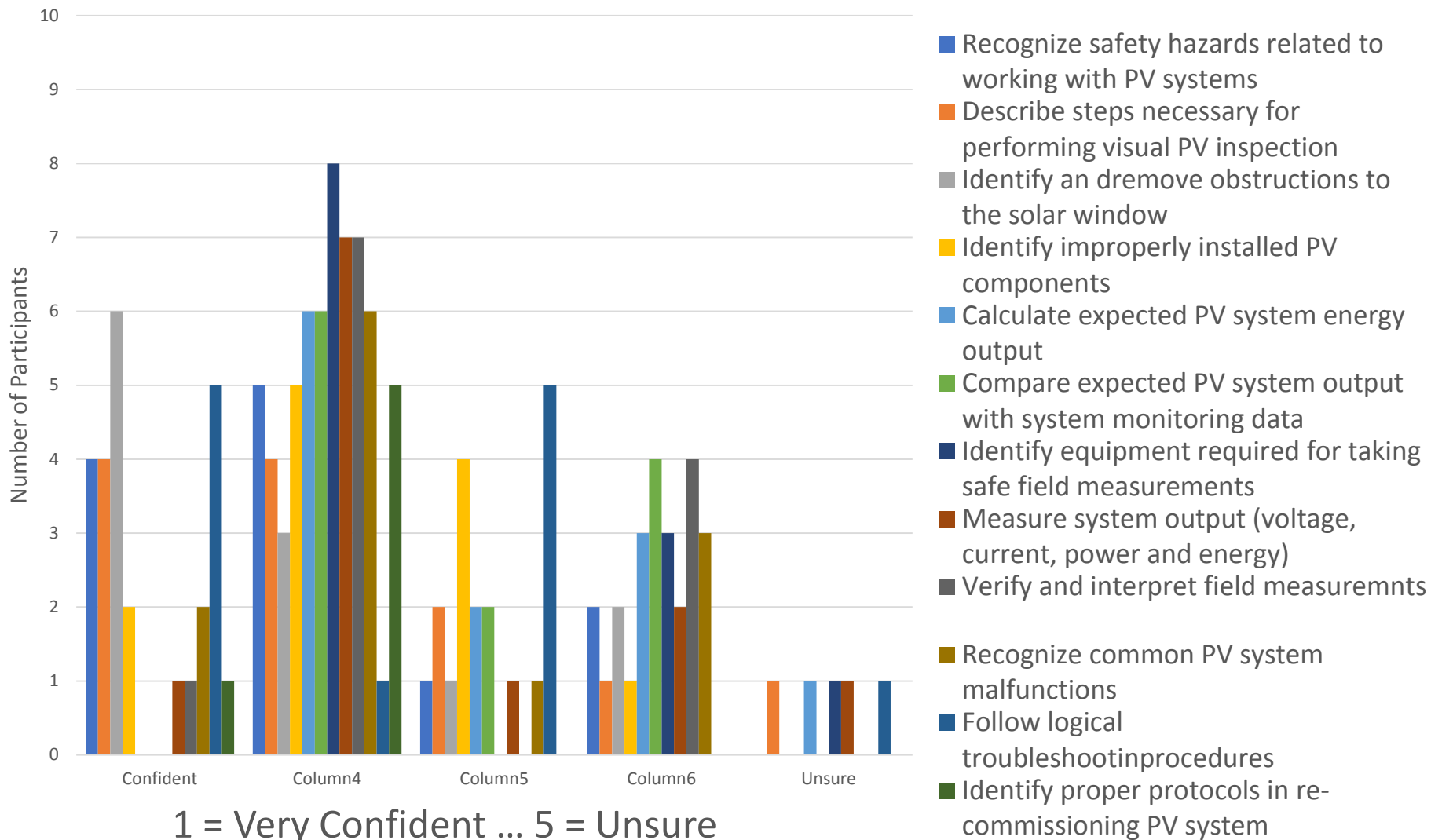


# Measuring Training Success

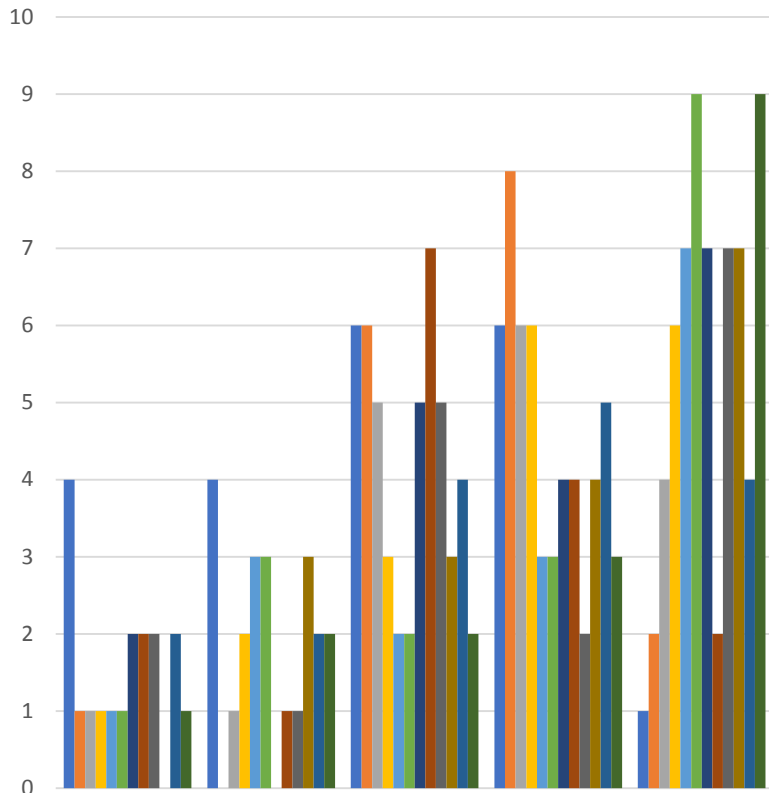
## Pre Training Assessment



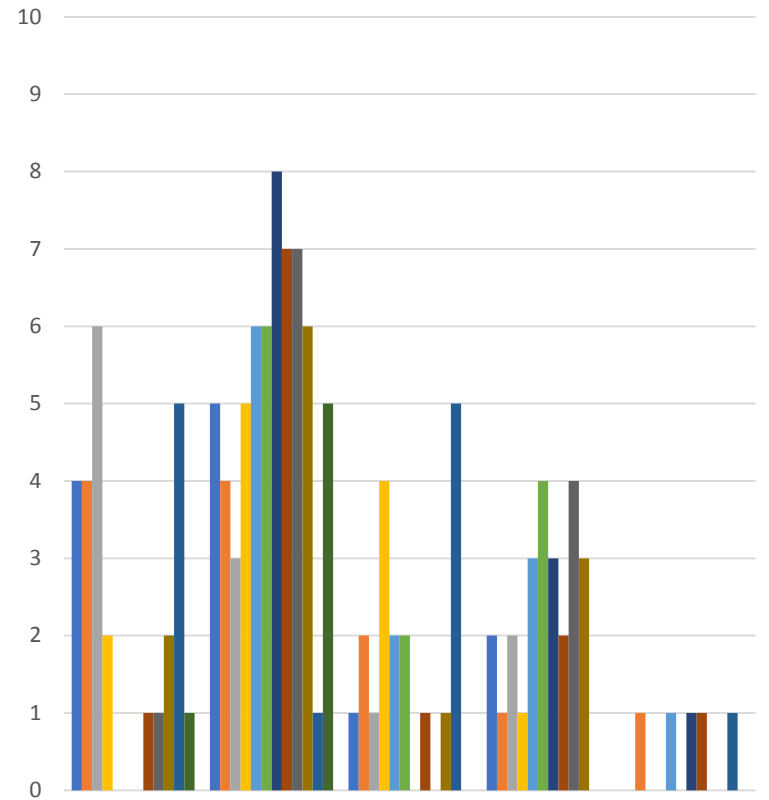
# Measuring Training Success Post Training Assessment



# Pre-Course vs. Post-Course Assessment



Pre-Course Assessment

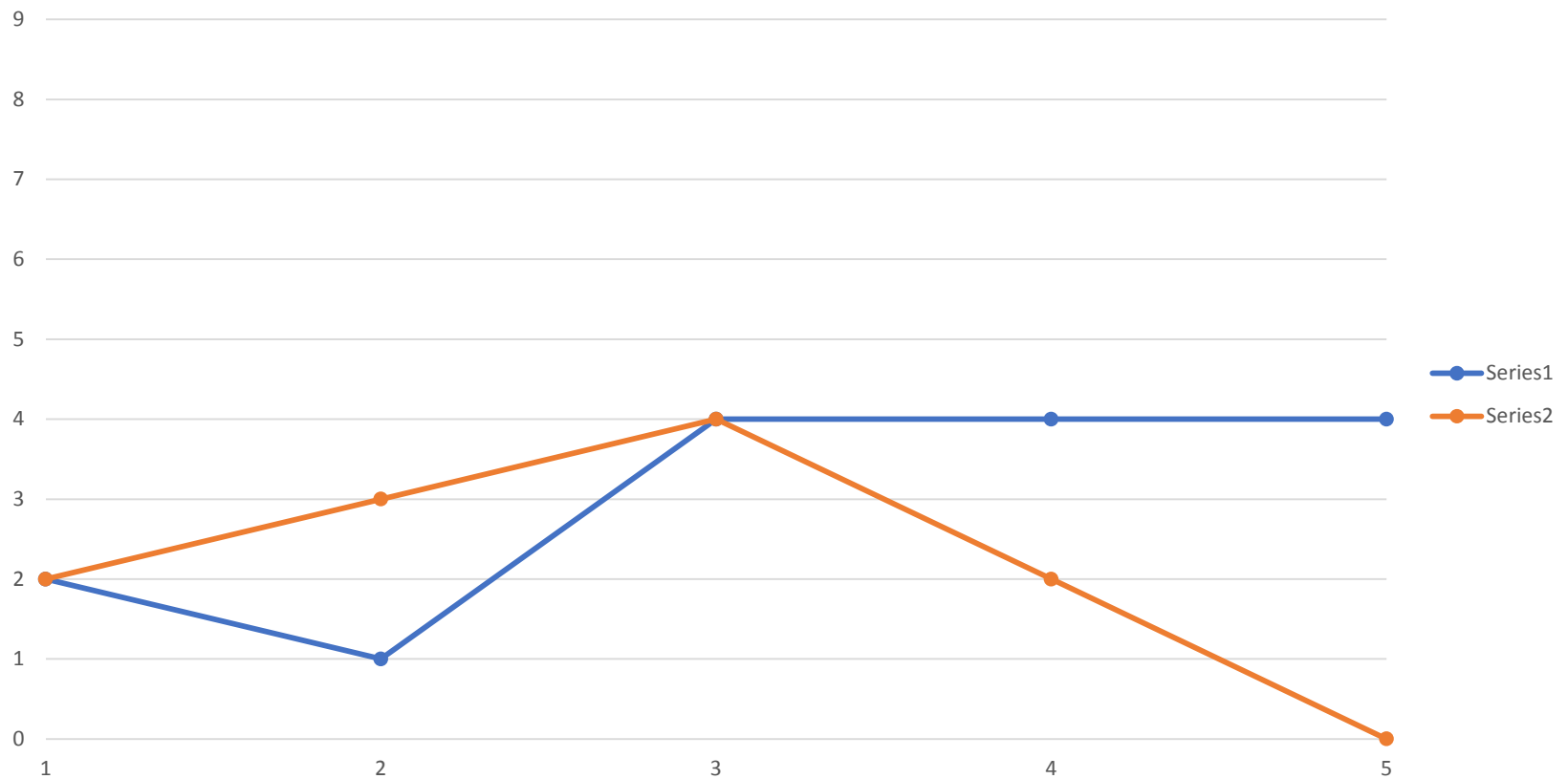


Post-Course Assessment

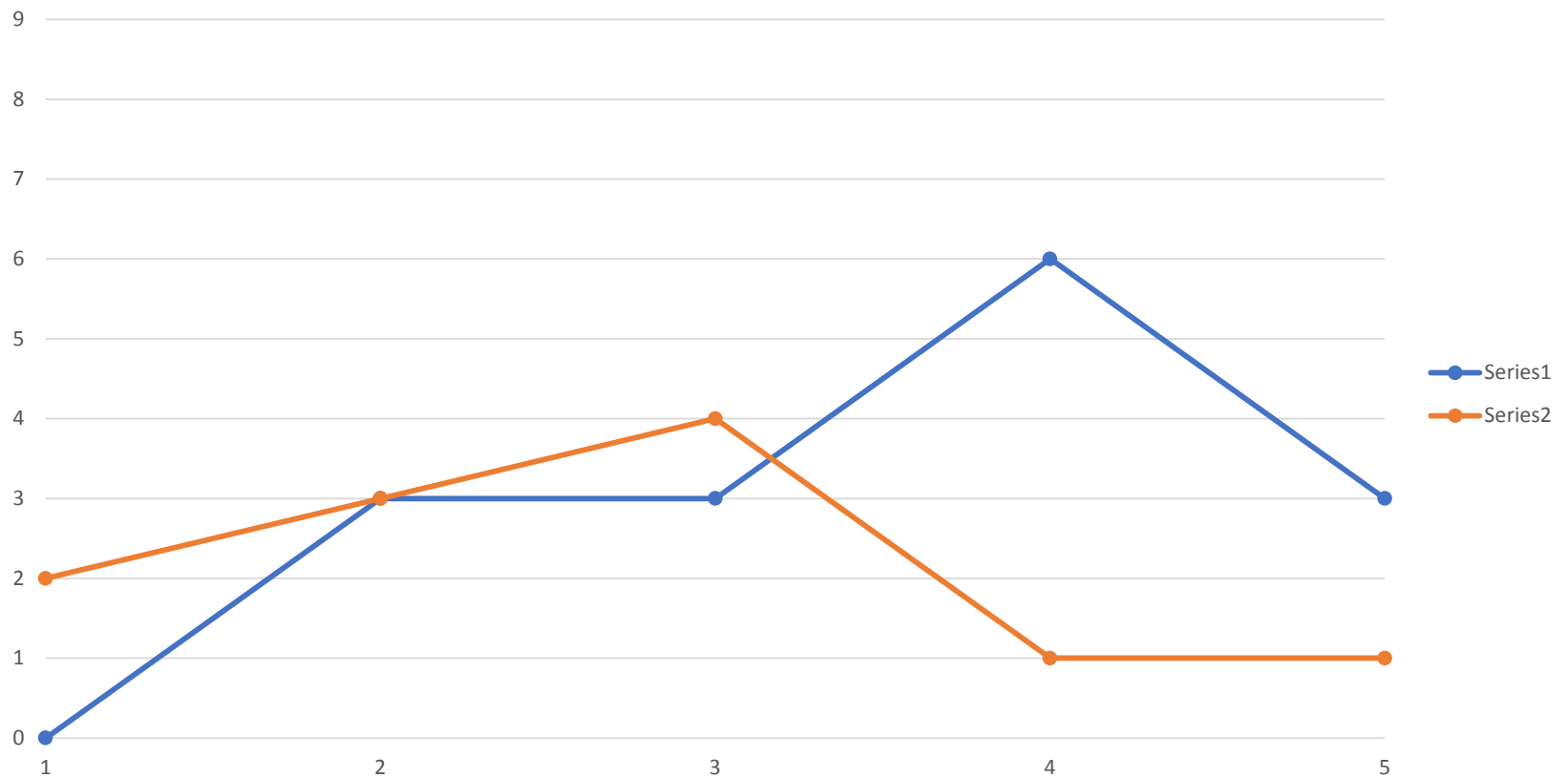
# Oneida System Renovation November 2017



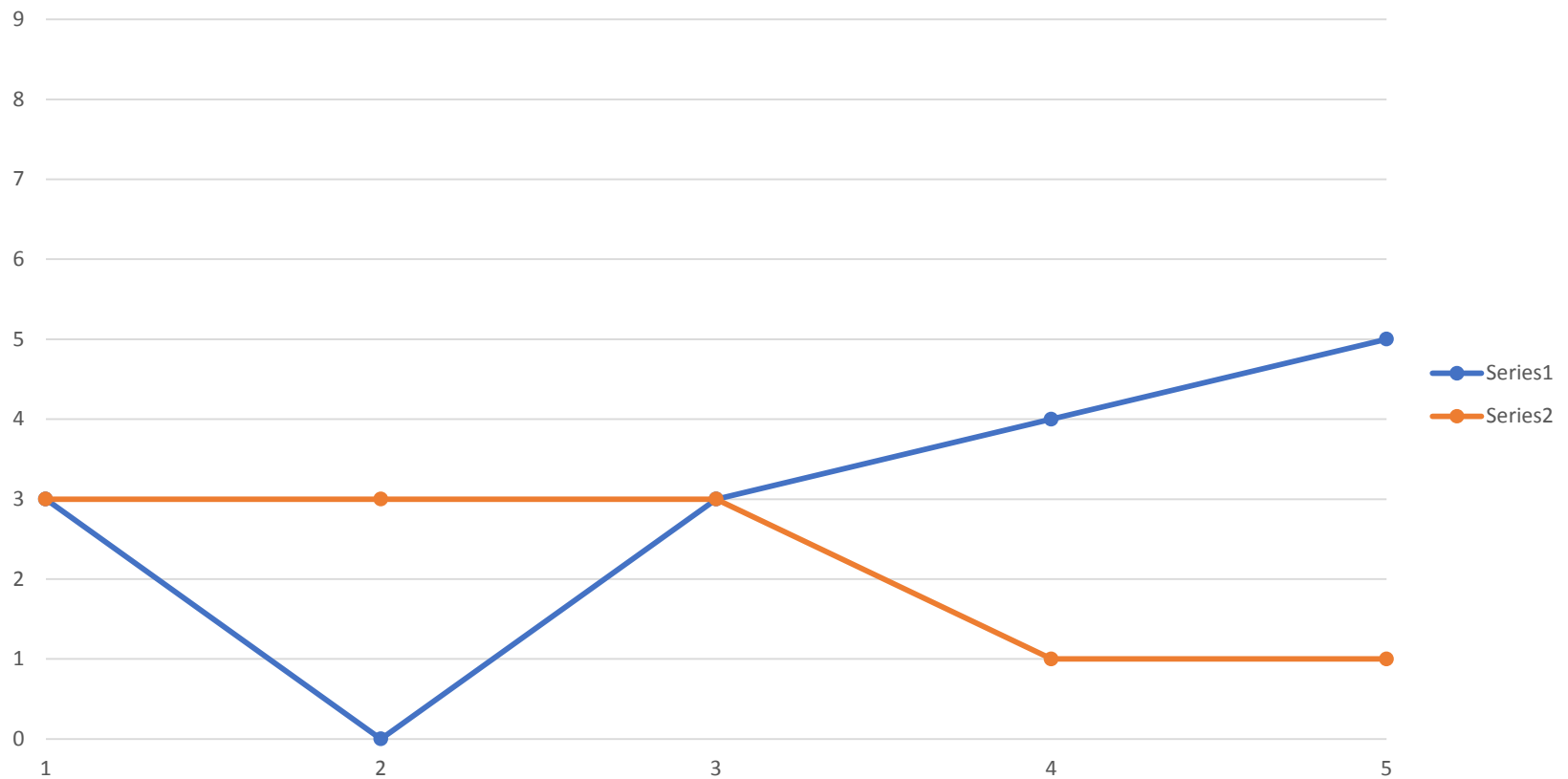
# 1) Recognize Safety Hazards Related to Working with PV systems



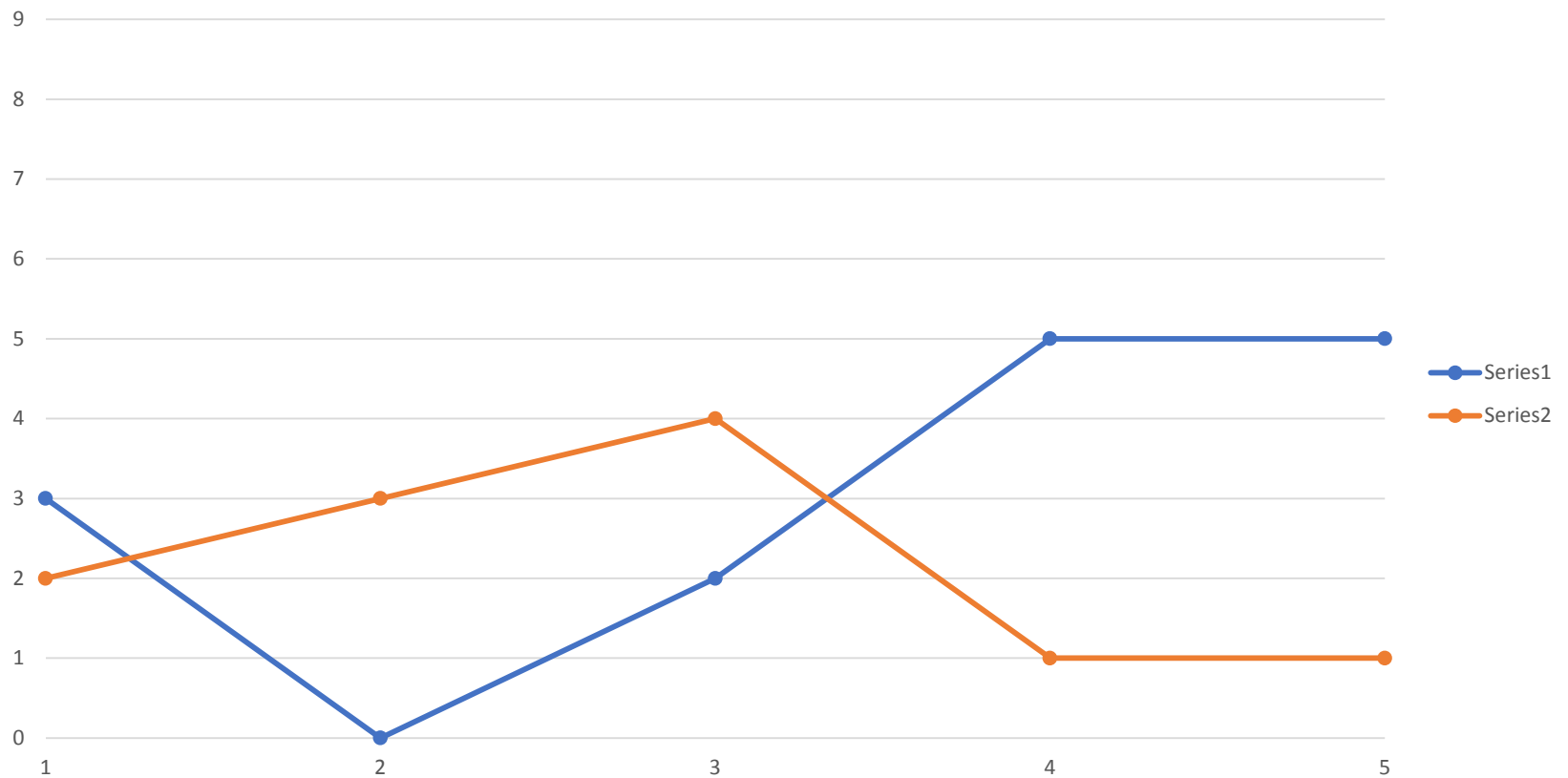
## 2) Describe Steps Necessary for Performing Visual PV Inspection



# 3) Identify and Remove Obstructions to the Solar Window

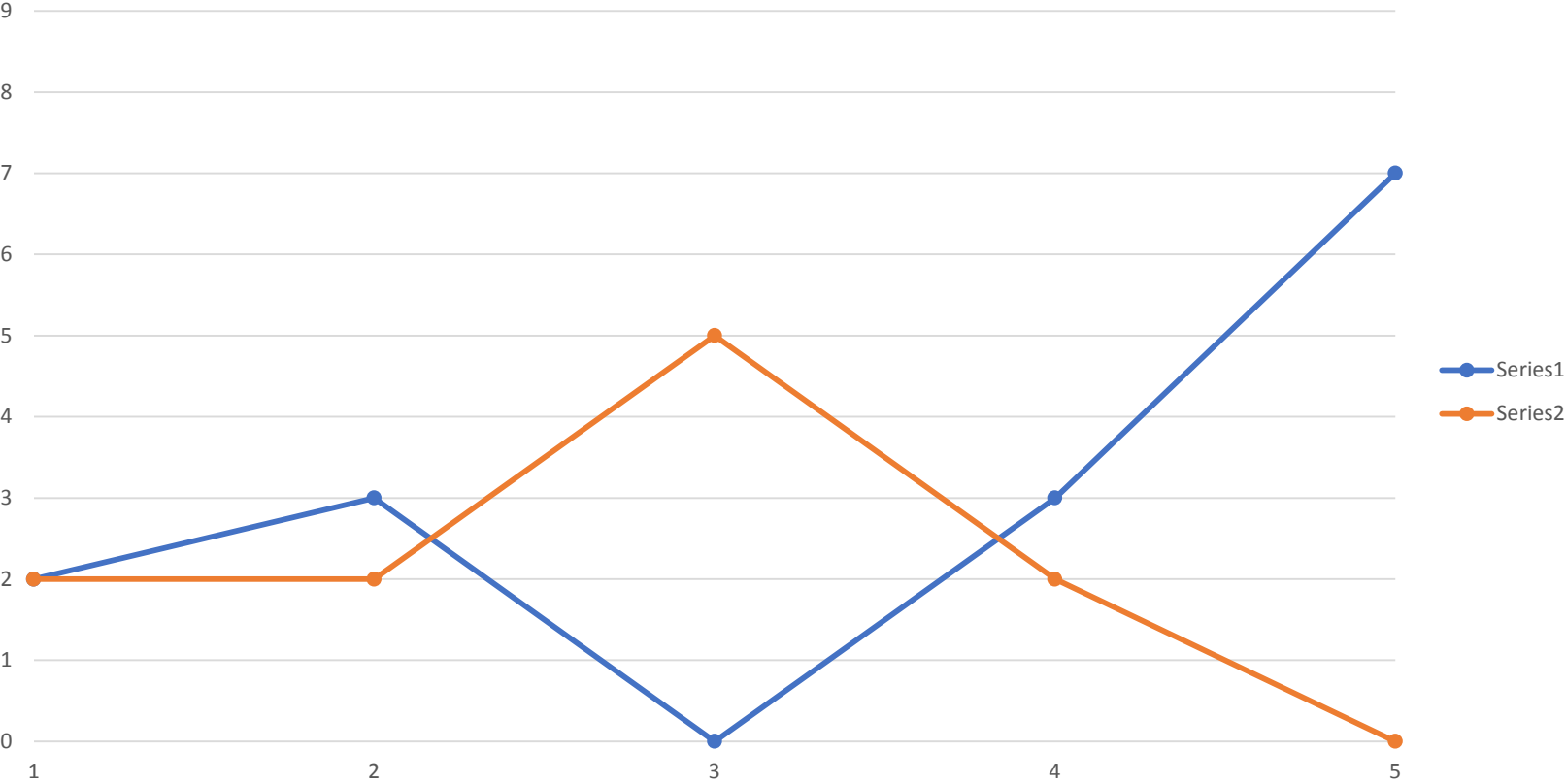


## 4) Identify Improperly Installed PV components

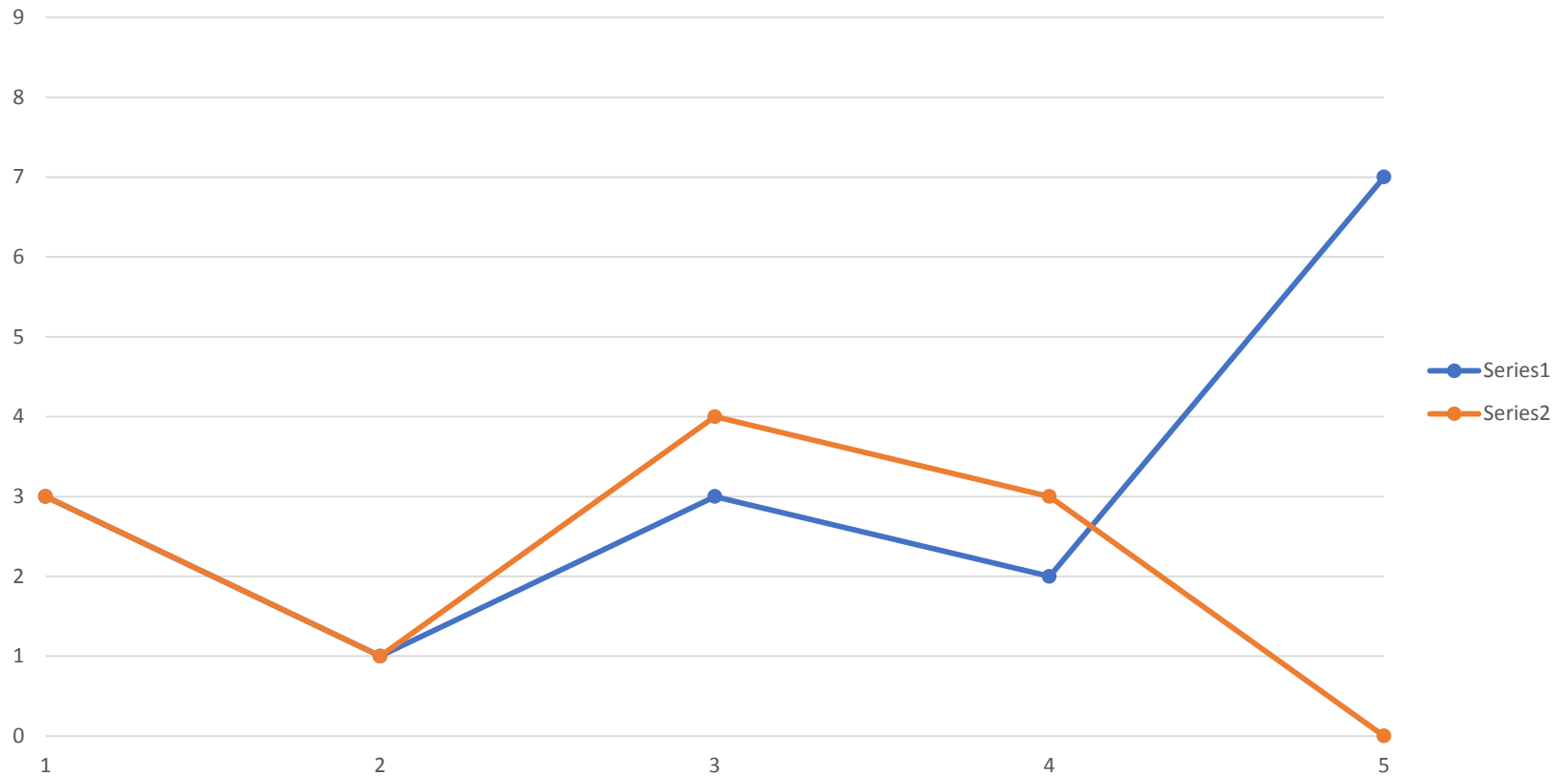




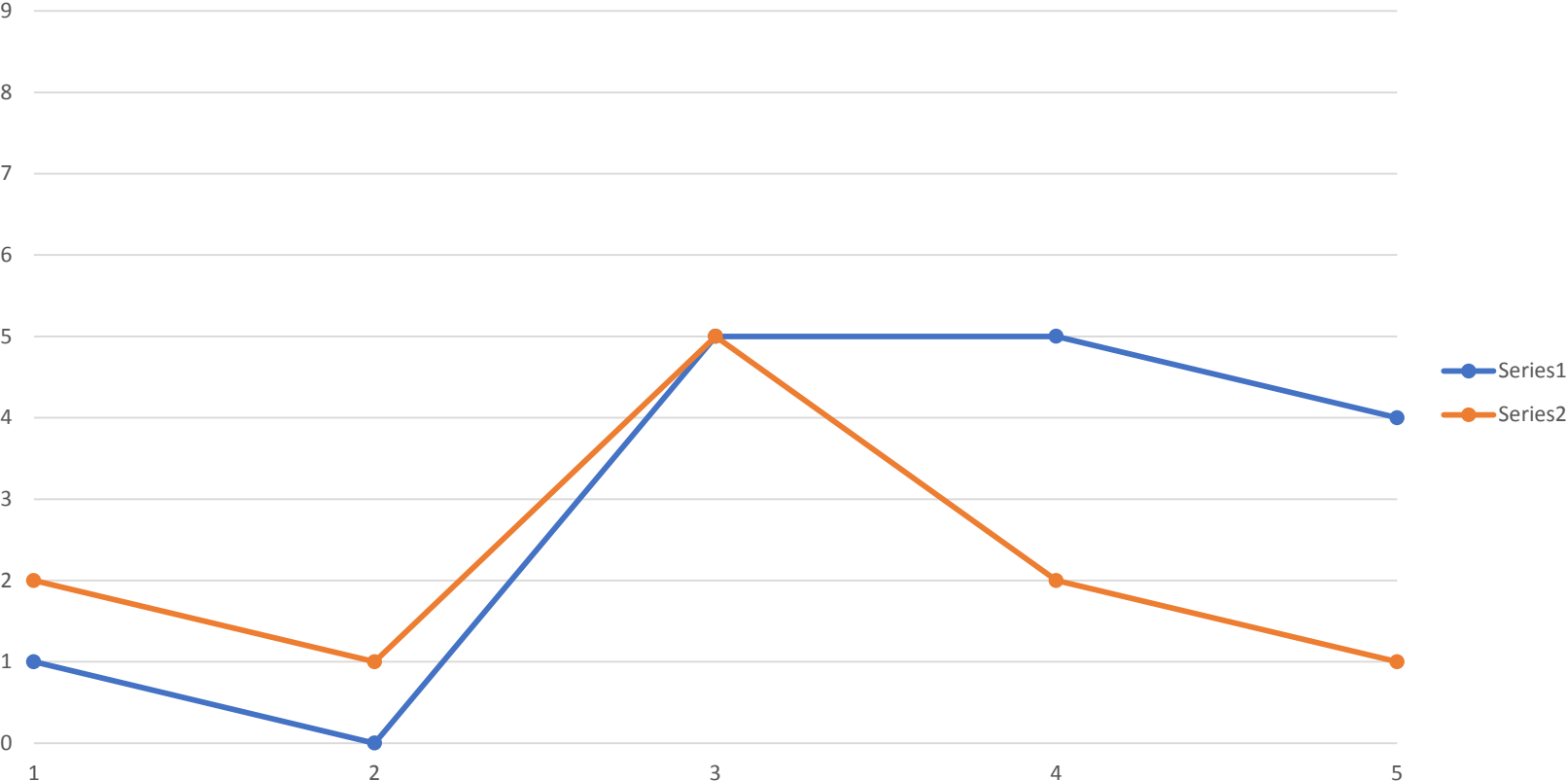
# 5) Calculate Expected PV System Energy Output



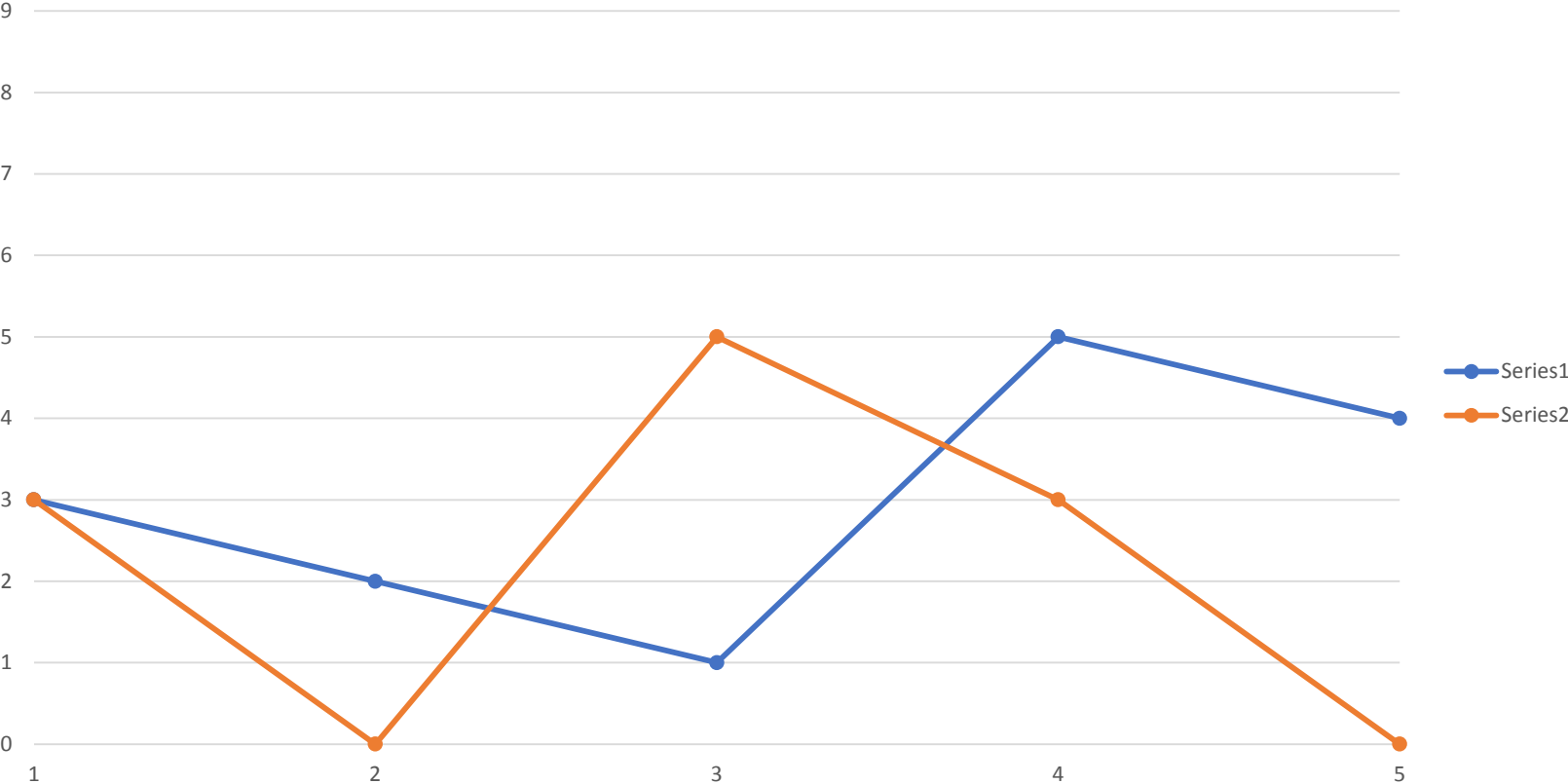
# 6) Compare Expected PV System Output with System Monitoring Data



# 7) Identify Equipment Required for Taking Safe Field Measurements

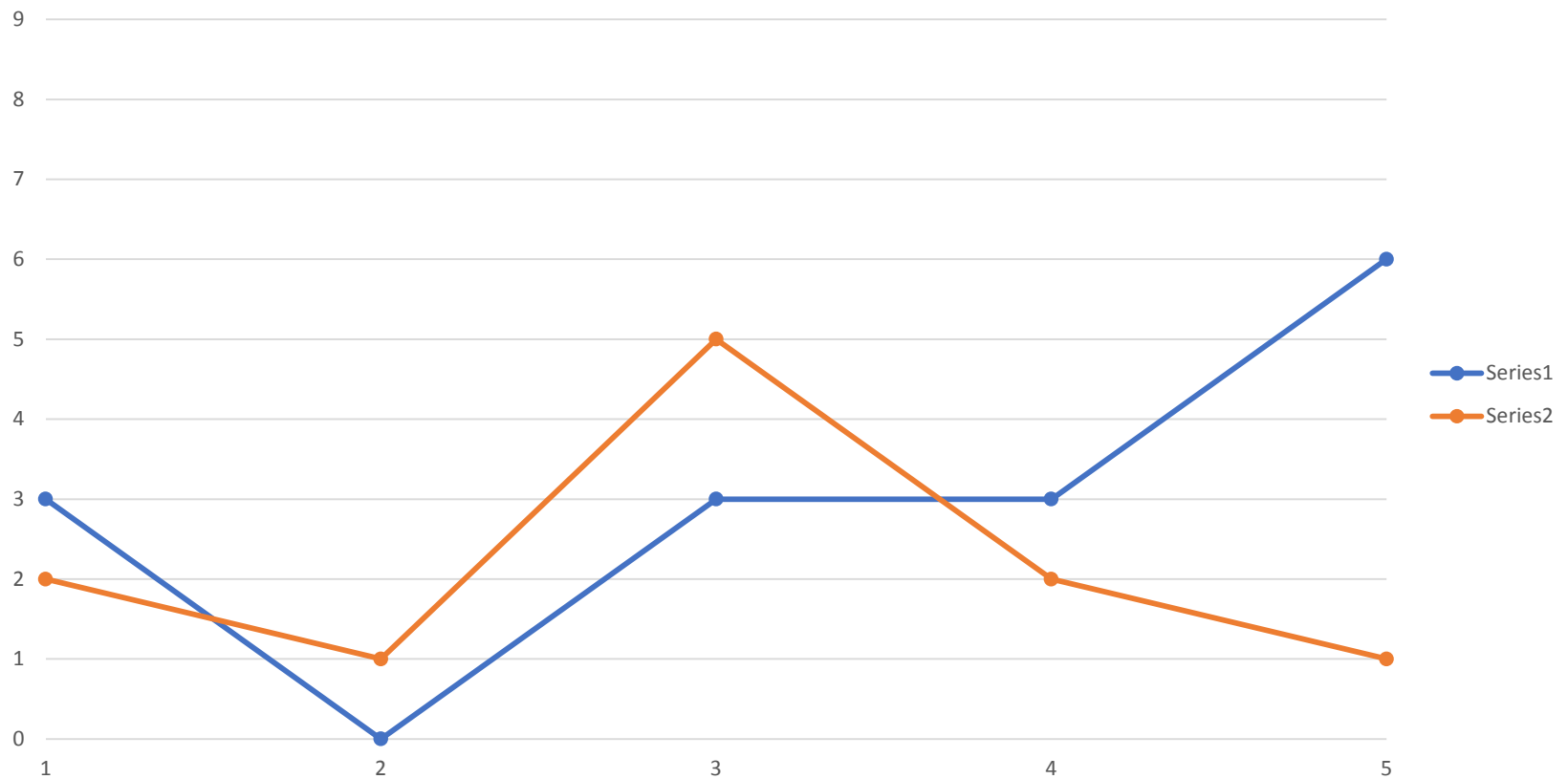


# 8) Measure System Output (Voltage, Current, Power and Energy)

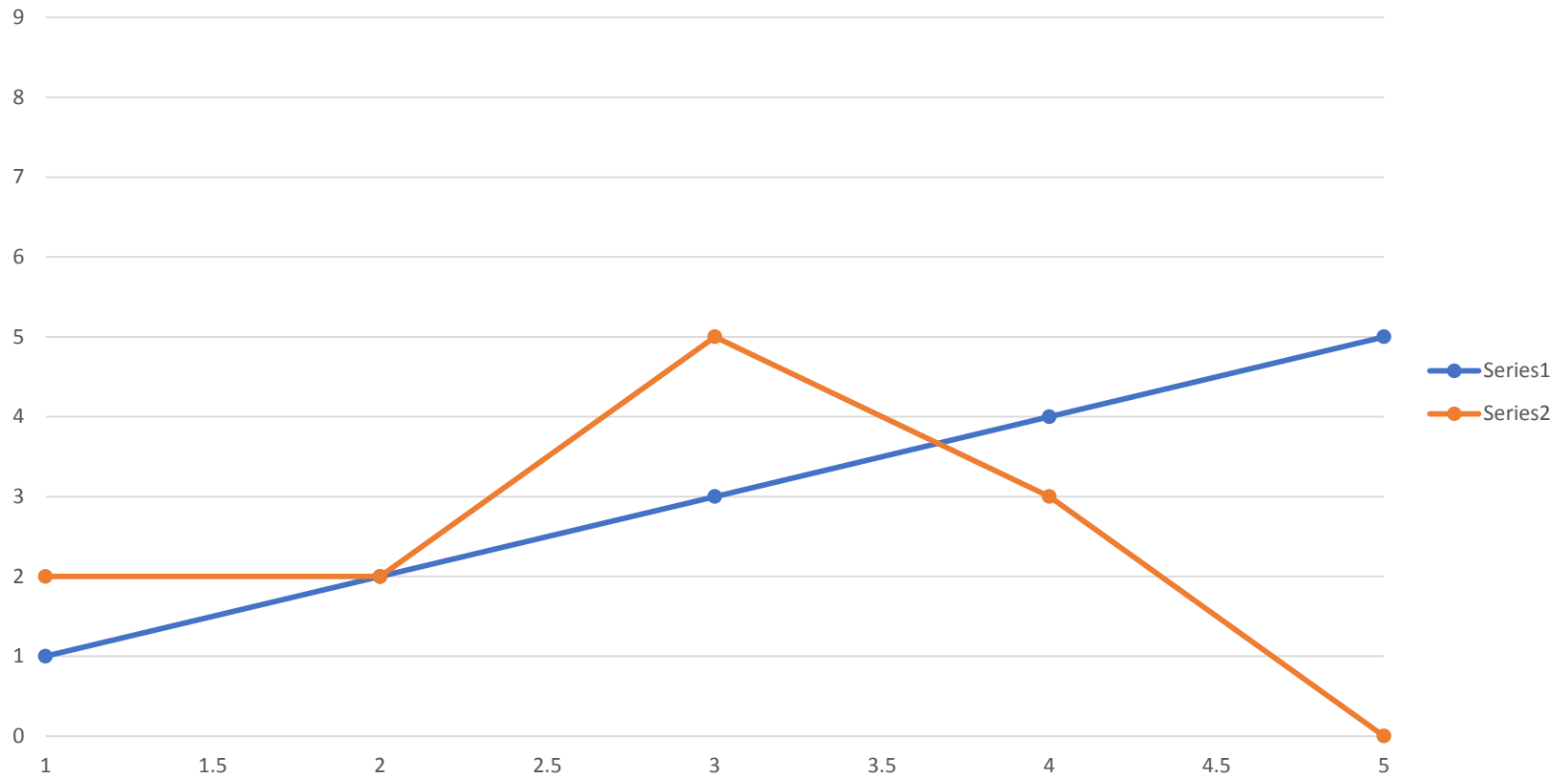


# 9) Verify and Interpret Field Measurements

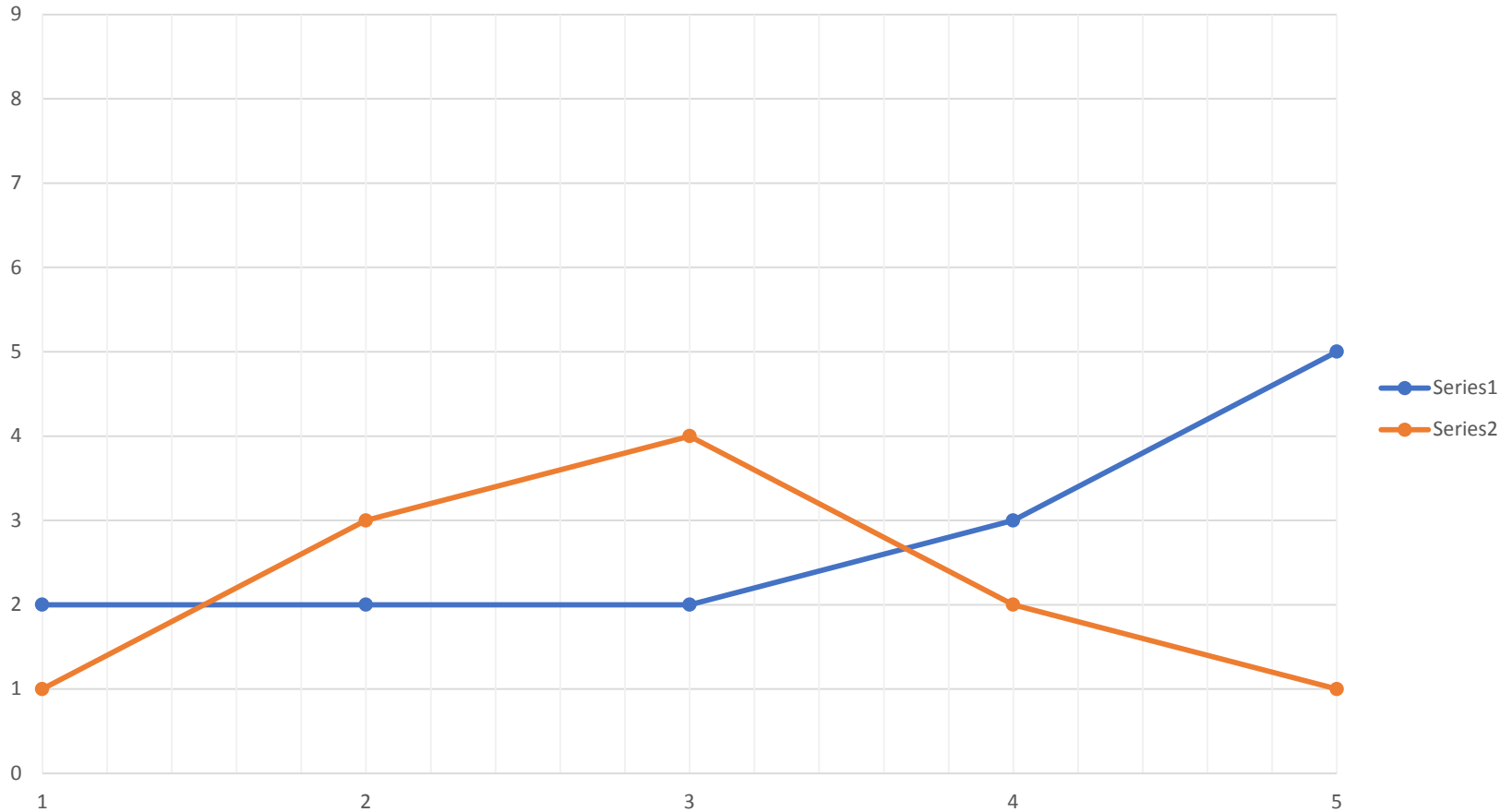
Verify and interpret field measurements



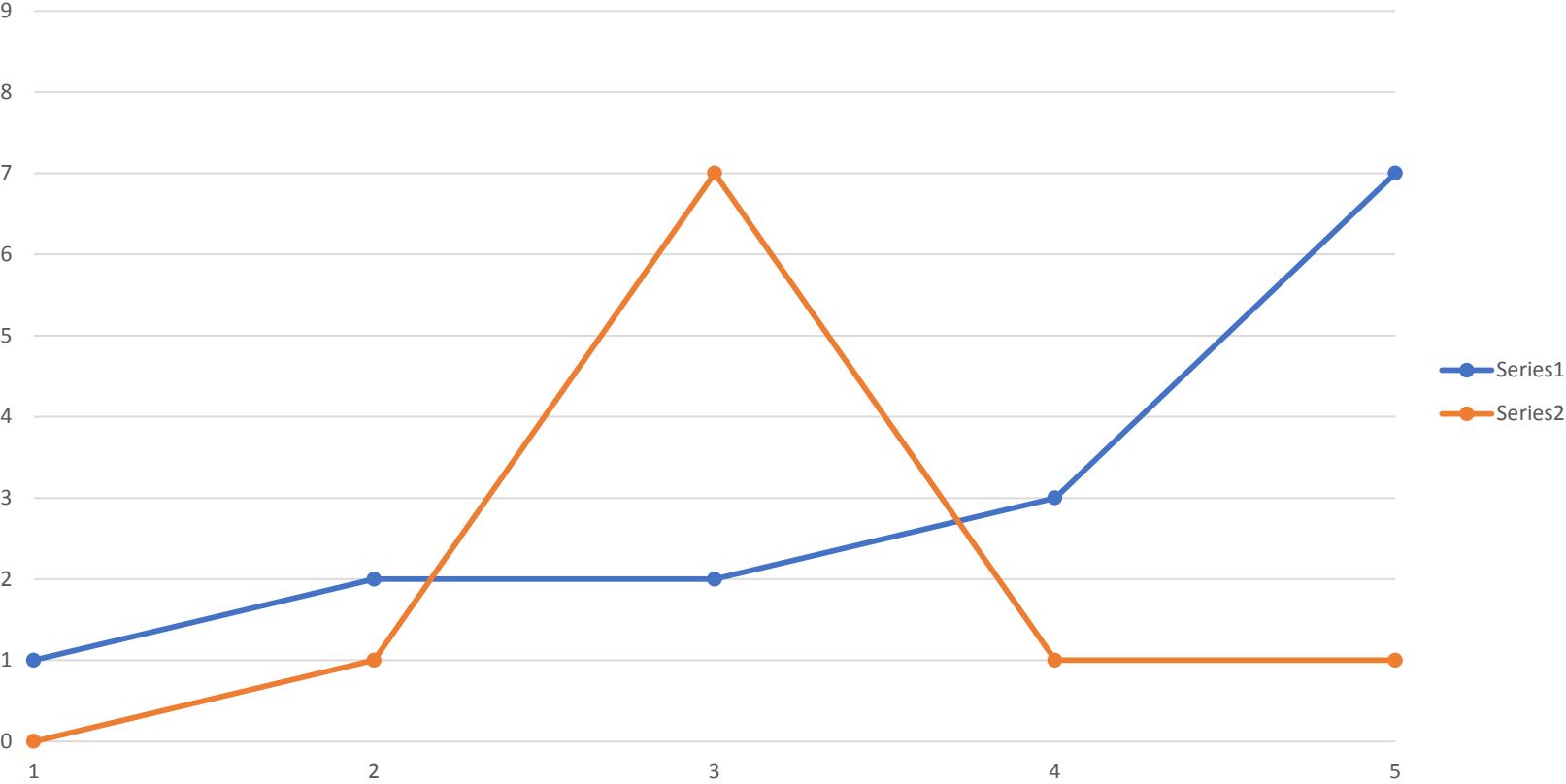
# 10) Recognize Common PV System Malfunctions



# 11) Follow Logical Troubleshooting Procedures

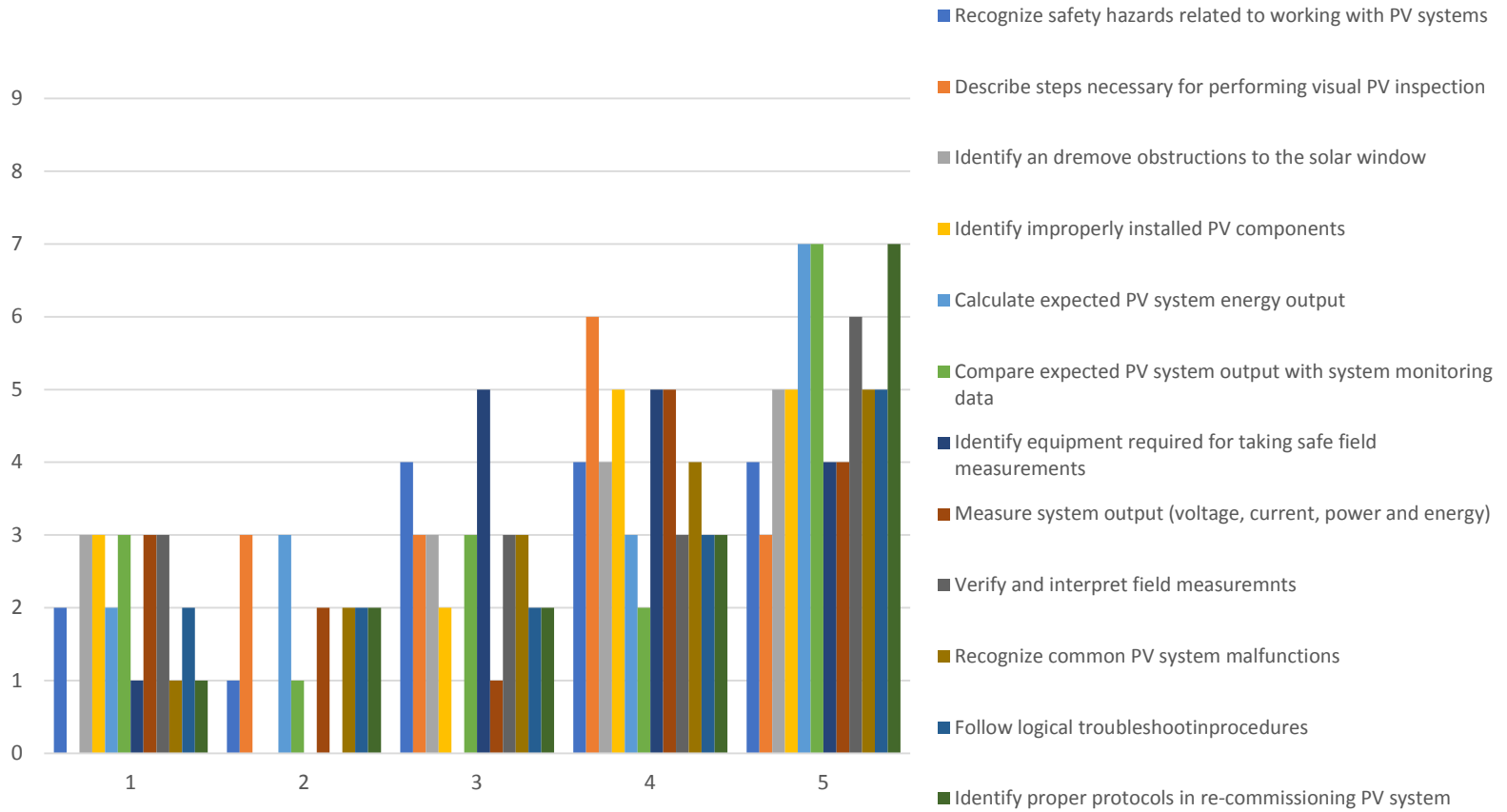


# 12) Identify Proper Protocols in Re-commissioning PV System

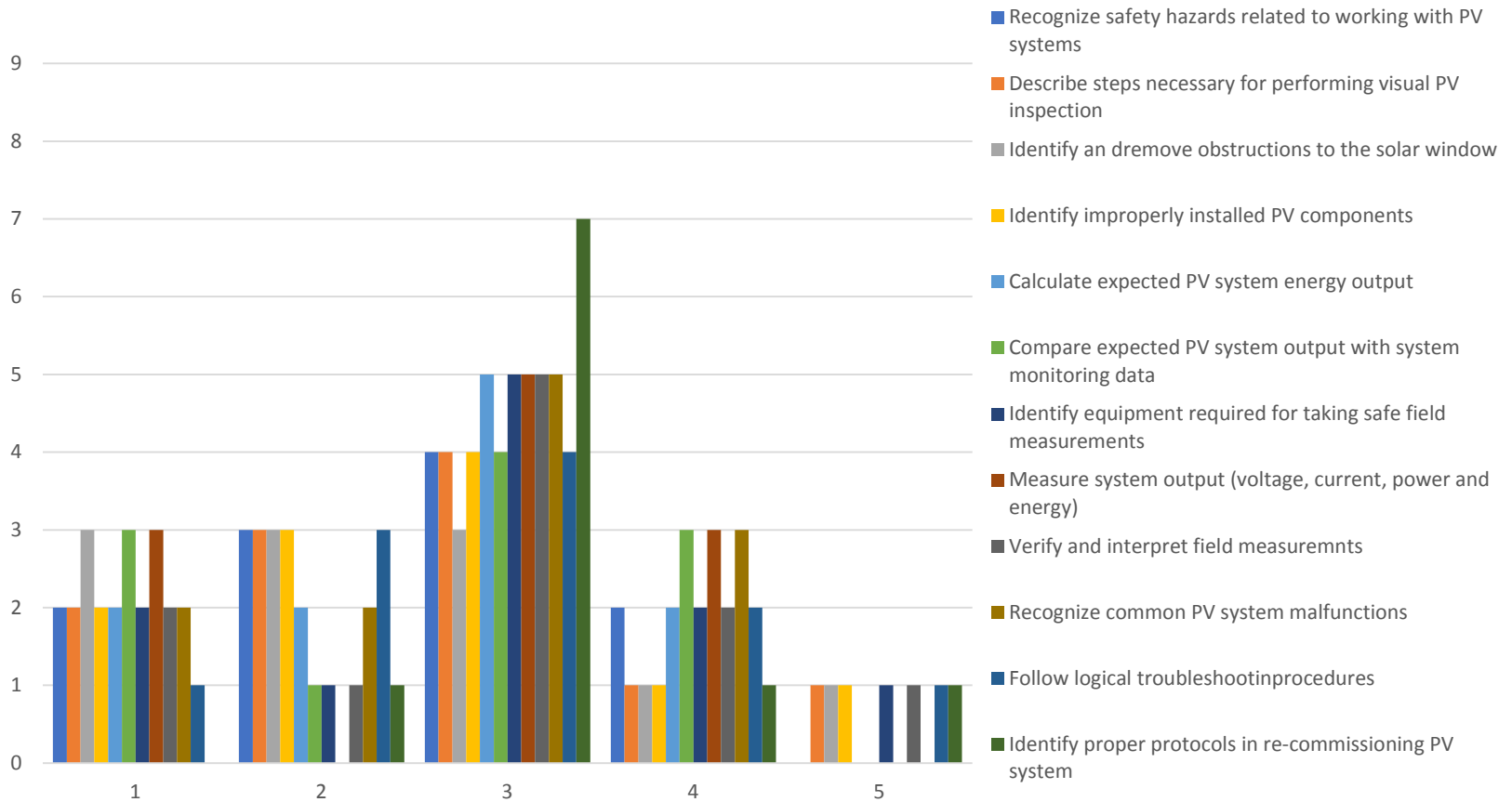




# Oneida Pre-Course Assessment



# Oneida Post-Course Assessment



# PV O&M Training

What's next?

- Offer the class online
- Offer the class at 2018 Energy Fair
- Submitted for Solar Power International 2018 in September
- Other regional Conferences

Thank you for making this training possible!