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O&M Workshop Breakout Session Summary

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BREAKOUT #1
FACILITATORS: JENNIFER GRANATA,
JAY JOHNSON, JACK FLICKER

What's possible for the industry? Where could we be in 10 (or 5) years?

- Use something similar to MicroGADS monthly reporting tools; NERC-approved reporting entity (http://www.navigant.com/industries/energy/business_planning_and_performance_improvement/nerc_microgads_reporting/)
- Translation tools
- Highly-trained technicians in the field
- Database compatibility. Database access: Take business models and competitiveness into account.
- Automated data analysis and reliability analysis
- Failure mode library
- Something like what SunSpec is doing: financiers have access to performance data
- Predictions of long-term costs and reliability
- Buying power: ex. Step-function warranties on modules that are unenforceable does not work
- More organization/power among the owners to manage vendors and expectations
- Cultural shift from competition to collaboration
- Increased sophistication in understanding the PV system and O&M needs
- Use third-party verified .PAN files
- Manufacturing process control/quality control
- Managing the dichotomy: sharing failure distributions impacts competitiveness, but without it, cannot predict reliability

What are the right data analysis techniques?

- What are the top three key performance indicators?
 - Performance Ratio, Availability, weather-adjusted energy comparison

- **Warranty standards**
- Insurance standards
- **Best practices**
 - Performing O&M properly, economically, sustainably
 - What to do, how to do it, what metrics to use
 - What has to be done for the warranty to be honored
- **Design and Installation**
- Transparency of quality and reliability
 - Solar Buyer, PV Evolution Labs
 - JD Power and Associates type
- Focus on North America, with the intent to merge as an international focus
- **Definitions**
 - Standardizing failure codes
 - Start from NERC GADS (Tom Christensen)

What terms should be included in a standard/guideline of O&M Definitions?

- KPIs
 - Performance Ratio, Availability, weather-adjusted energy comparison
 - Something is still missing
- What can we use from other similar industries?
 - Wind inverters
 - Wind turbines
- Reliability
 - Failures
 - Success

What should be included in a standard/guideline of O&M Best Practices?

- Error bands
- Distributions
- Data on failures, data on what works well, tie into location

BREAKOUT #2
FACILITATORS: ROGER HILL AND KEN
ARMIJO

What's possible for the industry? Where could we be in 10 years?

- Both good and bad places
- One thermal event away
- Better performance analytics
- Better clarity of requirements needs and exp.
- Industry template for O&M
- Better assessments of risk, lifetimes, failures
- Accountability and costs
- Building O&M into system design
- Improved/workable standards and certifications
- Creation of intelligent software

What are the right data analysis techniques?

- Data quality
- Accurate and consistent data and protocols
- Data literacy
- O&M cost benefit analyses
- Reliability, Availability, Maintainability (RAM)
- Get baseline data from commissioning/acceptance testing
- Field documentation and signage for disconnects and connected/affected portions of plant

What are the right approaches for developing best practices and standards?

- Safety is #1
- Communicate
- Walk before run
- Need recognized protocols
- Recognizing overkill in standard or practices—create the appropriate level
- Analytics for energy performance
- Industry maturity should drive what it needed

What terms should be included in a standard/guideline of O&M Definitions?

- Performance ratios, index analytics
- Language of risk and returns for financials
- Key performance indicators in O&M

BREAKOUT #3

**FACILITATORS: TRAVIS COLEMAN AND
CHARLIE HANLEY**

What's possible for the industry? Where could we be in 10 years?

- Companies that design components take a system point of view
- Models for life-cycle vs. initial cost
- Good info available to project developers so they can make good decisions on their own. Not teaching them how to use it.
- Cost analysis tool to evaluate warranty metrics or value
- Predictive maintenance, condition-based maintenance

What are the right approaches for developing best practices and standards?

- Common definitions: lifetime, availability , conditions of install, warranty terms, exclusions, etc.
- Guidelines for O&M negotiations: IP considerations (especially for spare parts after company gone)
- Qualification of how reliability metrics are developed
- Analytical processes: project developers could either choose to use or not use.
- Determine what kind of electrical testing, verification would you do on an annual basis, etc.
- Like CEC rating of modules/inverters, etc - good baseline. For MTBF of inverter reliability, develop regional (or microclimate) ratings on a standardized basis.
- Perhaps develop a guideline regarding how to apply either current or modified standards regarding MTBF and other reliability measures. Make them regional, microclimate adjustable, etc.
- Need a better regime of tests for inverters, etc.

What are the right approaches for developing best practices and standards?

- Lender perspective: find a failure rate so you can determine what's feasible
- At times, you don't get exactly the parts you ordered. Has to be worked in the supply agreement. What you have to test, how often, etc.
- Industry perspective: value in developing best practices method for procurements that cover O&M.
- Have programs like CSI throw their weight into warranty requirements to drive changes.
 - You need a more organized industry to leverage that.
- Requires getting all the right information.
- Look at 3rd generation of projects for improvements to take hold. Use O&M to drive specifications for next projects.
- Develop a standard for skills and training, levels of knowledge, experience

What do we need to do to make O&M standards happen?

- Get a group together.
- Focus on cost-related impacts, so a standard is reasonable.
- O&M providers currently provide a list of exceptions from warranty requirements. Move toward underwriting a scope of services.
- Lots of confusion about who pays for what. For lenders and project owners, that can be very confusing. Need to clarify as we move forward. How valuable is the warranty relative to the energy that's being lost? Would be great for owners to have a go/no-go spreadsheet regarding specific repairs
- What violates the warranty? What changes/fixes can be done by operator vs what cannot? Can the inverters go in the sun?
- Let's develop a standardized failure code so we can amass info. Work on a SCADA standard reporting format. SunSpec - barely adopted, but they're working on standard fault codes.
- Then, work as a peer group in driving manufacturers to improve reliability - if you don't improve your performance we'll drop you collectively.
- Need to talk about education/training and experience. Need to work on field experience. Need to do basic math. Need guys to be safe, accurate, and fast.
- Just recently, we've gotten a decent set of tools for O&M data collection - proper use of equipment is needed. Additionally, guidelines for actual types/frequency of data to be collected across O&M activities.
- Better tools to assess appropriate level of predictive (scheduled) maintenance.

What are the right data analysis techniques?

- Standardized failure mode definitions
- Develop a database for fielded PV component reliability data
- Better tools to assess predictive (scheduled) maintenance alternatives
 - This is one example of a broader set of analytical tools
- Automation for data collection, storage, pre-analysis