SOLVING THE WORLD’S COMPLEX CHALLENGES

BLACK & VEATCH CORPORATION IS A LEADING GLOBAL ENGINEERING, CONSULTING AND CONSTRUCTION COMPANY

• Founded in 1915
• Global workforce of more than 9,000
• More than 100 offices worldwide
• Projects in more than 100 countries on 6 continents
• $2.6 billion in annual revenues in 2012
• Employee-owned corporation
• Engineering News-Record ranking: #2 – Top 20 in Power
B&V PV HIGHLIGHTS

- Recognized industry leadership in Independent Engineering (IE)
- Owner’s engineer for over 1,000 MW of projects
- Development support for more than 1,500 MW of utility scale PV systems
- Independent Engineer for over 3,000 MW of PV capacity
- Automation of the nation's largest municipal solar incentive program
- Development of largest municipal feed-in-tariff
- EPC on multiple utility scale PV projects

Black & Veatch has been involved with half of the utility-scale PV facilities currently operating in North America
ENERGY PRODUCTION ESTIMATES
WHAT DO YOU NEED FOR AN ACCEPTANCE TEST?

1. Measurement methodology
2. Target or expected value
3. Reference conditions (sometimes confusingly referred to as reporting conditions)

- A method to compare measured and expected (will there be a tolerance?)

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ACCEPTANCE / PERFORMANCE TESTS

• Capacity Tests
  • ASTM E2848-2011 and WK37888 (Old PVUSA Test, 1995)
  • Power Performance Index Method (Regression using temperature corrected power)
  • Sandia Method (Not regression based)

• Performance Ratio Tests
  • Performance Ratio IEC61724
  • Temperature adjusted performance ratio
  • Weather adjusted performance ratio

• Adjusted Energy Test
  • Standard in the works

Source: SolFocus
WHAT IS PERFORMANCE TESTING?

Capacity tests, performance ratio tests
WHAT IS PERFORMANCE TESTING?

- Meteorological Data
- System Parameters
- Actual PV Plant
- Model
- Output kWh (Expected)
- Adjusted Energy Test
- Output kWh (Measured)
- Performance Metric (Expected)
- Performance Metric (Measured)
CAPACITY TESTS

• Old PVUSA Test
  • Used extensively in industry
  • Measure using ASTM E2848-2011
  • Set target and reporting conditions using WK37888

• Power performance index
  • Used extensively in industry
  • No standard, discussion of incorporating into ASTM E2848
  • Seasonality in results

• Sandia Method
  • Used in the industry
  • No standard

Source: Cogenera
PERFORMANCE RATIO TESTS

- Standard Performance Ratio Test
  - Used extensively in the industry
  - IEC 61274 (not comprehensive)
  - No reference conditions, seasonality in results

- Temperature Adjusted Performance Ratio Test
  - Used extensively in the industry
  - No standard
  - Irradiance weighted temperature is the reference condition

- Weather Adjusted Performance Ratio Test
  - Used in industry
  - No standard
LONG TERM ADJUSTED ENERGY TEST

System Inputs
Meteorological (Historical)
System Inputs
Meteorological (Measured)

Model
Output kWh (Predicted)
Model
Output kWh (Expected)
Output kWh (Measured)

Measured kWh is the compared to Expected kWh
SYSTEM MODEL VALIDATION

Good

Not so Good

Source: Kipp & Zonen

Source: PV Evolution Labs

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Together

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