The Need for Validation from Concept to a Terrawatt

NREL Workshop August 31, 2011
Money drives the process

Technology
Innovation &
Quality
Improvement

Construction
- Construction Equity
- Construction Debt
- Vendor Financing

Project Finance
- Tax Equity
- Permanent Debt
- Sponsor Equity

6+ Year
- Equity
- Refinanced Debt
the quality control chain

Manufacturing
- Quality Control
- Quality Assurance

Shipping
- Vibration
- Temperature

Engineering
- Inverter/Module sizing
- Code

Installation
- Knowledgeable
- Follow Designs
- Verify installed
- Ensuring Quality Installation

Commissioning
- Yield
- Degradation
- O&M Budgets

Operations
System/Module Validation

– Inputs
  • Degradation
    – uncertain
  • PVSYST Pan Files
    – Inaccurate/Inconsistent

– Models
  • Validation of PVSYST to “real” world

– Outputs
  • Expected System Yield
    • Curve not a point
    • Probability of performance
  • Residual Value
    • How long will the products work
Perceived Certainty
### Implications of performance

<table>
<thead>
<tr>
<th></th>
<th>100%</th>
<th>101%</th>
<th>102%</th>
<th>103%</th>
<th>105%</th>
<th>109%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield</td>
<td>100%</td>
<td>101%</td>
<td>102%</td>
<td>103%</td>
<td>105%</td>
<td>109%</td>
</tr>
<tr>
<td>Development Fee</td>
<td>5,300</td>
<td>5,900</td>
<td>6,500</td>
<td>7,000</td>
<td>8,800</td>
<td>10,400</td>
</tr>
<tr>
<td>% Increase</td>
<td>10%</td>
<td>20%</td>
<td>31%</td>
<td>51%</td>
<td>95%</td>
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</table>

<table>
<thead>
<tr>
<th>Degradation</th>
<th>0.75</th>
<th>0.60</th>
<th>0.50</th>
<th>0.40</th>
<th>0.30</th>
<th>0.20</th>
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<tbody>
<tr>
<td>Development Fee</td>
<td>4,600</td>
<td>5,300</td>
<td>5,900</td>
<td>6,500</td>
<td>7,000</td>
<td>7,600</td>
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<tr>
<td>% Increase</td>
<td>15%</td>
<td>28%</td>
<td>41%</td>
<td>52%</td>
<td>65%</td>
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</table>

<table>
<thead>
<tr>
<th>O&amp;M ($/W)</th>
<th>28</th>
<th>24</th>
<th>20</th>
<th>16</th>
<th>12</th>
<th>8</th>
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<tbody>
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<td>Development Fee</td>
<td>1,800</td>
<td>2,600</td>
<td>3,400</td>
<td>4,200</td>
<td>4,900</td>
<td>5,700</td>
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<tr>
<td>% Increase</td>
<td>42%</td>
<td>84%</td>
<td>126%</td>
<td>169%</td>
<td>211%</td>
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</tbody>
</table>

12.5 MW System  
Base Yield: 1950 kWh/kWp  
7% Unlevered Return  
0.60 Degradation  
O&M $10/MW
Monetizing Quality

• Day 0 is extremely important
• Predictability, viability, and solid sponsorship is essential.
• Every 1% increase in yield increases the project profitability 10%
• Increased certainty in degradation is worth millions
• Decreases in O&M certainty is also worth millions
• There is a magnified effect of these three variables.
Bankability

- Bank
- Independent Engineer
- Developer
- EPC Contractor
- Manufacture
- Tests/Data/Analysis
Conclusions

• Quality WILL lead to more *valuable* systems
• Determining quality tests that give certainty is *essential & difficult*

• We need better ways to prove
  – PVSYST PAN File validation
  – Quality test to determine residual value probability
  – Quality tests that establish certainty of yield
  – Quality tests that give more certainty of unscheduled maintenance
  – Quality tests that give more certainty of degradation

• More Communication earlier
• More Communication with Lenders
• More Communication with Independent Engineers
Thank YOU!

David Williams
Chief Risk Officer

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