Assessing the whole Spectrum of Risks in PV Plant Investment

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Solar Industry Anxious Over Defective Panels

Worldwide, testing labs, developers, financiers and insurers are reporting problems and say the $77 billion solar industry is facing a quality crisis just as solar panels are on the verge of widespread adoption.

An audit company located in the US, discovered defect rates of 5.5% to 22% during audits of 50 factories over the last 18 months, said the company’s senior marketing director. (Audit company “defect rate” is an arbitrary inspection rate; Tier 1 manufacturer typical return rate <0.1%)

The Energy Department’s National Renewable Energy Laboratory has studied the performance of solar panels up to 2010, according to Sarah Kurtz, a scientist who manages the laboratory’s photovoltaic reliability group. “The question is whether things are deteriorating rapidly or whether it’s a few isolated companies not doing so well on their quality control, “ she said. “I hear a lot of angst, but I haven’t seen a lot of solid information.”
The Role of Branding

Quantitative analysis of PV project lending criteria preferences of 40 German PV experts in the banking industry. Brand is of the highest importance for Bankability.

Lüdeke-Freund, Loock: Depth for Brands: Tracking down a Bias in Financing Photovoltaic Projects in Germany, 2011
“For me, Bankability is more like philosophy than business science. Because you cannot grasp it. It is quite differently valued by a large number of parties.”
Head of Supply Chain Management, Project Developer

“At the end, it is about this: is the cash flow secure or not? A secure cash flow means secure from a legal, technical and economic perspective.”
Head of Competence Centre Renewable Energies, Major bank

“Bankability means that the bank is convinced to the greatest possible extent that the cash flows are stable and the loan will be repaid.”
Credit Risk Manager, Structured Finance, Major Bank

20 in-depth expert interviews in Germany and China from Equity Investment, Project Development, Service Providers, Module Manufacturers and Banks

Publication:
The Myth of Bankability
Hampl, Lüdeke-Freund, Flink, Olbert, Ade, August 2011
Implication of Bankability

Investors
- Legal, technical and economic securities
- Project salability (Tax incentives)

Module Producers
- Certified quality
- Financial stability (Performance Warranty)

Project Developers
- Attractiveness for banks
- Attractiveness for investors
- Portfolio fit (Project salability)

EPC
- Certified technologies
- Location characteristics
- Secured energy yields and economic returns

Banks
- Legal, technical and economic securities
- Secured debt service
- Stable cash flows

Source: Lüdeke-Freund, Olbert: Presentation, March 10/11, St. Gallen 2011
Risk Perspective

Project Risk

System Performance Risk

Components Risk

System Integration Risk

Off Taker Risk

Module

Inverter

Project Development

Construction

Operation

FIT

PPA
Stampede Of Investors Sue Spain Over Cuts In Solar Subsidies

A flurry of investor lawsuits filed against Spain in recent months may make it more difficult to finance renewable energy projects in the future.

The lawsuits, which were filed with the International Center for the Settlement of Investment Disputes, claim that Spain’s decision to reduce premiums paid for electricity produced by solar thermal amounts to an act of expropriation – or, wrongful government appropriation.

The surge in subsidy-related litigation is likely to erode investor confidence in renewable energy projects that only pencil with subsidy support.
Off-Taker Risk Profile

✓ Political Risks: Source of Incentive, Regulatory Changes
✓ Legal Risks: Legal Infrastructure, Framework to Enforce Payments
✓ Microeconomic Risks: Financial Stability of PPA Off Taker
✓ Macroeconomic Risks: Exchange Rates, Interest Rates, Taxation
➢ For Investors IRR expectations must reflect Risks
System Integration Risks

Entire PV projects
- Main cause of system failures: improper implementation & installation
- 2008 – 2009: 300% increase in system failures worldwide (more than installations market growth rate)

 Causes of system failures (Germany)

- Implementation and installation: 13%
- System design and planning: 30%
- Manufacturing (components): 57%

Source: SolarKlima e.V.
Development Risks: Permits, Land Lease/Ownership, Site Location
Construction Risks: Track Record, Contracts, Project Management
Interconnection Risks: Installation, Weather, Commissioning
Operational Risks: O&M Service, Monitoring, Spare Parts

Construction and Bridge Finance with highest GM and Returns
Component Risks

- **Stage of Service Life:**
  - Start up Commissioning
    - Decreasing Failure Rates
    - Infant mortality
  - Normal Operation
    - Quasi-constant Failure Rates
    - Random failures
  - End of Life
    - Increasing Failure Rates
    - Wear out

- **Failure Rate Characteristics:**
- **Root Cause:**
  - Infant mortality
  - Random failures
  - Wear out
Component Risk Profile

- Technology Risks: Quality, Reliability, Warranty
- Insolvency Risk: Financial Stability of Component Supplier, Insurance
- Containment Risk: Strong After Sales Services in case of Excursions
- Lifetime Opportunity: Performance of Components beyond Warranties
- Bankability is a Barrier of Entry to the Solar Project Markets
## Addressing the Risks

### Module Manufacturers

#### Technology Risk
- Insolvency Risk
- Containment Risk

### Company Profile & Strategy
- Organization and Management Structure
- Competitive Advantages and Strategic Planning
- Company Setup for **Long-Term Success**

### Technology & Quality
- Capacity and Technology Roadmap
- Quality System and Process Control

**Test Records** of current High Performance Solar Cells and Modules Portfolio

### Financial Performance
- Financial Results and Balance Sheet, Cash Flow and Cash Reserves
- Industry Benchmarking
- Company Decisions for **Long-Term Performance**

### Sales & After-Sales Services
- Customer Oriented Business Processes, Reliable Business Partner
- Containment Oriented After-Sales Service

**Reputation** of Serving Customer Needs
Confidence in Quality

- **Long-term Reliability Test**
  - DH1000 to DH3000
  - TC200 to TC600
  - Mechanical load test 5400Pa to 10000Pa
  - HAST test DH1000 to 121°C and 100%RH
  - PID test: -1000V, 85°C, 85%RH, 96h

- **Special Test Certification & Factory Audit Program**
  - TÜV-Rheinland Ammonia Resistance Test Certificate
  - Intertek Salt Fog Spray Test Certificate
  - TÜV-NORD Salt Mist Corrosion Test Certificate
  - Certificate for H2S Acid Test
  - Overall Factory Audit by Third-party PI-Berlin
JA Polycrystalline modules were the first to pass the TÜV SÜD Thresher Test.

A Product that lasts 25 years
Ensuring long-term reliability and power output performance of modules
Challenging the ability of the module to perform safely and reliably in the long term. Higher level of confidence in terms of long-term reliability as compared to those having only basic certification.

Long term performance reliability beyond IEC 61215+IEC 61730.
Extended environmental and power output tests. Extended cycling and stringent pass rates including temperature cycles, up to 2,000 hours of damp heat testing with and without system voltage bias being applied.
More Power Per m²
- Higher Conversion efficiency
- More power production per unit area

Lower system costs
- Higher Conversion efficiency help you save:
  - Transportation Cost
  - Installation Cost
  - Balance of system Cost

Excellent Low-light performance
- Enhanced spectral response at longer wavelength boosts low-light generation performance, which can produce more than 1% additional power compared with conventional module at system side.
A 982 Panels System
(image courtesy of Abel Energy/Zenex Solar).

Comparing total profit over 20 years. Initial Capex vs (discounted) project incomes

4 Choices:
1. 250W at MIP - 245.5kWp
2. 270W JAM6R at MIP - 265.1kWp
3. 250W at 0.04 Euro below MIP. – 245.5kWp
4. 300W at premium pricing - 294 kWp

Power output over 20 years 7% more than 250W.

System Cost

<table>
<thead>
<tr>
<th>Panel Choice</th>
<th>000's GBP</th>
<th>Delta to JAM6R</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIP 270W</td>
<td>163k</td>
<td></td>
</tr>
<tr>
<td>Non MIP 250W</td>
<td>152k</td>
<td>-7%</td>
</tr>
<tr>
<td>300W</td>
<td>209k</td>
<td>+22%</td>
</tr>
<tr>
<td>MIP 250W</td>
<td>155k</td>
<td>-5%</td>
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</tbody>
</table>

Net Present Value

<table>
<thead>
<tr>
<th>Panel Choice</th>
<th>000's GBP</th>
<th>Delta to JAM6R</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIP 270W</td>
<td>366k</td>
<td></td>
</tr>
<tr>
<td>Non MIP 250W</td>
<td>349k</td>
<td>-3%</td>
</tr>
<tr>
<td>300W</td>
<td>341k</td>
<td>-2%</td>
</tr>
<tr>
<td>MIP 250W</td>
<td>345k</td>
<td>-5%</td>
</tr>
</tbody>
</table>

The extra Profit from increased generation over 20 years, even after discounting hits the sweet spot of investment options.
Total Liabilities / Total Equity

Average: 552.5%

Current Ratio

Source: Company filings.
Note: Balance sheet figures are as of 9/30/2013.
Development of Bankability

- Standardization of Bankability Criteria
- Emerging Markets and Bankability Prerequisites
- Post Grid Parity with new Bankability Challenges
- Bankability is a Strategic Choice

Source: Olbert, Ade, Hampl, Lüdeke-Freund, Flink: internal discussion, 2011 modified by Flink, 2013
THANK YOU!

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