The brilliance of solar made sensible.

**Efficiency Improvements Make it Ready for Prime Time!**

Anthony A. Coker
Sr. Director Strategy
Suniva, Inc.
Suniva Overview

Manufacturer of high-efficiency monocrystalline silicon PV cells and modules

- **High-Efficiency Cells**: 18% in production now; over 20% in laboratory; roadmap to over 20% in high-volume production by 2011
- **High-Power Modules**: 240W, 60-cell panels currently available; 300W, 72-cell panels (in certification) made with 85% US content
- **Made in the U.S.A.**: All cell research, design and cell manufacturing is US-based
- **Affordable**: Competitive cost / watt approaching Chinese cost structure
- **Manufacturing Capacity**: 100MW active, 70MW more in June

**Headquarters**: Norcross, Georgia

**Incorporated**: 2007

**Employees**: Approximately 150

**Investor Backing**: Warburg-Pincus, New Enterprise Associates (NEA), Goldman Sachs, H.I.G. Ventures, Advanced Equities, and others

Our Heritage: *Deep Roots in PV Technology*

Dr. Ajeet Rohatgi, Founder and CTO
- 15 world-record cells
- 11 patents
- 400+ Publications
- Westinghouse Engineering Achievement Award (85)
- IEEE Cherry Award (03)
- NREL Rappaport Award (03)
- 5 most influential in Renewable Energy (08)
- Collaborated with almost all silicon PV manufacturers

1985: Photovoltaic Program Established

1992: University Center of Excellence Established

2007: Suniva Founded
Focused on PV cells the key component in the PV value chain. Manufacturing Partners provide high-power modules.
## Solar Landscape – Silicon is King

<table>
<thead>
<tr>
<th></th>
<th>Silicon</th>
<th>Thin Film</th>
<th>Concentrators</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of Market</td>
<td>93%</td>
<td>6%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Key Players</td>
<td>SunPower, Suntech, Q-Cells, Sharp, Suniva</td>
<td>Unisolar, First Solar, Heliovolt, Mia Sole, Solyndra</td>
<td>Sharp, Spectrolab Solfocus</td>
</tr>
<tr>
<td>Strengths</td>
<td>Medium-to-high efficiency, high durability, scalability</td>
<td>Low cost, no supply challenge</td>
<td>Highest efficiency</td>
</tr>
<tr>
<td>Limitations</td>
<td>Cost has been hard to reduce</td>
<td>Low efficiency, low reliability and scalability</td>
<td>Requires direct sunlight and tracking, very location specific</td>
</tr>
<tr>
<td>Mkt Segment</td>
<td>Power generation (homes, industrial operations)</td>
<td>Building integrated (roofing tiles, opaque windows)</td>
<td>Large scale industrial operations, solar farms, hotspots</td>
</tr>
</tbody>
</table>
Key Drivers for PV Adoption

- Durability (30 Year Lifecycle)
- Tested/Proven Technology
- Scale and Capacity
- Vendor Reputation
- Economics (Cost / W)

Unlike competing technologies, first four drivers are not an issue for silicon PV
Balance of Systems’ Cost

Cost ($/Wp)

- Total system 2009: $5.84
- Module: $0.95
- Efficiency: $0.11
- Racking: $0.03
- Wiring: $0.02
- Power electronics: $0.11
- Engineering: $0.01
- Labor: $0.44
- Regulatory & SGA: $0.12
- Total system 2015: $4.07

Source: Lux Research, Inc.
www.luxresearchinc.com
Suniva’s Approach to Lowering Cost of PV

Sources of Module Cost

- **Si Substrate**: 50%
- **Processing**: 20%
- **Module Assembly**: 30%

**Sources of Cost Breakdown**

- **Si Substrate**: 50%
  - Use less silicon
  - Reduce wafer thickness from 250µm to 150µm
- **Processing**: 20%
  - Use fewer process steps
  - Use of screen printing
- **Module Assembly**: 30%
  - Improve efficiency
  - Create 20% cells without exotic materials

**Source:** Benner & Kazmerski, IEEE Spectrum, 1999.
Suniva Monocrystalline Si Solar Cell

Current Production (2 Bus Bar Shown)

(4.25 W produced under standard test conditions)
Comparison of Silicon Cell Efficiency

Suniva 10% more efficient than competition

10% higher efficiency at no additional cost results in $30m/yr additional pretax income on a 100 MW production line
Suniva Innovation – Baseline 17.0% Process

- **Texture Etch**
  - Tuned chemistry for optimum pyramid size and surface uniformity

- **Diffusion**
  - Balanced deposition/drive-in and profile control provides:
    - Superior electrical carrier collection
    - Surface properly conditioned for down-stream processes

- **PECVD (Plasma-Enhanced Chemical Vapor Deposition)**
  - Properly graded deposition enhances both surface and bulk

- **Electrical Contact Formation**
  - Enhanced carrier collection

- **Overall Process**
  - Strict optimization of process synergies through the line
  - Quantitative verification of processes at scale
Suniva Factory Build Schedule

- **Line 1** – First Production October 2008
  - 17.0% Base Technology, process improvements to 17.5%

- **Line 2** – First Production August 2009
  - 18.0% Technology

- **Line 3** – First Production 3Q’10
  - 19.0% Technology

- **Factory 2** – Site Selection 4Q’09
  - 20.0% Technology
Clear Roadmap to 20% Efficient Cells

3 Key Technology Improvements: Front Metallization

- Rear Surface Passivation and Reflectance
- High Sheet Resistance/Selective Emitter
Road to Cost Effective Si PV

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2009</th>
<th>2012-2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>PolySi ($/kg)</td>
<td>300-400</td>
<td>70-100</td>
<td>40-50</td>
</tr>
<tr>
<td>Mono Si Wafer ($)</td>
<td>9</td>
<td>3.50</td>
<td>3</td>
</tr>
<tr>
<td>BOS ($/W)</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Module Price($/W)</td>
<td>4</td>
<td>2.20</td>
<td>1.40-1.50</td>
</tr>
<tr>
<td>Module Efficiency (%)</td>
<td>14.30</td>
<td>15</td>
<td>18-20</td>
</tr>
<tr>
<td>LCOE (c/kWh)</td>
<td>26</td>
<td>18</td>
<td>10</td>
</tr>
</tbody>
</table>

Si is responding to the challenge from other materials by cost reduction via innovation in crystal growth, ingot slicing, low-cost technology development, and efficiency enhancement on thinner wafers.
Enough power for over 14,000 homes
1.69 Million Square meters (417 acres)

Enough power for over 14,000 homes, almost 1/3 of all Savannah.
Solar Land Area Requirements

3 TW
Solar Land Area Requirements

6 Boxes at 3.3 TW Each
## Renewable Portfolio Standards

**www.dsireusa.org / April 2010**

### State Renewable Portfolio Standards

<table>
<thead>
<tr>
<th>State</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>WA</td>
<td>15% x 2020*</td>
</tr>
<tr>
<td>CA</td>
<td>33% x 2020</td>
</tr>
<tr>
<td>NV</td>
<td>25% x 2025*</td>
</tr>
</tbody>
</table>
| OR    | 25% x 2025 (large utilities)*  
5% - 10% x 2025 (smaller utilities) |
| CO    | 30% by 2020 (IOUs)  
10% by 2020 (co-ops & large munis)* |
| AZ    | 15% x 2025 |
| NM    | 20% x 2020 (IOUs)  
10% x 2020 (co-ops) |
| HI    | 40% x 2030 |
| TX    | 5,880 MW x 2015 |
| MT    | 15% x 2015 |
| MN    | 25% x 2025  
(Xcel: 30% x 2020) |
| ND    | 10% x 2015 |
| SD    | 10% x 2015 |
| WI    | Varies by utility;  
10% x 2015 statewide |
| IA    | 105 MW |
| IL    | 29% x 2025 |
| MO    | 15% x 2021 |
| IA    | Varies by utility;  
10% x 2015 statewide |
| IA    | 105 MW |
| IA    | 105 MW |
| MA    | 22.1% x 2020  
New RE: 15% x 2020  
(+1% annually thereafter) |
| NH    | 23.8% x 2025 |
| ME    | 30% x 2000  
New RE: 10% x 2017 |
| VT    | (1) RE meets any increase in retail sales x 2012;  
(2) 20% RE & CHP x 2017 |
| MA    | 22.1% x 2020  
New RE: 15% x 2020  
(+1% annually thereafter) |
| RI    | 16% x 2020 |
| CT    | 23% x 2020 |
| PA    | ~18% x 2021† |
| NJ    | 22.5% x 2021 |
| DE    | 20% x 2020* |
| DC    | 20% x 2020 |

### Extra Credit for Solar or Customer-Sited Renewables

- Extra credit for solar or customer-sited renewables

### Minimum Solar or Customer-Sited Requirement

- Minimum solar or customer-sited requirement

### Solar Water Heating Eligible

- Solar water heating eligible

### Includes Non-Renewable Alternative Resources

- Includes non-renewable alternative resources

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### Notes

- 29 states + DC have an RPS  
(6 states have goals)
RPS Policies with Solar/DG Provisions

State renewable portfolio standard with solar / distributed generation (DG) provision

State renewable portfolio goal with solar / distributed generation provision

Solar water heating counts toward solar provision

www.dsireusa.org / April 2010

16 states + DC have an RPS with solar/DG provisions

WA: double credit for DG
OR: 20 MW solar PV x 2020; double credit for DG
NV: 1.5% solar x 2025; 2.4 - 2.45 multiplier for PV
CO: 3.0% DG x 2020; 1.5% customer-sited x 2020
UT: 2.4 multiplier for solar-electric
AZ: 4.5% DG x 2025
NM: 4% solar-electric x 2020; 0.6% DG x 2020
TX: double credit for non-wind (non-wind goal: 500 MW)
MI: triple credit for solar-electric
OH: 0.5% solar-electric x 2025
IL: 1.5% PV x 2025
WV: various multipliers
MO: 0.3% solar-electric x 2021
NC: 0.2% solar x 2018
MA: 400 MW PV x 2020
NY: 0.4788% customer-sited x 2015
NJ: 5,316 GWh solar-electric x 2026
PA: 0.5% PV x 2020
DE: 2.005% PV x 2019; triple credit for PV
MD: 2% solar-electric x 2022
DC: 0.4% solar x 2020

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And the lack of PPA for 3rd Parties hurts too

3rd-Party Solar Power Purchase Agreements (PPAs)

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- Authorized by state or otherwise currently in use
- Apparently disallowed by state or otherwise restricted by legal barriers
- Status unclear or unknown

At least 15 states + PR authorize or allow 3rd-party solar PPAs

Note: This map is intended to serve as an unofficial guide; it does not constitute legal advice. Seek qualified legal expertise before making binding financial decisions related to a 3rd-party PPA. See following slide for authority references.
340 kW Grid-Connected Photovoltaic System: Georgia Tech Aquatic Center

Operating Continuously since 1996 Olympic Games
Abundant Energy for Georgia

4 Billion Watt Hours produced by Georgia Tech Natatorium