First Solar at a Glance

Premiere Provider of PV Energy Solutions

- Over 6GW installed worldwide and ~3GW power plant pipeline
- Cost competitive with conventional energy sources today
- Delivering utility-grade PV energy solutions to global power buyers
- Driving innovation across entire value chain and plant solution
- Fully integrated PV solutions optimized for project specific economics
- Founded in 1999 and publicly traded on NASDAQ (FSLR)
<table>
<thead>
<tr>
<th>Site</th>
<th>System Size</th>
<th>Owners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agua Caliente, AZ, USA</td>
<td>290MW</td>
<td>NRG Energy &amp; MidAmerican Solar</td>
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<tr>
<td>Greenough River, WA, Australia</td>
<td>10MW</td>
<td>Verve Energy &amp; GE Energy Financial Services</td>
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<tr>
<td>Dhursar Solar Power Plant, Rajasthan, India</td>
<td>40MW</td>
<td>Reliance Power</td>
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</table>
Cadmium (Cd) is a metal byproduct of zinc refining

Tellurium (Te) is a semi-metal byproduct of copper refining

Cadmium telluride (CdTe) is a semiconductor compound
Critical Material – Tellurium (Te)

• **Where does Tellurium come from?**
  – Tellurium is abundantly present in the earth’s crust. It tends to mainly exist in metallic sulfide deposits.

• **How is Tellurium obtained?**
  – Te is currently obtained almost exclusively through recovery as a by-product of refining copper. Reserve estimates are uncertain and an increased definition of reserves would be motivated by the economics of materials extraction.

• **What is Te currently used for?**
  – Te is primarily used as a machining additive to steel. It is also used for thermoelectric devices (coolers, thermal detectors, electrical generators) and Infra-Red Detectors (IR astronomy, research telescopes, military applications, night visions and heat seeking devices)

• **How much Te is currently being produced?**
  – Current world production is 500 – 1500 metric tons/year and typically increases by 3-5%/year due to increase in copper production. Supply could be expanded at short notice by simply recovering more Tellurium from the anode slimes generated while electro-refining copper

• **What is the PV industry’s demand for Te?**
  – approximately 90-130 metric tons Te/GW
Recent Papers on Tellurium Supply

How PV can scale from GW to TW

1. The Impact of Tellurium Supply on Cadmium Telluride Photovoltaics (Zweibel; 2010)

2. Is Indium and Tellurium Availability a Real Concern for CdTe And CIGS Technologies? (Candelise, Winskel, Gross; 2011)

3. Perspectives on the pathways for cadmium telluride photovoltaic module manufacturers to address expected increase in the price for tellurium (Woodhouse et.al., 2012)

4. Sustainability metrics for extending thin-film photovoltaics to terawatt levels (Fthenakis, 2012)

5. Future recycling flows of tellurium from cadmium telluride photovoltaic waste (Marwede and Reller, 2012)
Life Cycle Management

Product Design | Material Sourcing | Manufacturing

Product Collection & Recycling

Product Use

- First Solar is committed to responsible life cycle management of end-of-life modules and BOS products
- First Solar’s state-of-the-art recycling recovers up to 90% of glass and 95% of valuable semiconductor material
- Continuous investments into recycling technology: to offer competitively priced solution and maximize recycling
Life Cycle Management of Tellurium

Product Design
- Decrease semiconductor layer thickness
- Increase module efficiency
- Increase energy output with tracking systems

Material Sourcing
- Te supply proportional to Cu production
- Increase Te recovery from 55 to 80%
- Obtain Te from Pb by-product
- Direct Te mining

Manufacturing
- Recycle overspray
- Recycle scrap

End-of-Life
- Collection and Recycling
- Semiconductor Refining

Demand Side Management

Supply Side Management
First Solar’s Module Recycling

Warranty/End-of-Life Modules and Manufacturing Scrap

~ 95% recycling of semiconductor material
~ 90% recycling of glass

Unrefined Semiconductor Material

Clean Glass Cullet

Dry Process

Shredder → Hammermill

Precipitation

Film Removal and Washing

Cullet de-watering

Glass-Laminate Material Separation

Laminate Material

Dewatering

Wet Process

Laminate Material
Addressing Critical Materials through Recycling

• How are you addressing the availability of Tellurium?
  — High recycled semiconductor content contributes to long-term security of Te supply and reduced life cycle Cd emissions. Currently 95% of CdTe is recovered during recycling of manufacturing scrap and end-of-life modules.
  — Because current recycling volumes are low, this recycled semiconductor content accounts for a small fraction (≈6%) of the total CdTe needed in the production of new modules.
  — Based on market projections from EPIA/Greenpeace¹ and IEA², in 2050, the quantity of annual CdTe PV waste (in MWp) is projected to be ≈81% of the newly installed CdTe PV capacity.
  — 81% waste content × 85% collection rate × 95% recycling rate × 97% refining rate: over 60% recycled semiconductor content by 2050.¹

• Is there any concern about future stocks of Cd in the future?
  — An oversupply of Cd projected as current demand for Cd decreases. Sustainable use for Cd is needed (e.g., CdTe PV systems).²

Clean.
Affordable.
Sustainable.
Global.