24 Hour x 7 Day/Week Surveillance
Profile – What we do

Location: 312 Main, Caldwell, ID 83605

Products/Services:

Solar module recycling

Semiconductor silicon recovery, IP obliteration, purification, electrical certification

Finished IC die manipulation and elemental extraction

Residential, commercial, and utility scale demolition/deinstallations

Multi – mono crystalline

EH&S conscious and compliant – end-to-end (Hallmark)
• Audit compliance – largest/leading IC corporations in the industry
• Acid containments, safe storage, advanced delivery systems, waste stream control, heavy metals, work area ambient particulate counts, bulk drainage neutralization, Ph monitoring, Air abatement – scrubber, air evacuation/filtration, respiratory protections
Genesis of the company formed around silicon extraction, processing, IP protections, customized tool sets, substrate purification for reintroduction back into solar industry.

Company mission:

Recycle various forms of otherwise ‘waste/scrap’ silicon – reintroduce as raw material feeding IC wafer and solar consumption demand

Re-focus: Solar vs. Semiconductor --- become the most capable, cost efficient, technical sophisticated, environmental conscience, and sustainable PV recycling organization in the industry
Technologies – Capabilities – Unique Attributes – Accomplishments

• High tech processing – to historically low tech environment

• Fundamentally new commercial initiative in material recycling

• Semiconductor fabrication methodologies and toolsets redesigned for customized/unrealized capabilities

• Surplus, end-of-life capital tools configured for novel recycling solutions

• Automation, innovation, capital efficiencies applied to offset/provide alternative to crude, polluting, off-shore, and unregulated recycling operations EH&S compliant – US based policy

• Chemical/mechanical sequencing using minimal/trace volumes of toxic/hazardous chemicals (acids)

• Heavy capital automation, volume output, low cost structure, superior alternative international methods
Differentiation

- Progressive environmental policies and objectives
- Audit compliant to strict EH&S operating standards (US based)
- Non toxic – non polluting end-to-end solutions
- NO release or disposal of constituent materials to landfill
- Deep knowledge and networks in Si materials recovery and reuse
- Growing base of supply – Solar farms, metal recyclers, specific module producers, military installations, government projects
- Technical/academia alignments formed to advance recovery percentages, develop more efficient processes, utilization of most advanced assay tools, vigilant focus on improvement/optimization
- Scale --- commercial leverage
- Direct, developed, and active relationships with Asian materials customers (Silicon from modules ‘are’ feeding the solar market)
GREEN – TO – GREEN === Others claim – we do

EH&S conscious and compliant, proven over many years, rigorous oversight (Intel, Micron, HP, TI, Spansion, Linear, IDT, Microchip – among others)

Sustained audit compliance with the largest/leading IC corporations in the world

**Acid containments**  
**Safe storage – monitored**  
**EPA License**  
**advanced delivery systems**  
**waste stream control**  
**heavy metals containment**  
**Workspace particulate counts**
Target constituent materials

- Aluminum: 10%
- Glass: 74%
- Silicon: 3%
- Polymers: 7%
- Ag: .006%
- Pb: .01%
- Tin, lead, Zinc Copper = trace levels
- Indium
Value = Silicon

- Mono-crystalline (single crystal)
- CZ ingot growth
- Elementally doped for proper conductivity/resistivity
- Boron – easily measurable and verifiable
- Visually assessed for quality – precludes advanced testing
- Conditioned for direct re-melt application with minimal preparation
- High purity
- High resistivity well controlled (<.50 ohm cm)
  - Monocrystalline
  - Multi-crystalline
  - Boron doped – high resistivity (> .50 ohm cm)
- Direct re-melt raw material
- Proprietary handling – processing methodologies
- Precious metals extraction – Ag – heavily being studied
- Comingle/aggregate with IC silicon to command “premium’ return
- Glass – Silicon amalgamations aggressively optimized
Methods for manipulation

• Mechanical finishing systems – wet/dry sequencing
• Customized media obliteration
• Chemical softening
• High pressure abrasives (environmental coatings) -
  • Cured poly
  • SiN2
  • SiC
• Ball milling
• Large cu. ft. turning
• Centrifugal Disc separation
• Vibratory bowl oscillation
• Media ‘shakers’
• Heating / incineration ------ Induction furnaces
• Solar
What else??

- Aggressive, technically advanced, and laser focused efforts around cost efficient recovery of Ag = Silver
- Mixing of high purity silicon with module Al (frames) high performance Al allow used in aerospace applications
- Junction box removal --- high percentages retain full function after removal and perfectly suited for used panel applications
- Glass easily and efficiently segregated through Si-SiO2 heat cycling methods
- Polymer back-sheet = methods to segregate, sequester, store.......

Supply Sources = need more

- Major supply contracts - de-installations, removals, field characterizations, full spectrum services
  
  - Swinerton
  - Hanwa/Qcell
  - Solid
  - S-Power
  - ConEdison
  - Bennington
  - OCI
  
- Principally large account procurement – guided entities through strategic steps
  
  - Municipalities
  - State / Federal projects
  - ID Dept of Education
  - Military
  
- DIY – Off grid presence – local outlet – spread solar awareness
Cell – IP PRESENT
Challenges

- Supply – Supply – Supply – Supply
- Money – investment – research
- Upcycling vs. Downcycling
- Poor economies of scale
- Disparate consolidation – lack of coordinated efforts

- Volume of supply
- Consistency of supply
- Commitment
- “Cherry Picking” – scrap metal scavengers after the good, polluting the bad
  - Ewaste repeated
- Custom vs. Index pricing
- Agreements – commitments – common utruistic solution
- Purity refinement process and chemical cleans (SC-1, SC-2)
  - Environments impacts
  - EH&S footprint
- Automation = capital intensive

High ecological index – high eco-efficiency – environmental relief (vs. impact)
1 minute or so on thin film vs. crystalline silicon solar (aka mono and poly), noting that First Solar recycles their own.

What’s a solar panel made of? by weight?

How much of each of these can be recycled? i.e., aluminum likely 100%, backsheet fluoropolymers 1% (a hard topic, but how should we handle the stockpiling of the not easy to recycle byproducts?)

Note: the new Washington law has a section on rare earth elements being recovered, so a comment on whether or not rare earth are used today.

Here’s the law and search for “stewardship”

http://washingtonlegislativebranch.wa.gov/Legislation/Pages/BillText.aspx?Session=2011&Year=2012&BillNumber=1216&BillNumberBegin=SB100&BillNumberEnd=SB1000&Index=2&pageSize=50&pdfpage=1

Are there ways solar module manufacturers can make their products easier to recycle?

The positive value of repurposing of partially functioning solar panels... e.g., Off grid, power

The positive value of repurposing of electrically dead but mechanically sound solar panels - e.g., Durable weatherproof building elements

thoughts on how to fund the full recycling process? (including what to do with the leftover materials such as the fluoropolymers). Should there be a pay in advance core charge on new purchases? etc???? but who’s paying the charge for oil, coal, and nuke cleanups

I’ve got a 2-hour drive ahead of me now but we could talk a little later tonight. (By) after I’m out of the car.
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