Development of Circular Economy for Precious and Rare Metals in Chinese Taipei

Dr. C.Y. Ma
CEO of Solar
2018. 03. 28

Economy
Ecology

Material Applications
Recycling & Refining

For internal use only & Proprietary
1. Evolution Trends of Industrial Development (1980s~2010s)

- **Technical Driving Forces:**
  - 1st: computer and calculation
  - 2nd: communication and video/audio
  - 3rd: networking and mobility

- **Platforms:** PC > NB > s-phone > i-Pad > robot

- **Trends:** enhancement of mobility / dynamic
Severe Issues Human Being Facing: Environmental Pollution / Protection

E-waste generated worldwide in 2009

53 million tonnes
13% was recycled

Source: ABI Research
Shortages of “Critical Raw Materials”

Forecast Surplus (Deficit) - 2020 (%)

2. Taiwan, a Leading Country of EEE Industry

Share of output value W.W.
Major EEE Ind. In Taiwan

- Semi 1
- Packaging 1
- PCB 2
- FPD 2

Source: DOIT, Ministry of Economic Affairs, Taiwan
Circular Economy Developed at Solar in Taiwan

- PM Chemical
- Sputtering Target
- Catalyst
- PM Metals

Industrial Customers (HD, ODS, FPD, LED, PCB...)
Circular Economy of Gold (Au) at Solar

Sampling Pre-treatment

Material Production

Recycling

Au 95-99%

- Incineration
- Melting
- Dissolution

- Reduction
- Replacement
- Electrolysis

Scrap from Customer Process

LED
PCB
OSL

Gold bump
GaAs device
IC packaging

MEMS

Target
Slugs

Chemicals
Wire

Au
Density: 19.3
M.P: 1164°C

>5N (99.999%)
### Ten Industrial Applications Developed at Solar for WW Customers

<table>
<thead>
<tr>
<th>Application</th>
<th>Image</th>
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<tbody>
<tr>
<td>HDD</td>
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<tr>
<td>PV</td>
<td><img src="image" alt="PV" /></td>
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<tr>
<td>Semi</td>
<td><img src="image" alt="Semi" /></td>
</tr>
<tr>
<td>FPD</td>
<td><img src="image" alt="FPD" /></td>
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<tr>
<td>CD/DVD/BD</td>
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<tr>
<td>PCB</td>
<td><img src="image" alt="PCB" /></td>
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<tr>
<td>LF</td>
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<tr>
<td>LED</td>
<td><img src="image" alt="LED" /></td>
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<tr>
<td>Auto-Chemicals</td>
<td><img src="image" alt="Auto-Chemicals" /></td>
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</tbody>
</table>
3. R&R of Electronic Wastes (e-wastes)

- Critical metals
- Precious metals
- Rare Earths

Solar panels and wind turbines convert to electronic wastes.
Value Chain of e-Waste Circular Economy

City Mining Circular Economy

- Wastes Collecting
- Dis-mantling
- Sorting
- Separation Stripping
- Recycling
- Refining
- Material Application
e-Waste R&R via Pyro Process (existing)

- PCB
- Crush
- Smelter

High energy consumption / High carbon emission / High investment
High volume required / Longer treatment time required (8~10 weeks)
e-Waste R&R via Green Process (emerging)

Process

Eco-friendly Stripping (EFS)

iPhone 6

Dismantling

Flexible board

SnST-550A tin stripping

Rigid board

Empty board

Connector

BGA/IC chip

Grnd to powder

Case and iron component

Others

MLCC and others

UW-860 gold stripping

99.99% Au

Sn
Green Electronics Resources Alliance (GERA)

Cycle Time ~ 2 weeks
### 4. e-Waste R&R for Mobile Phone

- **Casing (51%)**
- **PCB-r (19%)**
- **PCB-f (10%)**
- **Others (12%)**
- **S. Steel (8%)**

#### Based on statistics in scraped mobile phones (1 ton / 50,000 pcs), there are around 340g Au, 1.2Kg Ag, 20Kg Sn and 300Kg Cu.

#### W.W. scraped volume ~ 1.2 bn phones per year.

<table>
<thead>
<tr>
<th>部件</th>
<th>空板</th>
<th>BGA/IC</th>
<th>MLCC</th>
<th>SIM卡連接器</th>
<th>其他連接器</th>
<th>其他零件</th>
<th>合計 (每公斤)</th>
<th>合計 (每趨)</th>
<th>合計 (RMB/每趨)</th>
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<tbody>
<tr>
<td>金</td>
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<td>0.008g</td>
<td>0.006g</td>
<td>0.001g</td>
<td>0.001g</td>
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<td>0.4g</td>
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<td>0.003g</td>
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<td>18.4g</td>
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<td>0.13g</td>
<td>0.001g</td>
<td>0.002g</td>
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<td><strong>19.05g</strong></td>
<td><strong>19.05kg</strong></td>
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<td>4.8g</td>
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<td><strong>328.8g</strong></td>
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<td><strong>9863</strong></td>
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<tr>
<td>合計</td>
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<td><strong>111035</strong></td>
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</table>

- **W.W. scraped volume ~ 1.2 bn phones per year**
e-Waste R&R for Notebook

Circular Economy
Full Close Loop

Target
Slugs
Green R&R Process

Chemicals
Wire

Dell

SOLAR
Change for Excellence!
5. Collaboration is the best way to implement!

Synergy of Academic & Industry

Making Research Real

Visions: Green / Value / Future

From Inside (TW) to Outside (WW)
6. Strategy in Sustainable Industrial Development (1P / 2I / 3R / 4S)

Platform

Innovation
Integration

3R
Reuse
Reduce
Recycle

4S
Speed
System
Solution
Sustainability

All Win Policy (AWP)
Industry, User, Society
Thank You for Your Attention!

You see waste, we see resource!

Circular Economy for a Better Life!