US EPA ARCHIVE DOCUMENT
Case Study: Reducing & Reusing Water in Manufacturing
Agenda

• Overview of Intel
• EHS in Technology Development
• Water Recycling and Conservation
  – CA Case Study
  – AZ Case Study
• Selected Results
• Challenges & Opportunities
Our “Fun” Facts:

- Founded on **July 18th, 1968**
- Number of employees: >80K
- >$38 Billion in annual revenue
- 294 offices/facilities in 48 countries
- 43,000 technical degrees & “Intel U”
- Rated 7th most valuable brand by BusinessWeek and InterBrand
More than half of all Intel employees work in manufacturing.
“It’s no longer enough to just produce a profit. Instead, we need to continually improve our manufacturing process, thereby reducing our burden on the environment and becoming an asset to the communities in which we live and work”.

Gordon Moore, Intel Chairman
Letter in EHS Report, January 1995

“Continuing our commitment to the highest performance in all we do—from product innovation to corporate responsibility—is good business.

Paul Otellini, President and CEO
CSR Report, May 07
Intel’s EHS Guiding Principles:

• Prevent all injuries in the workplace
• Be an EHS leader in our communities and our industry
• Reduce the environmental footprint of our products, processes and operations
### Environmental Goals

<table>
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<th>Goal</th>
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<tr>
<td>Reduce absolute global-warming gas footprint by 20% by 2012 from 2007 levels.</td>
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<tr>
<td>Reduce energy consumption per chip 5% per year from 2007 through 2012.</td>
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<td>Achieve engineering and design milestones to ensure that Intel products keep the energy-efficiency lead in the market for our next two product generations.</td>
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<tr>
<td>Reduce water use per chip(^1) by 2012 from 2007 levels.</td>
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<td>Reduce generation of chemical waste per chip by 10% by 2012 from 2007 levels.</td>
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<tr>
<td>Recycle 80% of chemical and solid waste generated per year.</td>
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\(^1\) Assuming a typical chip size of approximately 1cm\(^2\). (Chips vary in size depending on the specific product.)
Environmental, Health & Safety in Technology Development (TD)
Intel EHS Technology Engagement Model

Very early engagement through universities and government labs

Early engagement through supplier targets

Optimum Time to effect change in technology

Technology frozen, major changes require much more effort - use continuous improvement

1. Very early engagement through universities and government labs
2. Early engagement through supplier targets
3. Optimum Time to effect change in technology
4. Technology frozen, major changes require much more effort - use continuous improvement

Research
Commercialization Phases
Demonstration
Ramp to HVM

YEARS to High Volume Manufacturing
Reduce Demand - Emissions & Water
300 vs. 200mm Equipment Tool Set

Normalized 200mm vs 300mm performance at peak of ramp

Normalized Emissions per in² silicon

Intel 200mm baseline (130nm)*

Intel 300mm (90nm)

*Note: Intel 130nm baseline averages ~60% of Industry average
Water Recycling & Conservation
Intel’s Overall Strategy

- **1 - REDUCE**
  - Know your water
  - Reduce water demand at Tools
  - Leverage worldwide team of water experts
  - Drive water reuse/conservation in new Fab design
    - Baseline: Once-through water use
    - Generation 1: Ultra-pure Reclaimed Water (URW)
    - Generation 2: URW + Intense heat recovery (reduce cooling tower evaporation)
  - Add conservation measures based on local conditions (e.g. water quality, infrastructure, climate)
    - Developed standard “toolbox” for projects beyond BKM

- **2 - RECLAIM**

- **3 - RECYCLE**
CA Case Study
“Local” Solutions

• Step 1: Wall-to-wall audit
• Step 2: Pareto Opportunities – biggest bang for $.
• Step 3: Get Help!!! Examples include...
  – Commercial Water Softener Rebate Programs
  – Cooling Tower Rebate Programs
  – Commercial High Efficiency Toilet Program
  – Irrigation Technical Assistance Program (ITAP)
  – Water Efficient Technologies (WET) Program
Water Efficient Technologies (WET) Program

• ‘90s “Slow the Flow” Campaign in Santa Clara Valley

• Successful collaboration between Intel, SCVWD and SJ/SC/WPCP

• Santa Clara Campus “D2” Fab
  – Scrubbers
    • Caustic injection to replace water
  – Cooling towers
    • Installation of Electro Dialysis Reversal (EDR) to pre-treat RO Reject

• At least $175K in rebates –
  Easy Money! 😊
Chandler Reverse Osmosis Water Treatment Facility

Ocotillo, Arizona

1,000 ft set-back from homes
Selected Results:

• Over 3.5 billion gallons of drinking-quality water recharged into AZ aquifer

• Operations conserve up to 75% of daily water demand

• U.S. EPA’s 2007 Water Efficiency Leader Award:
  – EPA recognized Intel Ocotillo as one of six winners of the 2007 Water Efficiency Leader (WEL) awards.
  – Winners were chosen by a panel of national water experts and based on three criteria: Leadership, innovation and water saved
Intel’s Water Savings in last 10 years...

✓ Invested ~$100M on water conservation
✓ >90,000 acre feet enough for >280,000 homes for a year

This savings represents all the water that goes over Niagara Falls in >11 hours!
Challenges & Opportunities
Challenges Ahead...

- Single Wafer Processing...
- Water Use Demands and ROIs...
- Moore’s Law and the Periodic Table...
- Infrastructure Limitations...
- Concentrating the problem...
Water-Related Opportunities...

• **BE PROACTIVE** (Covey’s 7 Habits)
  - Get “out there”, assess, prioritize, plan\(^4\)
  - Follow through!

• **Don’t reinvent the wheel**
  - NUMEROUS excellent water reduction planning documents and web sites available\(^4,5,6,7\)
  - Leverage other people, companies, institutes

• **Education and mentoring of others...**
  - Share successes AND failures
  - Change paradigms (for example...)
    • Waterless urinals...
    • Thinking outside box (& even property boundaries)...
    • Holistic impacts – complete ROI’s assessments
Supporting Data
References and Resources

5. At the Crest of a wave: A Proactive Approach to Corporate Water Strategy (http://www.bsr.org/reports/BSR_Water-Trends.pdf)
8. Google – “Know your Water” and “Water IQ”
## Comparative Water Use

<table>
<thead>
<tr>
<th>Product</th>
<th>Gallons of Water to Produce</th>
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<tbody>
<tr>
<td>Glass of Milk</td>
<td>65</td>
</tr>
<tr>
<td>1 Steak</td>
<td>2,607</td>
</tr>
<tr>
<td>Ton of Alfalfa</td>
<td>13,500</td>
</tr>
<tr>
<td>1 Egg</td>
<td>120</td>
</tr>
<tr>
<td>Pair of Jeans</td>
<td>1,800</td>
</tr>
<tr>
<td>Sunday Newspaper (Average)</td>
<td>150</td>
</tr>
<tr>
<td>Wheat for 2 lb. loaf of Bread</td>
<td>1,000</td>
</tr>
<tr>
<td>Core 2 Duo</td>
<td>&lt;10</td>
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</tbody>
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*SOURCE: Intel & EPA Office of Water*
Chandler Reverse Osmosis Water Treatment Facility
Brine Evaporator System
Air Scrubbers - Typical

Vertical

Horizontal
Cooling Towers - Typical

AZ Cooling Tower Utilizing Reclaimed Wastewater
Landscaping the Smart Way... Xeriscaping
Chandler’s Total Water Use

Chandler 2007 Total Annual Water Use
(65,570 Acre Feet)

- Single Family / Multi-Family: 56%
- Non-Residential: 44%

Intel = 4% of City's Total Non-Residential and Residential Use
Chandler’s Total Water Use
Non-Residential Sector

Chandler Annual Non-Residential Metered Water Use (2007)
(29,007 Acre Feet) by Major Sector

- Sprinkler meters (turf Facilities) (metered) 33%
- Construction - Hydrant Meter (metered) 4%
- Miscellaneous (unmetered) 20%
- Industrial (metered) 22%
- Commercial (metered) 18%
- Government 3%

Intel = 10% of City’s Non-Residential Use
Intel = 45% of City’s Industrial Use