ENVIRONMENTAL COMMITMENT

We’re continually assessing our environmental impact and taking steps to reduce it.

GM has a commitment to the environment and sustainability that applies to every part of our business – from our supply chain, to product manufacturing, to the vehicles we put on the road.
Environment: Our Commitment
We’re committed to continuous improvement as we reduce the environmental impact of our vehicles and facilities. Our culture of environmental responsibility makes us think creatively, consistently innovate, and be leaner and more efficient.

<table>
<thead>
<tr>
<th>Waste Reduction</th>
<th>Energy Efficiency</th>
<th>Resource Preservation</th>
<th>Greener Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>We strive to be the automotive industry’s waste reduction leader.</td>
<td>We strive to reduce emissions &amp; petroleum dependence by being more energy efficient.</td>
<td>We help preserve natural resources and enhance habitats surrounding our facilities.</td>
<td>We’re building fuel-efficient vehicles that fit our customers’ needs and lifestyles.</td>
</tr>
</tbody>
</table>
GM MANUFACTURING COMMITMENTS

Sustainability is integrated into our business. Every plant globally contributes to our companywide goals.

- **Renewable Energy**: 125 MW
- **VOC Emissions**: 10% reduction (kg/veh)
- **CO₂ Footprint**: 20% reduction (CO₂e/veh)
- **Energy Use**: 20% reduction (MWH/veh)
- **Water Use**: 15% reduction (m³/veh)
- **Total Waste**: 40% reduction (kg/veh)
- **Biodiversity**: All sites with WHC certified habitats
- **Landfill Free**: 150 sites total; 100 manufacturing; 50 non-manufacturing
- **Community Outreach**: All global sites
WATER REDUCTION AT GM’S GLOBAL FACILITIES

32% FROM 2005-2010

10% FROM 2010-2015
ENVIRONMENTAL SUSTAINABILITY ADVISORY GROUP
WATER BENCHMARKING - AIAG

- Auto OEMs benchmarked water management, use, and best practices
- FCA, Ford, GM, Honda, Nissan, Toyota participated
- Identified 135 aspects to benchmark – metrics, management, processes, sustainability, and best practices
- Benchmarking helps identify areas for improvement with best practices
- Next steps are to extend to automotive supply chain

The AIAG water workgroup provides a forum for benchmarking and promoting water reduction activities
## Results

**Auto OEM Company Water use per Vehicle (M3/Vehicle)**

- Assembly: 3.9
- Engine: 3.9
- Transmission: 4.2
- Casting: 2.8
- Stamping: 3.0
- Non-Manufacturing facilities: 3.4

**Average**: 3.5

<table>
<thead>
<tr>
<th>Auto OEM sites included in Water Benchmarking</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembly</td>
<td>51</td>
</tr>
<tr>
<td>Engine</td>
<td>26</td>
</tr>
<tr>
<td>Transmission</td>
<td>18</td>
</tr>
<tr>
<td>Casting</td>
<td>12</td>
</tr>
<tr>
<td>Stamping</td>
<td>22</td>
</tr>
<tr>
<td>Non-Manufacturing facilities</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>149</td>
</tr>
</tbody>
</table>

Scope is North American automotive OEMs
Only one OEM included non-manufacturing, excluded in this chart
ENVIRONMENTAL SUSTAINABILITY ADVISORY GROUP
WATER BENCHMARKING - AIAG

Results

Water Benchmarking Assembly Plants, M3/Vehicle

Source

<table>
<thead>
<tr>
<th>Source</th>
<th>Per-cent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Water</td>
<td>13%</td>
</tr>
<tr>
<td>Surface Water</td>
<td>2%</td>
</tr>
<tr>
<td>Municipal</td>
<td>83%</td>
</tr>
<tr>
<td>Grey Water</td>
<td>1%</td>
</tr>
<tr>
<td>Rain Water</td>
<td>0%</td>
</tr>
</tbody>
</table>

Municipal source is most common
Lowest use per vehicle is high volume or water stressed areas
ENVIRONMENTAL SUSTAINABILITY ADVISORY GROUP
WATER BENCHMARKING - AIAG

Results

Water Benchmarking Engine Plants, M3/Engine

- High – low volumes
- Low – high volume and water stressed
ENVIRONMENTAL SUSTAINABILITY ADVISORY GROUP
WATER BENCHMARKING - AIAG

Results

Water Benchmarking Casting Plants, M3/Ton

Casting

High – Aluminum, low volumes
Low – Iron casting, Aluminum high volume

OEM: A B C D E F
Low: 1.6 2.5 1.7 1.0
Average: 1.7
High: 8.3 7.9

Casting

AIAG Automotive Industry Action Group
Results

Water Benchmarking Stamping Plants, M3/Ton

Stamping

High – low volumes
Low – high volume

OEM: A B C D E

Low Average High

0.22 0.24 0.43 0.27 0.56
BEST PRACTICES SHARED FOR WATER EFFICIENCY

- Perform site-wide water balance to better understand water usage, identify opportunities and knowledge gaps
- Develop water scorecard and integrate into site business plan
- Implement aggressive water reduction and recycle, up to and including ZLD in water stressed regions
- Install real-time water metering for high water usage area/department
- Implement rinse system cascading
- Install conductivity control on fresh water make-up to rinses
- Use RO reject for cooling tower or paint sludge system make-up
- Use job present sensor to control fresh water rinse inputs (automatic turn-off rinses during gaps in production)
- Process stage make-up water supplied from respective rinse stage
- Capture cooling coil condensate for reuse (paint sludge system or cooling tower)
- Specify 85% recovery RO systems to reduce RO reject (75% is typical)
TRACK WATER/SEWER USAGE

“What gets measured, gets done!”

• Track incoming water, revenue meters
• Install water meters for high water usage area/department

“If a meter is installed and no-one reads it, does it still measure water?”

• Measuring water necessary for management buy-in and business case development
DEVELOP WATER SCORECARD/TRACKING

- Track usage monthly (at least)
- Management commitment to water reduction
- Develop company reduction goal
  - Normalized to production
- Set goals by facility (or department)
- Integrate into business plans
- Incentives
  - Recognition, friendly competition
  - Tie to plant manager bonus
PERFORM SITE-WIDE WATER BALANCE

- Better understand water usage
- Identify largest users (and knowledge gaps)
- Identify opportunities
- Develop business cases
- Prioritize projects
- Present to management
PAINT SHOP WATER USAGE

- 80% of assembly plant water
- Pretreat 30-40%
- E-coat 10-20%
- Paint sludge 5-10%
- Humidification 5-10%
- High purity water 5-10% (reject)
- Cooling towers 10-20%
**RINSE SYSTEMS – BEST PRACTICES**

- Additional rinse stages reduces water
- Cascade rinses from cleanest to dirtiest
- Job present sensors/automatic shut off fresh water
- Knock-off rinse
- Contaminant measurement/control (log sheets, graphs, spec)
- Process make-up with excess rinse water
- Rinse wastewater recovery – membrane process, capacitive DI
# SINGLE V. MULTI-STAGE RINSES

<table>
<thead>
<tr>
<th>Number of Rinse Tanks</th>
<th>Gallons of Rinse Water Required for every Gallon of drag-in *</th>
<th>Water Reduction</th>
<th>Reduction Compared to Single Rinse</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>10.00</td>
<td>90.0%</td>
<td>90.0%</td>
</tr>
<tr>
<td>3</td>
<td>4.64</td>
<td>53.6%</td>
<td>95.4%</td>
</tr>
<tr>
<td>4</td>
<td>3.16</td>
<td>31.9%</td>
<td>96.8%</td>
</tr>
<tr>
<td>5</td>
<td>2.51</td>
<td>20.6%</td>
<td>97.5%</td>
</tr>
<tr>
<td>6</td>
<td>2.15</td>
<td>14.2%</td>
<td>97.8%</td>
</tr>
</tbody>
</table>

Concentration of Chemicals in Process Bath: 4,500.0 mg/l

Maximum Allowable Chemical Concentration in Final Rinse: 45.0 mg/l
• Specify 85% vs typical 75% recovery
• RO reject to cooling towers
• RO reject to paint sludge system
• RO reject recovery – new technologies
• Most locations can run 5-6 cycles of concentration
• Proper chemical control
• Monitor for scaling and corrosion
• Alternate sources of water, e.g., RO reject
• Hardness removal technologies for very high COCs
OTHER OPPORTUNITIES

- Water usage unknown – measure it!
- Poor maintenance – things not working
- Rinse job present sensors not installed/working
- Rinse contamination control – manual, automatic, none
- Steam condensate return – energy + water
- Improper level control – overflow (water and chemicals)
- Limited or no cascading
- Frequent tank dumps
- Leaking “dump” valve
ALTERNATE WATER SOURCES

• Require chemical analysis, system knowledge
• Cooling coil condensate/humidification blowdown for reuse (paint sludge system or cooling tower)
• Treated industrial wastewater to cooling towers
• Foundation drainage (artesian well) to cooling towers, paint sludge
• Stormwater for cooling towers, sludge system, and RO feed, etc.
• Treated industrial/sanitary for CT, irrigation, toilet flushing
• Zero liquid discharge
Detroit Hamtramck reuses stormwater in cooling towers

Saving Costs Through Water Reuse

Using storm water saves water for approximately 2,200 families in Detroit

Using storm water saves water for approximately 2,200 families in Detroit
SAVING COSTS THROUGH WATER REUSE

Mexico plant reuses 90% of their water after treatment

Success: the first zero liquid discharge plant in GM's history. The goal to convert 90% of the plant's secondary wastewater into reusable water is being achieved.

Following free oil removal, metals precipitation and biological treatment, water is softened in a multi-stage process using the proprietary high-rate chemical softening technology.