Los Angeles Sustainability Executives Roundtable (LASER)

Best Practices Guide

Sustainability in Manufacturing

Leveraging the 4th Industrial Revolution to Reduce Emissions and Improve Health
Best Practices Guide
Sustainability in Manufacturing

National Energy Consumption

<table>
<thead>
<tr>
<th>Industrial Sector</th>
<th>Manufacturing</th>
<th>Mining</th>
<th>Construction</th>
<th>Agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>33%</td>
<td>77%</td>
<td>12%</td>
<td>7%</td>
<td>5%</td>
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</tbody>
</table>

Percentage shares of industrial energy consumption by the four major types of industries in the Annual Energy Outlook Reference case for 2020.

Smart Manufacturing (SM) is the information-driven, event-driven, efficient, and collaborative orchestration of business, physical, workforce, and digital processes within plants, factories, and across the entire value chain."

- CESMII


Smart Manufacturing
Productivity + Precision + Performance

Internet
Data Interconnectedness

Cyber-Infrastructure
Data Management and Computation as a Service (Cloud)

Industrial Internet of Things (IIoT)
Interconnected device and operational data

Cyber–Physical Human Systems
- Human Innovation
- Human–Machine Interaction
- Machine to Supply Chain
- Optimization

Wide-area networked-based communication

Cyber Physical Human Systems

Physical
- Manufacturing Assets (Products)
- Equipment Devices
- Advanced Sensors
- Control Devices

Cyber
- Platforms, Applications & Interfaces
- Data Analytics & Modeling
- Digital Operations
- Artificial Intelligence

Smart
- Assess
- Learn
- Predict
- Optimize
- Automate
- Self Evaluate

Human–Machine Interaction
- Operations Innovation
- Product Innovation
- Business Innovation
- Jobs
Best Practices Guide
Sustainability in Manufacturing

Smart Sensing

Control Sensors
- Machine (e.g. Speed, Power)
- Process (e.g. Temperature, Level)
- Environmental Sensing (e.g. humidity, air quality)

Image, Movement, Sound Sensing
- Machine vision (camera)
- Vibration
- Acoustic
- Thermal imaging
- Composition imaging

Software and Systems Sensors
- Unmeasurable Product Properties
- Quality Sensing [in-process measurements of product attributes (dimensions, properties, surface)]
- Carbon modeling
- Hardware health
- Real-time KPIs

Human Input
- Manual Data
- Wearables
- AR/VR

Case Study: Data Modeling for Smart Aerospace Additive Manufacturing

Who: Honeywell & CESMII

Partners: UCLA, USC, Missouri University Science & Technology, Identify 3D, and Keselowski Advanced Manufacturing

Goal: Develop technologies on data modeling, machine learning, and data-centric analytics for metal powder-based additive manufacturing (3D printing)

Process: Data was collected and analyzed for layer images, infrared thermal images, machine sensors, and part geometries. Use of both optical and infrared sensors to monitor each layer as it is sintered with lasers. Machine sensors typically included position, speed, and power.

Results:
- Additive manufacturing processing yield from 90% to 95%
- Reduction of energy consumption overall by 5%
- Developed predictive models to reduce part failures, re-coater jams, and high energy consumption
- Demonstration of advanced image processing and machine learning for process monitoring and anomaly detection

Smart technologies increase productivity; improve products, operations, safety, and employee health; reduce waste, energy consumption and carbon emissions; enable new economic opportunities.
## Thermal Processing: Boilers

**Federal Energy Management Program (FEMP) Resources:**

<table>
<thead>
<tr>
<th>Minimum efficiency requirements and thermal efficiencies</th>
<th>Energy Cost Savings Calculator for existing boiler retrofit or replacement</th>
<th>Information on fuel-specific (oil or gas-fired) boiler or furnace retrofits</th>
</tr>
</thead>
</table>

**Thermal Processing in U.S. Manufacturing**

- **75% of total final energy demand**
- **17% of energy demand for U.S. Manufacturers**

**Energy Saving Features:**

- Sealed combustion
- Low mass
- Water temperature reset
- Modulating burners
- Air-fuel ratio
- Optimum start control
- Hybrid systems

**New Boiler Considerations:**

- High AFUE (90–98.5%)
- System size
- Peak heat demand
- Load capabilities
- Facility characteristics (quality of insulation and building relationship to surrounding climate)

**Heat Recovery:**

- Heat Exchangers
- Economizers
- Reuse heat from blowdown
- Return condensate to steam boilers
- Increase boiler and pipe insulation

**Case Study**

The J. Craig Venter Institute (JCVI).

Cooling tower, heat exchangers, & thermal energy storage tanks for heat recovery.

"Electric heat pumps for low-and medium-temperature heat demand and electric-powered mechanical vapor recompression (MVR) equipment for evaporation are already used on some industrial sites. Electric boilers that can generate industrial heat up to approximately 350 degrees Celsius are widely available."

- A McKinsey & Company Analysis

**References**

- Lawrence Berkeley National Lab Report

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*Best Practices Guide: Sustainability in Manufacturing* (April 2022)
Renewable Energy

**Emerging Renewable Sources & Technologies:**
- Green Hydrogen
- Advanced Batteries
- Long-term storage of zero-carbon electricity

**In 2017,**
- Fuel used for energy in the industrial sector accounted for approx. **45%** of total energy consumption
- Fossil Fuels accounted for **78%** of energy consumed in industrial sector
- Electricity accounts for only **21%** of total industrial energy

**Economic Benefits of Renewables**
- Lower prices when renewable sources are at peak production
- Receive government subsidies & tax credits
- Sell excess energy back to the grid
- Charge more for using cleaner fuels

SoCal Gas has proposed the largest green hydrogen energy infrastructure system, Angeles Link, which would deliver clean energy to the Los Angeles region, convert up to four natural gas power plants to green hydrogen and eliminate up to 25,000 tons of nitrous oxide emissions.

Energy Storage

**Solutions for long-duration energy storage are critical to the integration and expansion of renewables into the electricity grid.**

Green hydrogen is able to provide long-term and seasonal storage of fuel. A new initiative called HyDeal LA, developed by the Green Hydrogen Coalition is working towards launching green hydrogen ecosystems which aim to halve fuel costs by 2030. HyDeal LA is working with LADWP on a project in Utah that will transform its coal-fired Intermountain Power Project into a combined-cycle gas turbine facility that will provide power to LADWP’s service areas.

A recent Deloitte survey of more than five hundred U.S. executives found that **62%** of the executives in the power and utility industry are either building or procuring grid-scale solar that includes storage.
Case Study: HVAC Efficiency Projects in 3 Aerospace Manufacturing plants

Who: GREEN ECONOME

Where: Sylmar, CA

Problem: Demand charges reached peaks of over $16,000 per month for Plants 1, 2, and 3, which accounted for approximately 20% of the billed costs.

Process: Green EconoME identified lighting, HVAC, and thermostat systems that could be upgraded for financial and energy savings. They installed wireless, programmable thermostats that allow for remote control, and four HVAC units serving Plant 1 were replaced with smaller, more efficient units. They also hired IMS to perform HVAC Optimization Testing on ten HVAC units on Plant 1 after applying cleaning and replacement of HVAC units, improvements to ductwork, adding supply, return registers, and adding insulation to the roof piping.

Results:
- Saved the plant 18 tons of cooling annually
- Units performed 80% better than the Test In
- 151% more cooling was delivered into the space
- Addition of the Pelican Wireless Thermostat system further provides energy control
Process: **GREEN ECONOME** replaced outdated lighting technology (fluorescent, metal halide, and incandescent) throughout the interior of three aerospace plants. They were replaced with new ballast bypass LEDs. Intermittently used spaces received occupancy sensors to minimize the burn hours when unoccupied.

LADWP’s **Commercial Lighting Incentive Program** provides rebates on the installation of newly purchased and installed energy-saving lighting and controls. This includes lamp and fixture replacements, as well as sensor-based controls including occupancy and daylight controls.

Benefits: Improves workers’ morale, health, & productivity + Conducive environment for quality checks + Increases tenant comfort & safety + Enables asset tracking + Assists demand response + Integrates with other building systems

**Case Study: Lighting Efficiency Projects in 3 Aerospace Manufacturing plants**

- Total lighting usage for all three plants was reduced by 719,232 kWh
- All three lighting projects had payback periods under 1.6 years

**High Heat Days**

**Best Practices:**
- Interior climate control (HVAC)
- Provide ample access to water and shade
- Provide mandated rest-time
- Continuously monitor for heat illness
- Train employees on heat illness prevention & emergency management protocols

Upgrades and retrofits can prevent building heat absorption, for instance:
- Assessing insulation strength
- Install double-pane windows with low E glass
- Air sealing
- Cool roofs

Develop and implement a robust heat illness prevention plan: assessing the location and its associated systems, the equipment and clothing worn by workers, and rest times and exertion levels.