

It Ain't Easy Being Green: Sustainable Manufacturing with an eye on Cost Avoidance & Stewardship

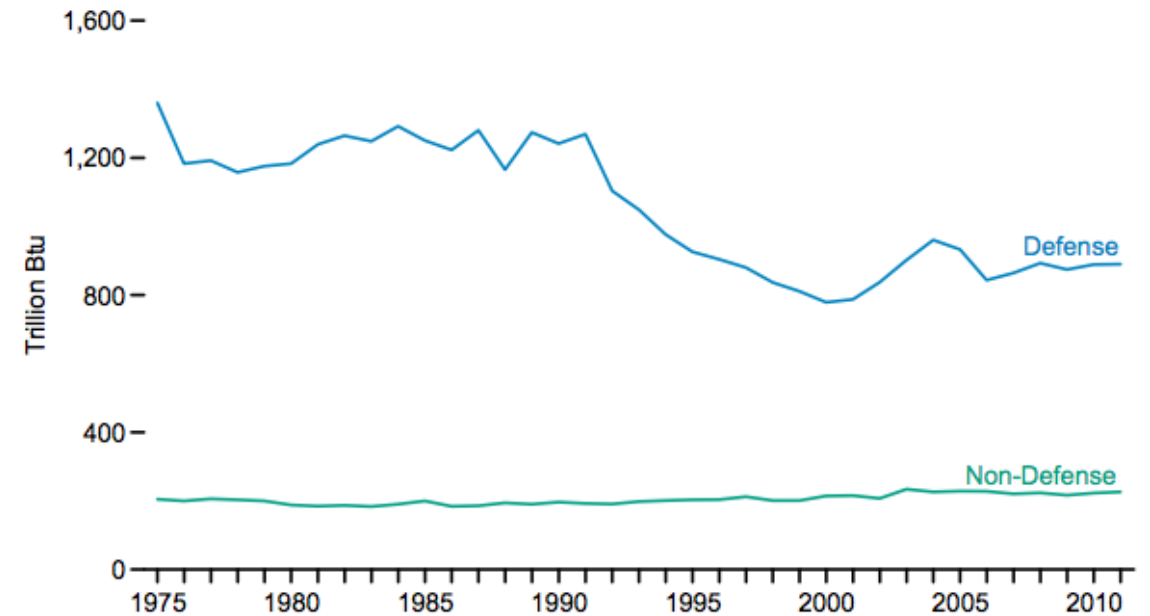
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Department of Defense Energy & Resource Use

- ▶ In FY 2012 the DOD used 89.8 million barrels of liquid fuel/operational energy = \$14.8 Billion
- ▶ If the DOD was it's own country it would have ranked 58th in the world for electricity consumption in 2006
- ▶ The single largest energy user and consumer in the Nation

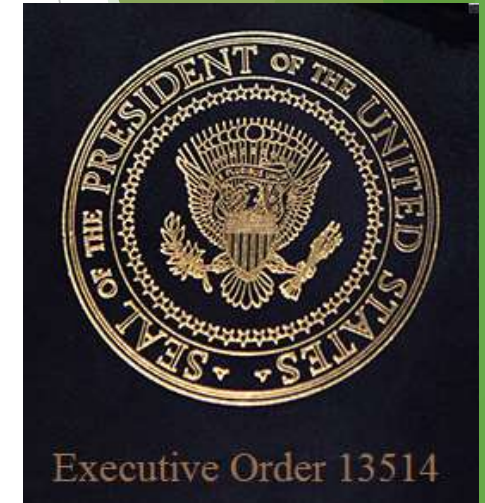
U.S. Department of Defense and Non-Defense Agencies, Fiscal Years 1975-2011



“The Department of Defense (DOD) vision of sustainability is to maintain the ability to operate into the future without decline—either in the mission or in the natural and man-made systems that support it.” -Strategic Sustainability Performance Plan

Overarching Policy and Directives

- ▶ Executive Order 13514 signed by President Obama on October 5, 2009
- ▶ Memorandum of Understanding (MOU) between the DOD and DOE signed in July, 2010
- ▶ DOD Energy Handbook of Alternative and Renewable Energy Options for DOD Facilities and Base signed March, 2011
- ▶ Operational Energy Strategy: Implementation Plan signed March, 2012
- ▶ DOD Strategic Sustainability Performance Plan (SSPP) FY 2012, signed September, 2012
- ▶ DOD Directive Number 4180.01 “DOD Energy Policy,” signed April, 2014
- ▶ Armed Service Branches:
 - ▶ Army - Operation Energy Policy (April, 2013)
 - ▶ Navy - Strategy for Renewable Energy (October, 2012)
 - ▶ Marines - Marine Corps Order 3900.17 (May, 2013)
 - ▶ Air Force - Energy Strategic Plan (March, 2013)



“The challenge with capturing energy in our requirements and acquisition processes is the fact that most energy consumers are often not responsible for the energy they use and those that supply energy have no controls over the consumers” -Marine Corps Order 3900.17

Sustainability in Weapon System Acquisition

- ▶ Previous research has focused on Key Performance Parameters (KPPs) for weapon systems and fuel usage to reduce fossil fuel consumption
- ▶ The goals outlined in the DOD's Strategic Sustainability Performance Plan (SSPP) focus on reducing environmental impacts from installations
- ▶ Gap exists in current research and policy for incorporating sustainability into the Production and Deployment stage of acquisition
- ▶ An important element of weapon systems acquisition currently not under the purview of the DOD's sustainability strategic plan is sustainable manufacturing
- ▶ Little guidance is currently available for DOD acquisition professionals on how to incorporate sustainable manufacturing practices into the systems acquisition stage of the Planning, Programming, Budgeting, and Execution (PPBE) process

Sustainable Manufacturing

- ▶ Energy, water, and waste are three environmental elements affected by manufacturing facility operations and are a main focus of the SSPP
- ▶ DoD's major OEMs already have sustainable manufacturing practices in place; however, there is currently no official policy incorporating sustainable manufacturing in acquisition
- ▶ Why Sustainable Manufacturing?
 - ▶ Continuous improvement
 - ▶ Cost Savings
 - ▶ Competitive advantage
 - ▶ Do more with less (Better Buying Power 2.0)
 - ▶ Positive culture and public image
 - ▶ Conserve our resources



Lockheed Martin F-35 Production Line

“The creation of manufactured products that use processes that minimize negative environmental impacts, conserve energy and natural resources, and are economically sound and safe for employees, communities, and consumers”
- U.S. Department of Commerce

Energy

- ▶ More than 30% of all energy consumed in the United States is used during manufacturing operations
- ▶ Sustainability practices related to energy
 - ▶ Using purchased energy more efficiently
 - ▶ Replacing incandescent bulbs with CFLs or LED lights reduces electricity demand
 - ▶ Cleaning filters regularly and sealing leaks in duct works for HVAC systems
 - ▶ Insulation, motion sensors, shutting off machinery when not in use, energy efficient appliances
 - ▶ Replacing fossil-fuels with renewable energy
 - ▶ Solar, wind, geothermal, hydroelectric, biomass
 - ▶ Renewable Energy Certificates (RECs)



Sustainable Manufacturing Examples: Energy

- ▶ Energy cost reduction activities (turning off lights & unplugging equipment) at Lockheed Martin Mission System and Training facility in Orlando, FL equates to ~\$330,000 cost reductions annually
- ▶ General Dynamics Ordnance and Tactical Systems worked with U.S. DOE Advanced Manufacturing Office to complete Superior Energy Performance (SEP) certification. Identifying significant energy users in facility and implementing efficiency measures resulted in 107 billion Btu and \$956,000 cost savings annually
- ▶ OEMs renewable energy use examples:
 - ▶ Boeing: uses hydroelectric and other renewables for almost 50% of total electricity consumption
 - ▶ Raytheon: purchased 2.5M kWhs of wind electricity to meet 10% of Aurora, CO facility needs
 - ▶ LM: 500kW solar array to fuel electric grid at its Denver, CO site

Water

- ▶ Common uses for water in manufacturing: cooling, process uses, cleaning, steam generation, employee sanitation, and irrigation
- ▶ Water reduction practices include:
 - ▶ Installing water meters, pressure-reducing valves, low-flow showers, faucets, and toilets
 - ▶ Repairing water leaks
 - ▶ Preventing unnecessary heating of water
 - ▶ Using recycled or rainwater for landscaping
 - ▶ Planting native vegetation
- ▶ Reducing the overall use of water can reduce the quantity of disposed water and the risk of litigation from water that might be tainted with toxic or hazardous chemicals



Sustainable Manufacturing Examples: Water

- ▶ Boeing and Lockheed Martin have utilized reverse-osmosis filtration techniques to filter waste water and reuse it in cooling towers or recycle it back into the tank line
- ▶ Lockheed Martin spent over \$2M on water conservation initiatives (upgraded cooling towers, upgrades restrooms, installed smart sensors) which resulted in estimated water savings of 43 million gallons per year
- ▶ Boeing Santa Susana installed biofiltration system which acts as a stormwater treatment system and habitat for pollinator species

A biofilter storm water treatment system at Boeing Santa Susana site



Waste and Recycling

- ▶ Approximately 7.6 billion tons of solid waste are generated each year by U.S. industrial facilities
- ▶ The foundation of any waste management program involves reducing, recycling, and treating waste
- ▶ Waste reduction practices include:
 - Reducing packaging
 - Composting
 - Printing double-sided
 - Remanufactured office equipment
 - Reusable or recyclable containers for shipping products
 - Improving inventory system
 - Using less toxic or nontoxic products
 - Waste to energy conversion
 - Installing reusable furnace and air conditioner filters
- ▶ Benefits of reducing waste include lower disposal and material costs, improved operating efficiency, and reduced regulatory burden

Sustainable Manufacturing Examples: Waste

- ▶ Boeing Product Chemical Profile System identifies and records chemicals used in products
 - ▶ Boeing developed chrome-free paints and primers which is now used on various military products
- ▶ Lockheed Martin partnering with ConcordBlue USA to develop advanced waste-to-energy conversion system that uses gasification process to convert waste products into electricity, heat, and synthetic fuels
- ▶ Lockheed Martin has implemented recycling and reuse program for various products such as paper, cardboard, scrap metal, wood, construction materials, computers, batteries, tires, fluorescent light bulbs, mercury thermometers, and cables



Current Concord Blue waste-to-power facility in Herten, Germany

Cost Avoidance

- ▶ Sustainable manufacturing is needed to sustain economic development
- ▶ The 2014 DOD Sustainability Analysis Guidance describes three areas of interest to consider during Life Cycle Cost Estimates (LCCE)
- ▶ Many sustainability-related costs are often not fully accounted for, however considering the following impacts will help determine a more accurate LCCE

Mission Resources	Environmental Health	Human Health
Water Resources -Water Use Impact	Water Resources -Water Use Impact	Water Resources -Water Use Impact
Non Renewable Resources -Fossil Fuel -Mineral & Metal Use	Non Renewable Resources -Fossil Fuel -Mineral & Metal Use	
Land Resources -Land Degradation Potential	Land Resources -Land Degradation Potential	
	Air Quality -Global Warming Potential -Respiratory Effects (Inorganic) -Respiratory Effects (Organic)	Air Quality -Global Warming Potential -Respiratory Effects (Inorganic) -Respiratory Effects (Organic)
	Toxicity -Cancer (External) -Non-cancer (External) -Ecosystem	Toxicity -Cancer (External) -Non-cancer (External) -Ecosystem
		Noise Pollution -Noise Exposure Potential

Acquisition Recommendations

- ▶ New language added to the FAR Sustainable Acquisition Policy (23.103)
- ▶ Track important metrics in central repository and require OEMs to submit data to the US Government for acquisition decision making
- ▶ Consider cost savings when conducting source selection/proposal evaluations and during negotiations so that benefits are passed onto the warfighter and taxpayer
- ▶ Implement Advanced Manufacturing Tax Credit for Prime and Tiered Subcontractors who invest in clean energy technology in their facility
- ▶ Establish Government/Industry/Academia forums, conference and working groups to share ideas and best practices

Data Collection Recommendations

- ▶ Environmental impact
 - ▶ GHG emissions (kg CO₂ eq./unit)
 - ▶ Ratio of renewable energy used (%)
 - ▶ Total water consumption (kg/unit)
- ▶ Energy consumption
 - ▶ In-line energy use (kWh/unit)
 - ▶ Energy use for maintaining working environment (kWh/unit)
 - ▶ Energy consumption for material handling (kWh/unit)
- ▶ Economic cost
 - ▶ Labor cost (\$/unit)
 - ▶ Energy cost (\$/unit)
 - ▶ Maintenance cost (\$/unit)
- ▶ Worker safety
 - ▶ Exposure to corrosive/toxic chemicals (incidents/person)
 - ▶ Injury rate (injuries/unit)
 - ▶ Near misses (near misses/unit)
- ▶ Worker health
 - ▶ Chemical contamination of working environment (mg/m³)
 - ▶ Mist/dust level (mg/m³)
 - ▶ Physical load index (dimensionless)
- ▶ Waste management
 - ▶ Mass of disposed consumable (kg/unit)
 - ▶ Consumables reuse ration (%)
 - ▶ Ratio of recycled chips and scrap (%)

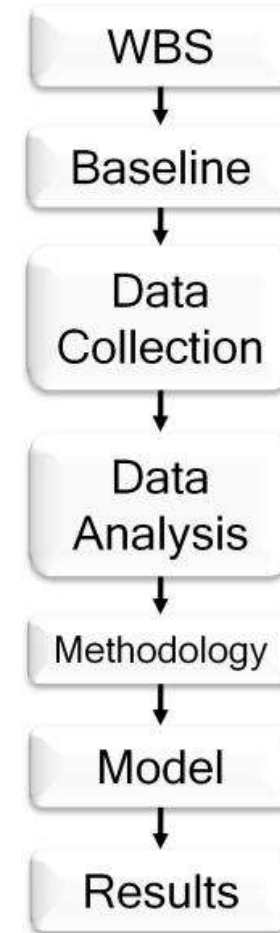
(Lu et al, 2010, p. 4)



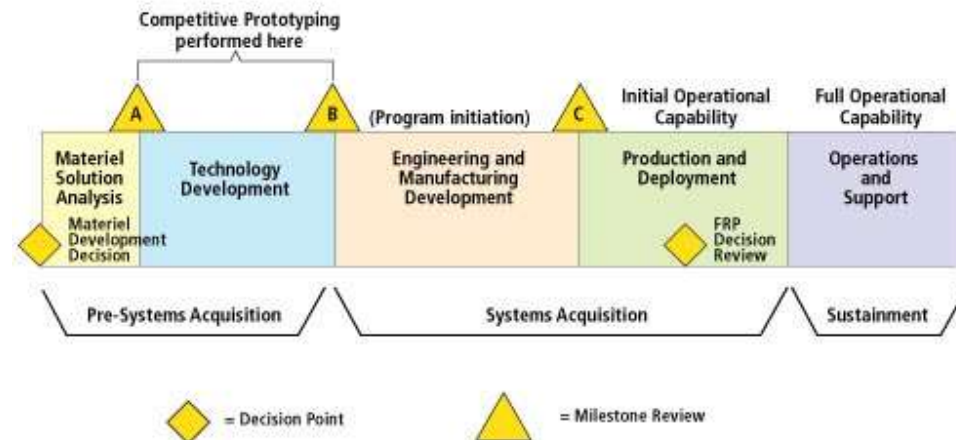
Construction of the USS Virginia (SSN-774) Virginia Class Submarine

How can Cost Analysts Help?

- ▶ Improve LCCE and Total Ownership Cost (TOC) estimate methodology to incorporate sustainability into each phase of the life cycle
- ▶ Incorporate sustainability into every aspect of the life cycle (cradle to grave) and the estimating process
 - ▶ Data Collection
 - ▶ Analysis
 - ▶ Model and Documentation
- ▶ Additional research and analysis is needed to understand cost impacts and savings



Sustainability/Sustainable Manufacturing Practices should be incorporated into all stages of the Acquisition & Cost Estimate Process



Conclusions/Future Study

- ▶ This is just the starting point for sustainable manufacturing - let's get the conversation going!
- ▶ More attention is needed in the guidance and policies set forth by the DOD and the Service Branches
- ▶ Cost effectiveness should not be the only criterion for implementation:
 - ▶ Environmental awareness
 - ▶ Employee morale and safety
 - ▶ Community relations
- ▶ It's our responsibility to conserve our resources to protect and serve future generations



Questions or Concerns?

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