PURDUE UNIVERSITY
TECHNICAL ASSISTANCE PROGRAM

Lean Manufacturing & Pollution Prevention

Reducing W.A.S.T.E. and Saving $$

September 20, 2012

What is Lean ?

"A systematic approach to identifying and eliminating waste (non-value added activities) through continuous improvement by flowing the product at the pull of the customer in pursuit of perfection"

—The MEP Lean Network

What is Sustainability (Green) ?

"Meeting the needs of the present without compromising the ability of future generations to meet their own needs."

- Brundtland Commission

Lean Core Concept: Elimination of Waste

Waste is "anything other than the minimum amount of equipment, **materials**, parts, space, and worker's time which are absolutely necessary to add value to the product."

- Shoichiro Toyoda, President, Toyota

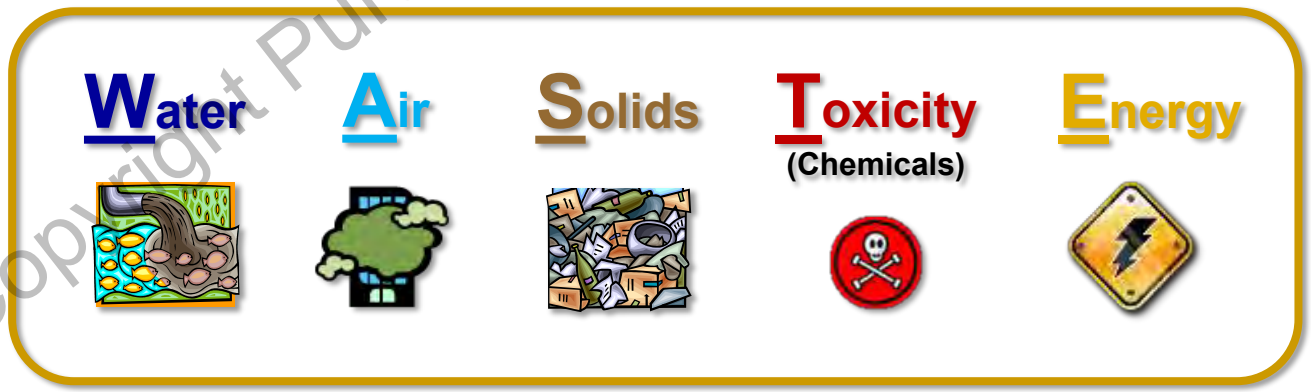
Sustainability (Green) is Lean

"Lean Thinking" core concept:

<u>Eliminate</u> <u>waste</u>!

Sustainability core concept:

Eliminate Environmental W.A.S.T.E.!



Environmental WASTE Categories

Water

Air

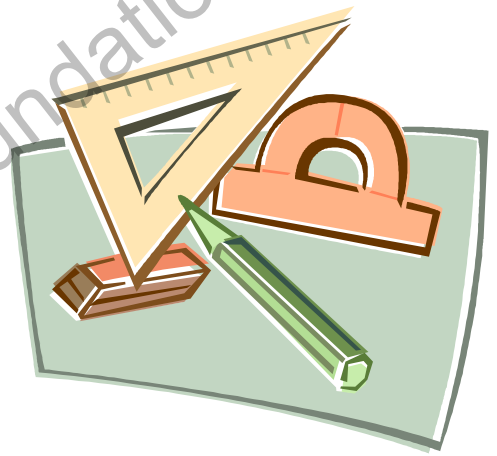
Solids

Toxicity
(Chemicals)

Energy

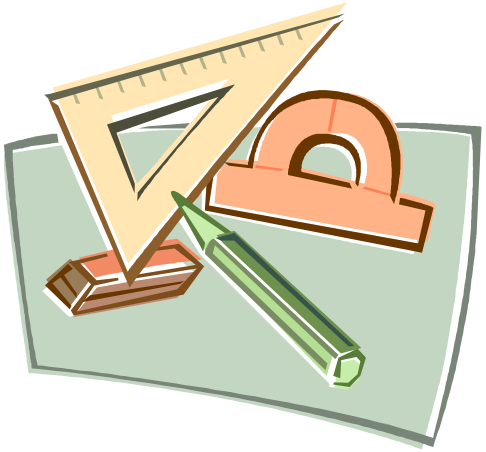
Lean Tools

- 5S (Sort, Straighten, Shine, Standardize, Sustain)
- Value Stream Mapping
- ISO 9000
- Quick Changeover
- Six Sigma
- Standardized Work
- POUS (Point Of Use Storage)
- TPM (Total Productive Maintenance)

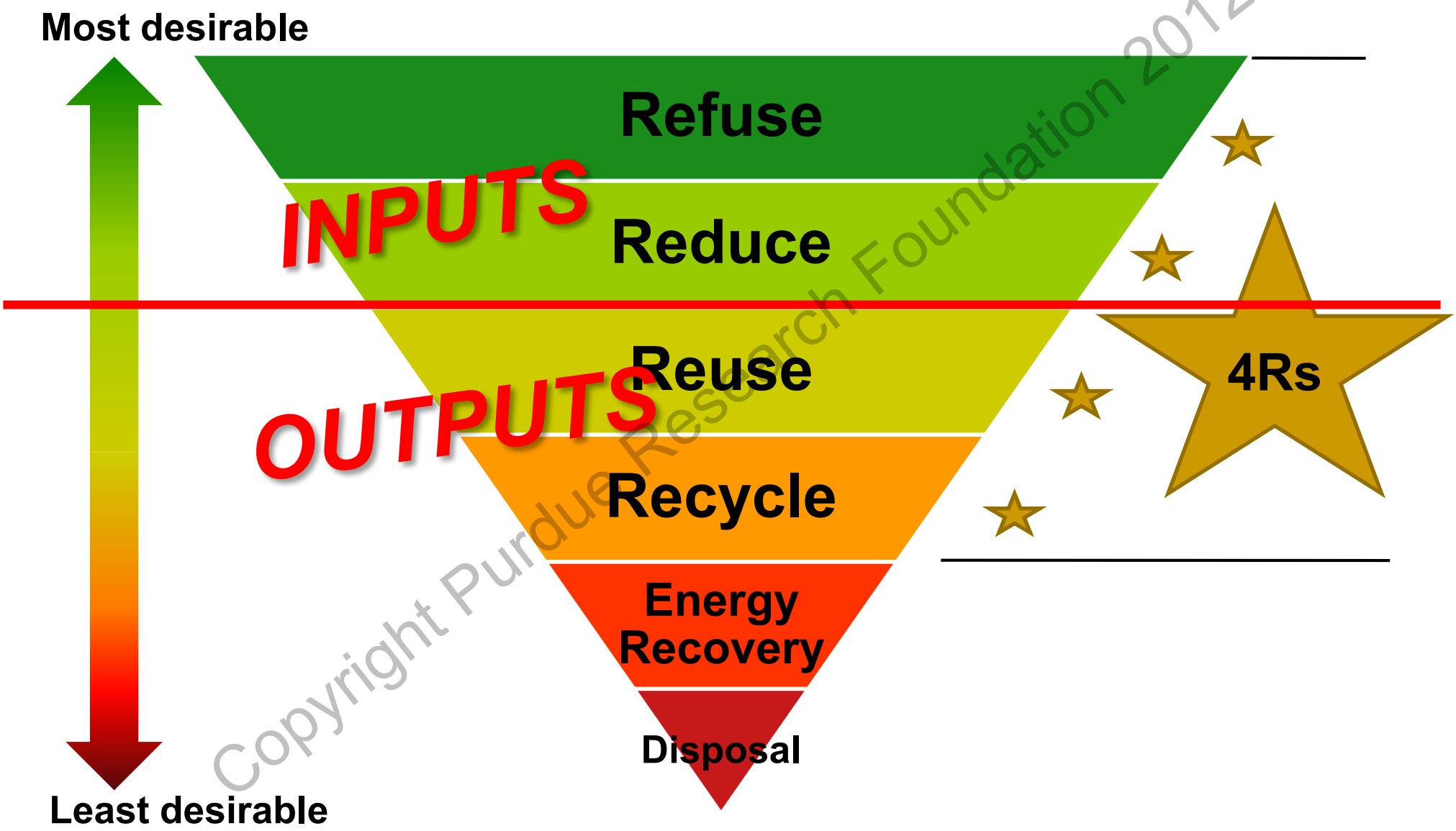


Green Tools

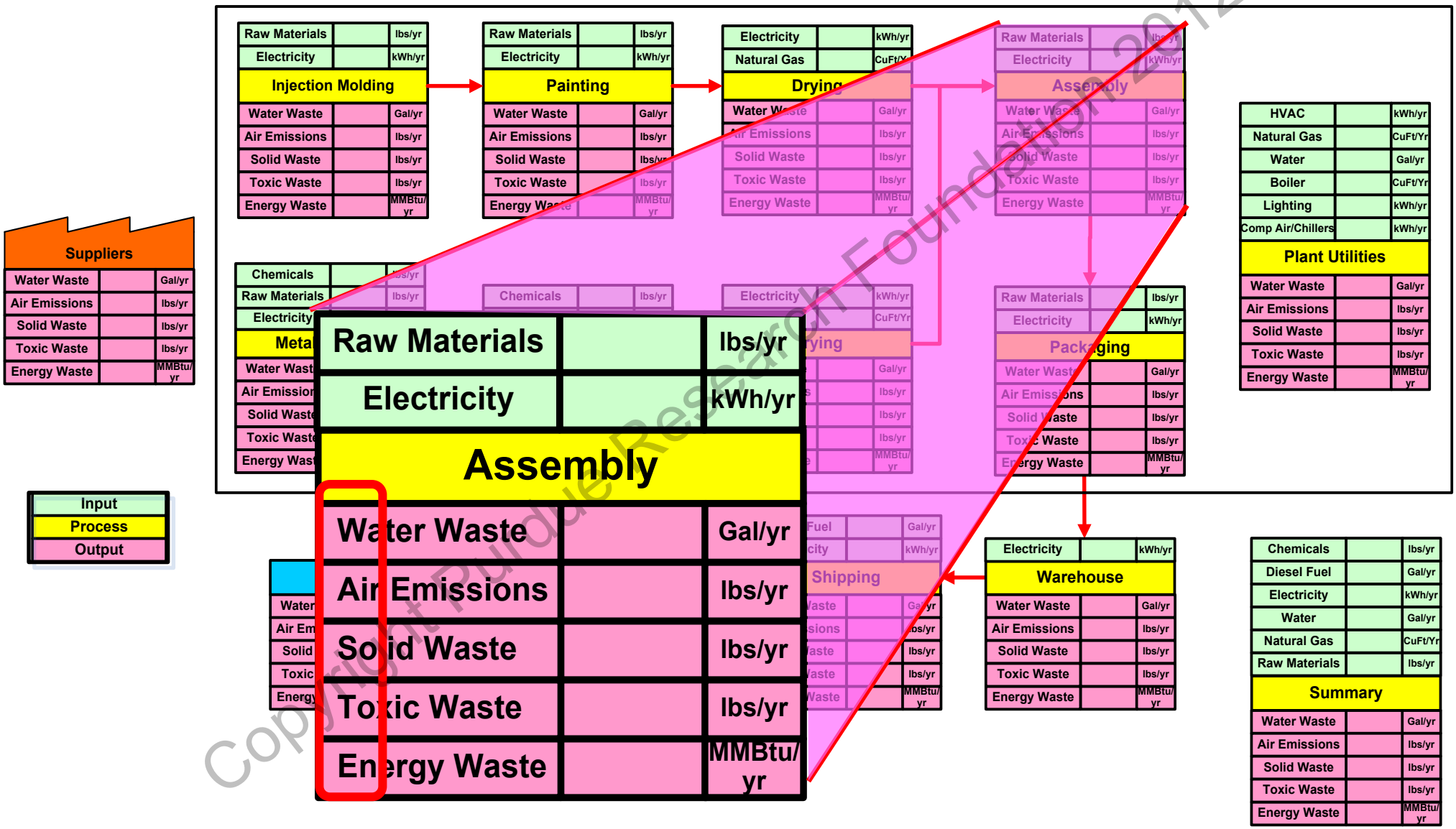
- 4 “R”s (Inputs/Outputs)
- W.A.S.T.E. Stream Mapping
- ISO 14000 / 50000
- PDCA (Plan-Do-Check-Act)
- 3 “P”s (People, Planet, Profit)
- LCA (Life Cycle Analysis)
- Separation at the Source
- Dumpster D.I.V.E.



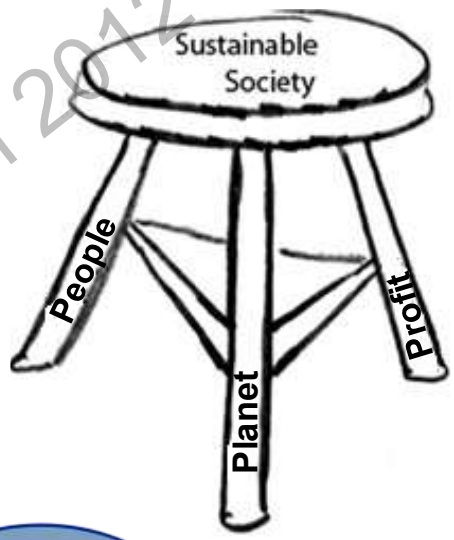
4R WASTE Hierarchy



Example: Overall System WSM



Sustainability "Triple Bottom Line"

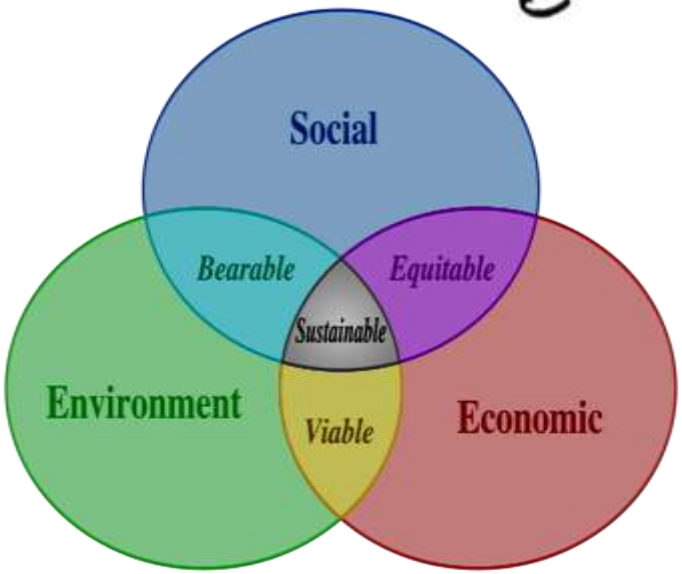


Profit (Economic)

- Improves efficiency & lowers costs
- Reduces regulatory compliance costs
- Creates revenue enhancement opportunities

Planet (Environmental)

- Reduces demand for resources and energy *from* nature
- Reduces waste *to* nature



People (Social)

- More resources and energy become available for others
- Closing the loop (cradle-to-cradle) generates new jobs

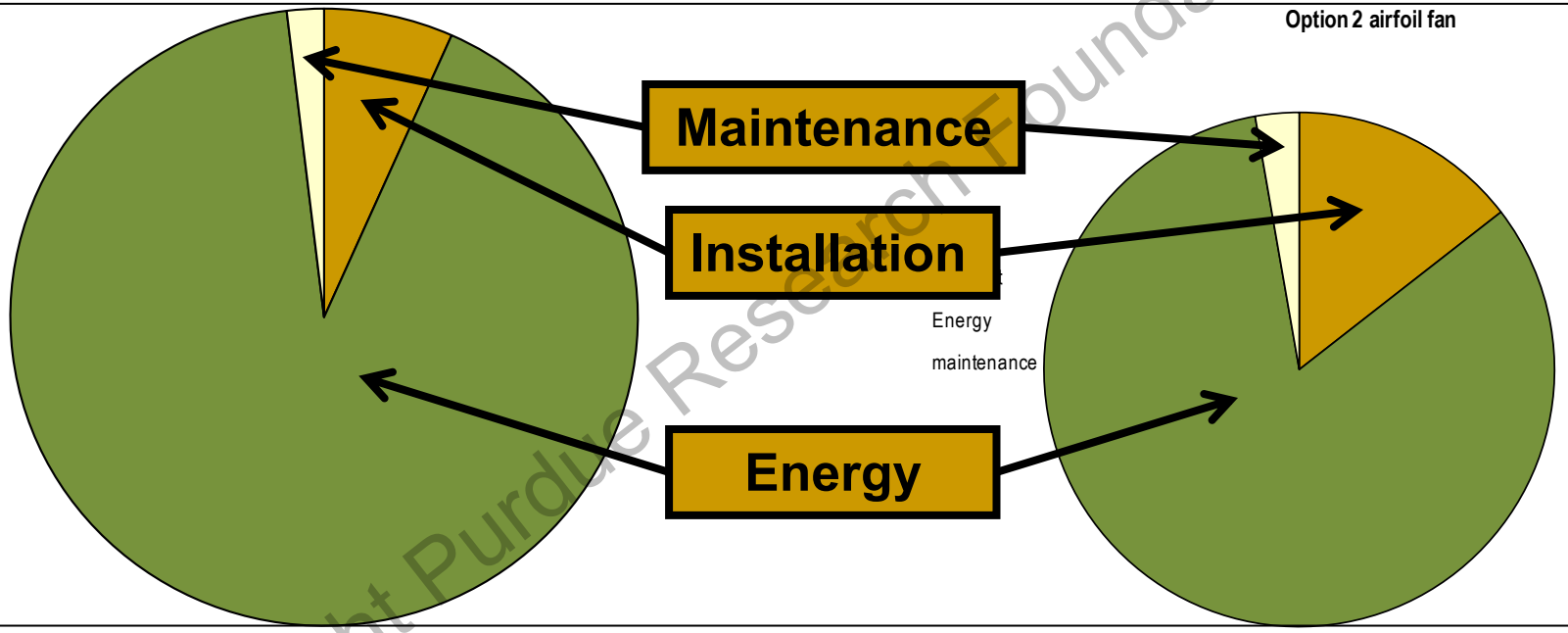
Considering Life Cycle Costs

Option #1:

200 HP Radial Fan

Option #2:

150 HP Airfoil Fan

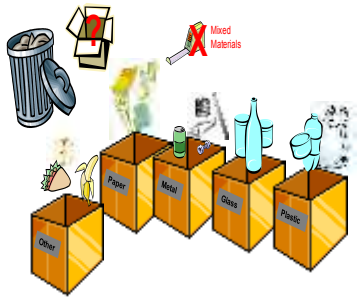


Lifetime Cost
$1,050,000

Lifetime Cost
$725,000

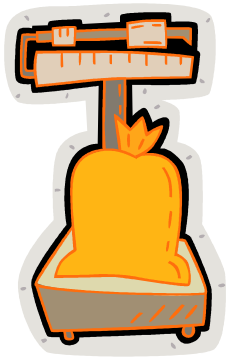
Zero Landfill (DIVE) Process

Divide



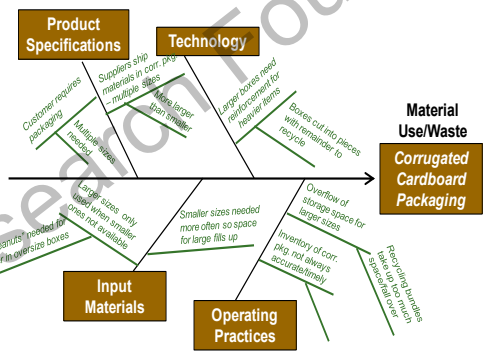
- Sort
- Categorize
- Sample

Investigate



- Weights
- Volumes
- Costs
- Oddities

Verify



- Sources
- Root Causes
- Interactions

Eliminate

- Apply 4R's
- Quantify

Both Lean & Green…

- Focus on systematic and on-going efforts to identify and eliminate waste
- Seek active employee participation in improvement activities
- Emphasize the importance measurement to generate metrics that inform decisions
- Seek engagement with the supply chain to improve enterprise-wide performance

Where to Start

- Broaden the definition of waste ➔ W.A.S.T.E.
- Use existing Lean practices, philosophies, & personnel to focus on "green" opportunities
- Drive sustainability through your supply chain through "green" product development, initially focusing on packaging and delivery

Lean → Green

- Defects → **Solid Waste & Environmental (Toxic) Waste**
- Overproduction → **Energy, Water, & Labor Waste**
- Waiting → **Energy & Labor Waste**
- Not Using Employees K, S, A → **Labor Waste**
- Transportation → **Reduced Air Emissions & Energy Waste**
- Inventory → **Reduced Hazardous (Toxic) & Solid Waste**
- Motion → **Energy Savings**
- Excess Processing → **Energy Savings**

Why Make Green a Part of the Lean Methodology?

- Eliminates previously ignored waste
- Reduces direct costs
- Strengthens environmental compliance
- Reduces or even eliminates risk
- Piggybacks environmental improvement on lean methodologies
- Removes environmental obstacles to competitiveness
- Creates a competitive advantage as customers increasingly expect products & services with less of an ecological footprint

Lean's "Blind Spots"

- Hidden environmental waste is often buried in overhead and facility support costs
- Environmental and human health risks are often not explicitly considered in lean initiatives
- Environmental impacts throughout the product lifecycle can affect customers and stakeholders
- Explicit materials use vs. need not always captured by lean

Challenges

- Increasing environmental requirements around the globe
- Earth's resources are limited
- Population expect to grow by 50% over next four decades
- CO_2 emissions and global climate change

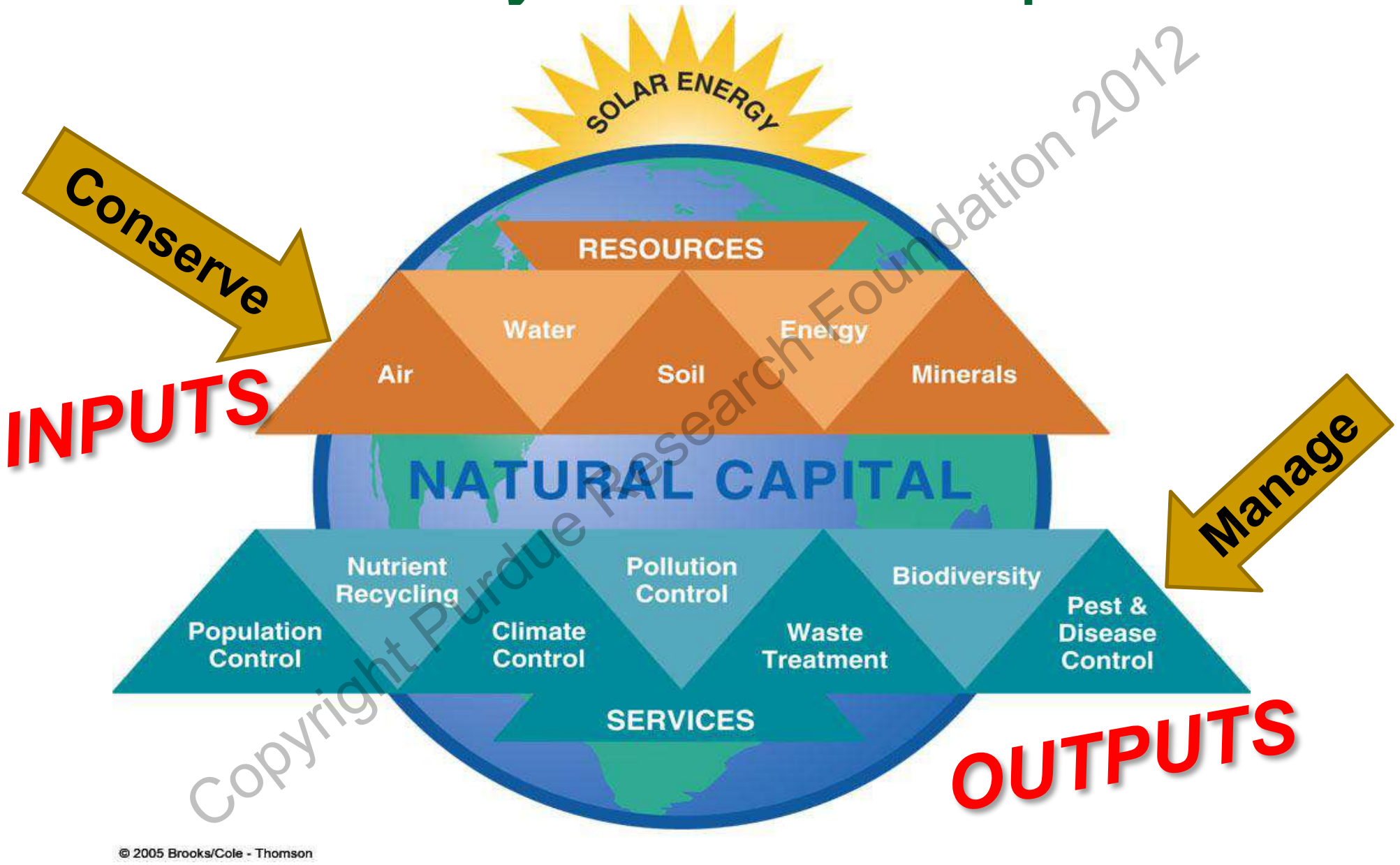
International Drivers

- *Restriction of Hazardous Substances*
  - Restricts use of **TOXIC HEAVY METALS (Lead, Mercury, Cadmium and Hexavalent Chromium)**, polybrominated biphenyls, polybrominated diphenyl ethers, and Deca-bromodiphenylether (2006)

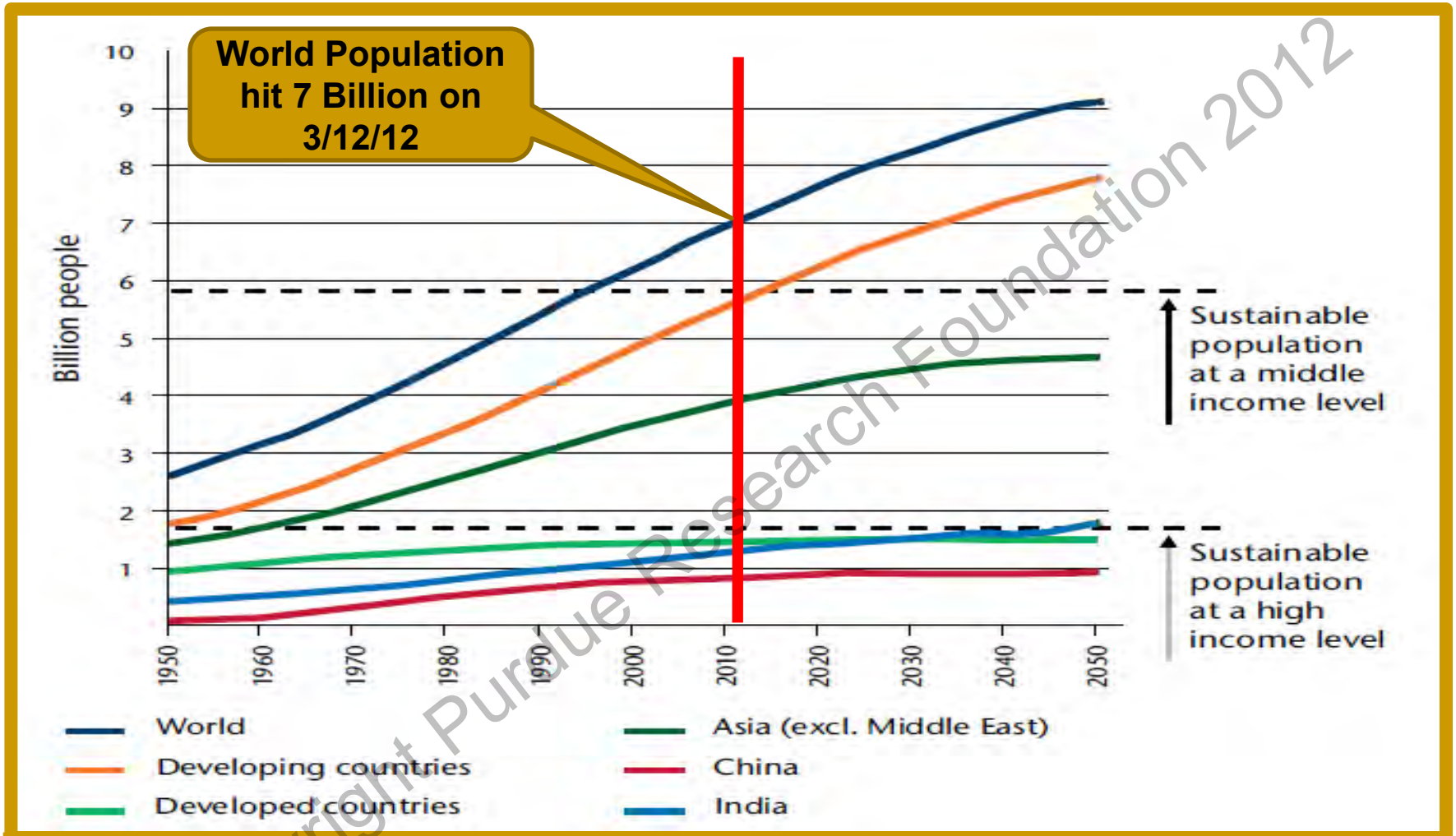
- *Waste Electrical/Electronic Equipment **(WEEE)** Directive*
  - Requires producers of electrical/electronic equipment to finance collection arrangements for their products at the end-of-life (2005)

- *Registration, Evaluation, Authorization/restriction of Chemicals **(REACH)***
  - Requires all manufacturers and importers into the European Union (EU) to register all chemical substances into a database managed by the European Chemicals Agency (2008)

Sustainability – Global Impact



Unsustainable Consumption



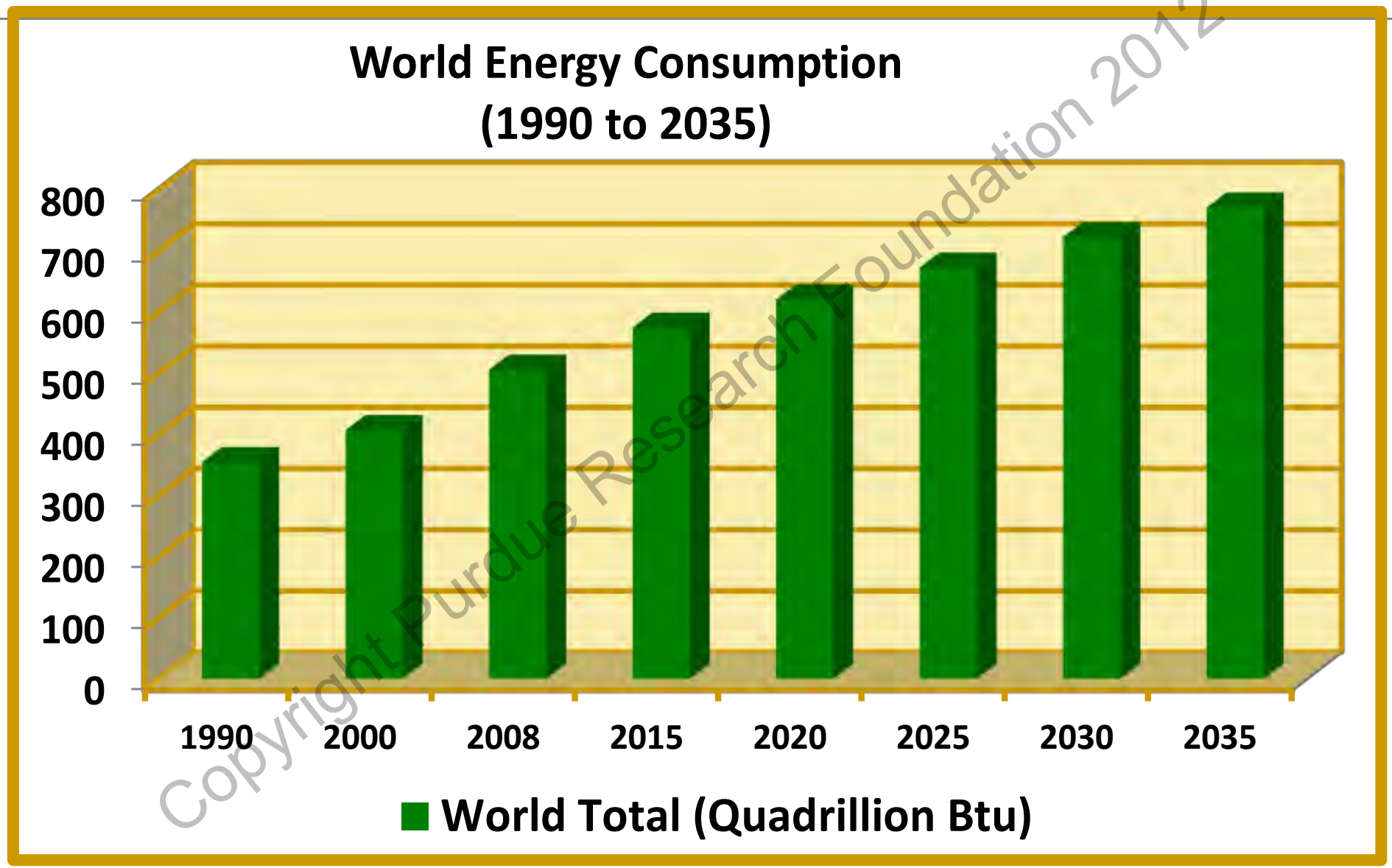
Up to <u>5 times</u> the Earth's resources would be required if U.S. consumption was copied by the rest of the world.

Source: United Nations Environment Program, UN Global Compact and Utopies, 2005
also, World Resources Institute (WRI)/Earthtrends, 2008

Current State – CO_2

graph from NASA (National Aeronautics and Space Administration) website: climate.nasa.gov/causes

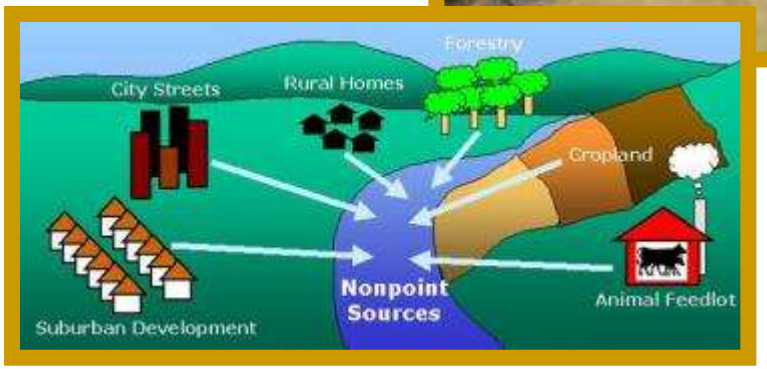
Increasing Energy Demand



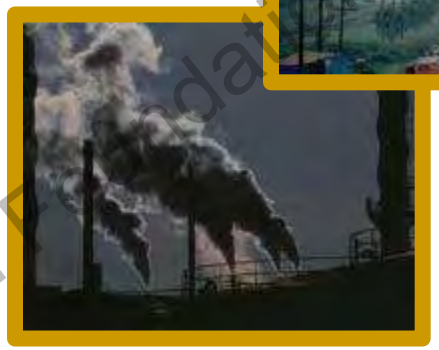
Source: Energy Information Administration (EIA), International Energy Outlook 2011 (September, 2011 Release)

Water Module Topics

- Water Quantity & Quality
- Point Source & Non-Point Source Pollution
- Water Regulations
- Wastewater Treatment Systems
- Runoff Management
- 4Rs & Water
- Taking it Home



Air Module Topics



- Types / Categories of Pollutants
- Greenhouse Gases
- Climate Change
- Air Emission Reduction Technologies
- Carbon Footprint
- 4Rs & Air
- Taking it Home

Solids Module Topics

- Zero Landfill
- Solid Waste Streams
- Solid Waste Management
- *Dumpster D.I.V.E.* Process for Zero Landfill
- Root Cause Analysis
- 4Rs & Solids
- Taking it Home

Toxicity Module Topics

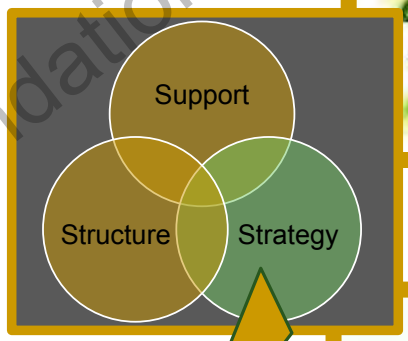
- "Green Chemistry" Philosophy
- Regulatory Factors
- Hazard & Risk Assessment
- Chemical Substitutions
- Bioplastics
- 4Rs & Toxicity
- Taking it Home

Energy Module Topics

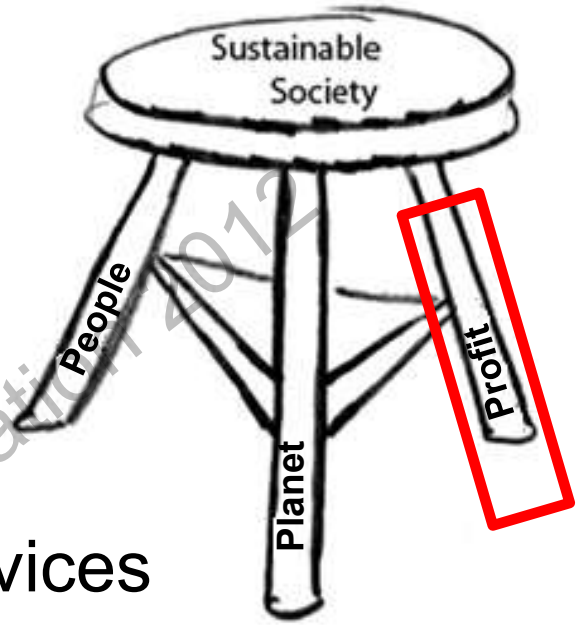
- World & U.S. Energy Consumption & Production
- Non-Renewable Energy Sources
  - Coal, Petroleum, Natural Gas, Nuclear
- Industrial Utility Bills
- Energy Intensive Systems
  - e.g., Compressed Air, HVAC, Lighting, Boilers
- 4Rs & Energy
- Taking it Home

Sustainable Business Module Topics

- Green Business Concepts and Trends
- Innovation & Job Creation
- Sustainability Culture
- Green Teams

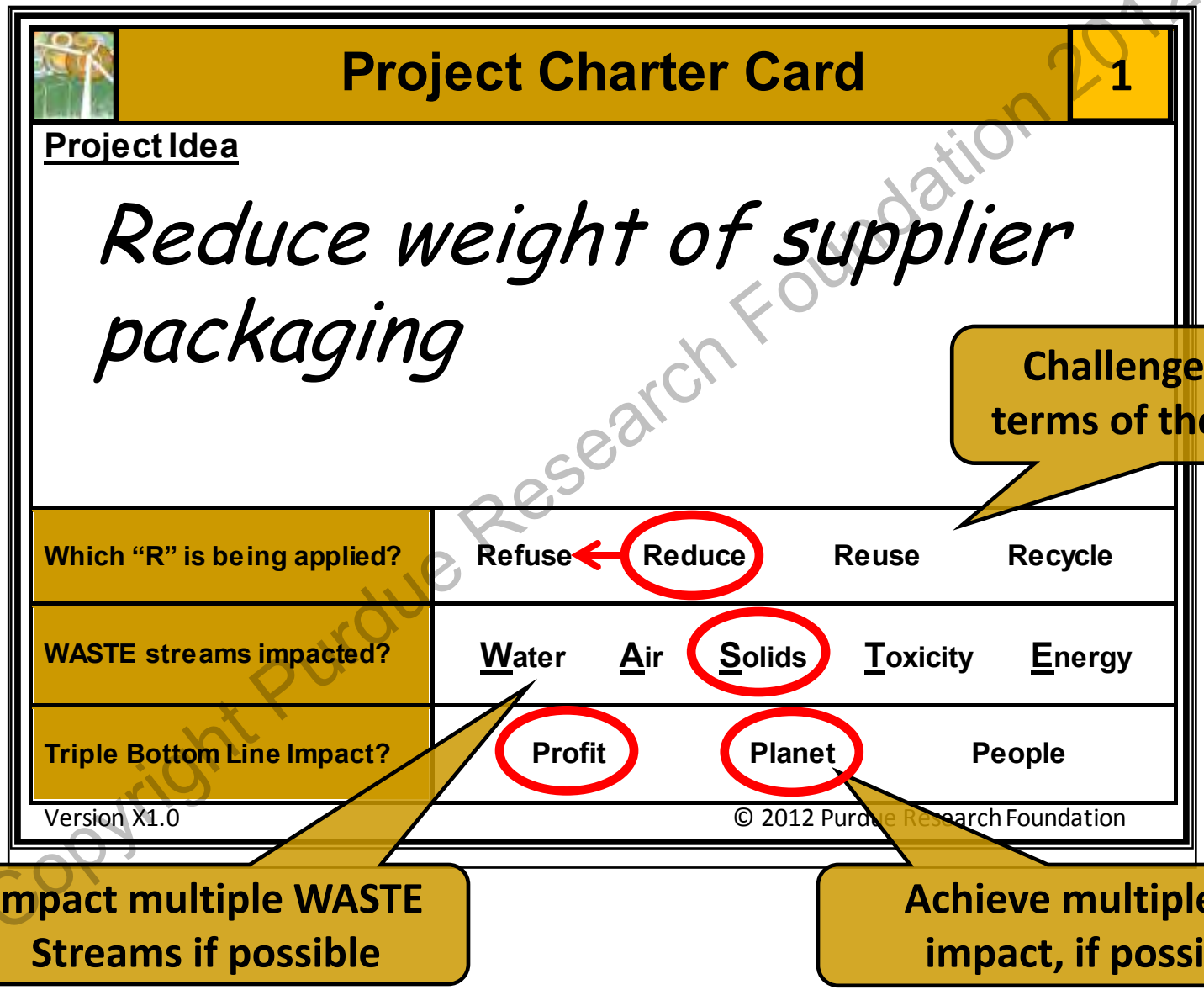


Bottom Line Impact – Increase Revenue

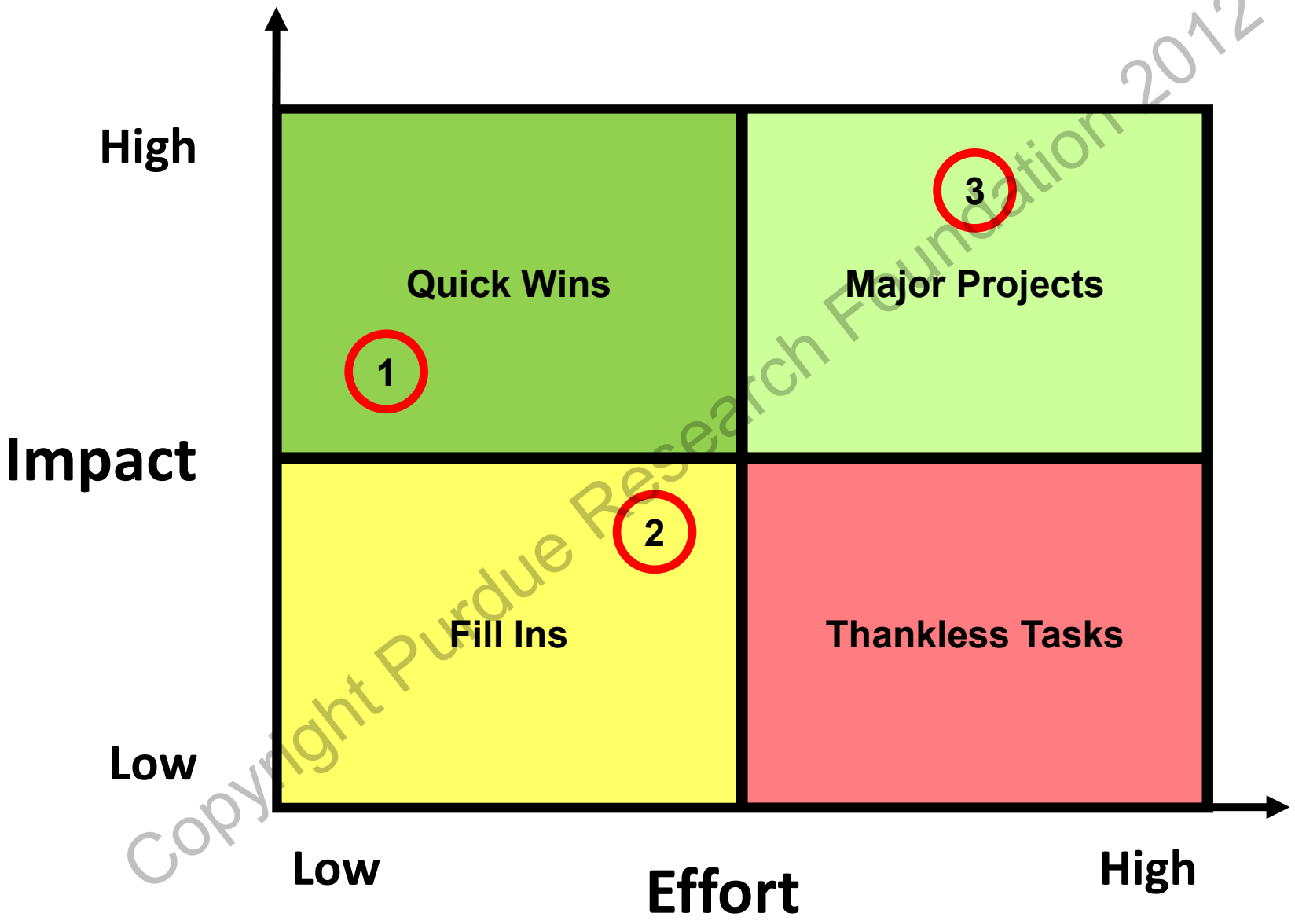


- New products / services
- New markets for existing products / services
- Product differentiation in existing markets
- Higher price points
- Market positioning
- Byproduct markets
- Company image & good will
- New business models

Project Selection Exercise



Evaluating Options



IN Manufacturer

- Replaced 285 400W Metal Halide fixtures with 6 bulb T5HO fluorescent fixtures.
  - decreased energy usage by 27%
  - increased floor level foot candles by 51%
  - reduced load on AC system
  - EPACT tax rebate, Utility Company rebate
  - Direct Payback (Energy Costs only) < 2.0 years

- Implemented recycling program for scrap wood, cardboard, & shrink-wrap
  - decreased solid waste generation by 89% within 1 year

IN Manufacturer

- Lighting Upgrade project replaced 187 existing fixtures, 400 watt Metal Halides (458 watts total) with 187 T5 fluorescents (6 bulbs, 321 watts total)
- Investment ~ $30,000; Annual Savings ~ $15,900; Payback = 23 months; ROI = 53%

Benefits

1. Energy Bill Savings
2. New Lamp/Lighting System
3. Higher Maintained Lighting Levels
4. Reduced Maintenance Costs
5. KW Load Reduction - Possible Lower Demand Charges
6. ALTO Technology - Reduced Disposal Costs
7. Pollution Savings

IN Manufacturer

- Installed T5 fluorescent lighting replacing 400 watt HID lighting
- Installed VFD's on cooling tower fans, circulating pumps, and other applicable support equipment
- Replaced older air compressors with more efficient models including VFD controls
- Replaced air cooled chillers with much more efficient indoor water cooled chillers
- Installed motion controls on grinders to reduce idle running
- Savings averaged $100,000 annually with an 8-11% decrease in energy intensity each year since 2008

IN Manufacturer

- Installed T8 fluorescent lighting replacing 400 watt Metal-Halide lighting; SPP = 9 months
- Installed motion controls on lighting so they only come on when needed. Significant reduction in usage and cost.
- Implemented 4 R's. Installed recycling stations at 4 areas in the plant. Reduced our trash pickup by 50%.
- Eliminated the vending machine with plastic bottles in favor of the one with aluminum cans to simplify the recycling program.

Questions ?

Thank You !

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