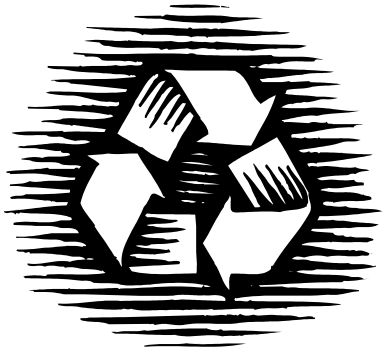

UNIT F

CLEAN MANUFACTURING, WASTE MANAGEMENT & RECYCLING

NM Standards and Benchmarks

Social Studies

Economics Strand, Content Standard IV-B:
Analyze and evaluate how economic systems impact the way individuals, households, businesses, governments, and societies make decisions about resources and the production and distribution of goods and services.
Performance Standard #8:
Evaluate economic systems by their ability to achieve broad societal goals (e.g., efficiency, equity, security, employment, stability, economic growth).

Science

Strand III, Science and Society, Content Standard I:
Examine and analyze how scientific discoveries and their applications affect the world, and explain how societies influence scientific investigations and applications.
Performance Standard #4:
Understand the scientific foundations of common technologies (e.g., kitchen appliances, radio, television, aircraft, rockets, computers, medical X-rays, selective breeding, fertilizers and pesticides, agricultural equipment).

Career Readiness, Content Standard III and IV

Students will demonstrate the technological knowledge and skills required for future careers.
Students will develop and demonstrate responsible and ethical workplace behaviors.

Mathematics

Strand: Data Analysis and Probability
Students will understand how to formulate questions, analyze data, and determine probabilities.

Content

In this unit, students will become familiar with the common extraction-to-waste model of manufacturing and distribution of products. Students' awareness will be heightened of our acceptance of planned-obsolescence and marketed "memes." They will evaluate their household consumption and waste patterns and begin to pay attention to over-packaging and insufficient opportunities to recycle unwanted materials. Through this awareness, students will be introduced to a variety of industries that are going green, especially in their own region of the state.

Vocabulary

extraction
production
distribution
consumption
disposal
clean manufacturing
waste stream
waste management
source reduction
reduce
reuse
recycle
pollution prevention
planned obsolescence
durable
disposable
industrial ecology
life-cycle assessment
life-cycle efficiency
supply chain
triple bottom line

Essential Questions

- In clean manufacturing, waste management and recycling, what careers are emerging and what interests me?
- What career paths interest me and suit my talents?
- What are the skill-sets needed to be successful in the workplace?

Focus Questions

- What constitutes "clean manufacturing"?
- What constitutes hazardous waste and by-products?
- What are some of the clean manufacturing industries found in our region?

Time Allocation

1.5 weeks

Introduction

(1 - 2 classes)

Objective:

Students will demonstrate understanding of the environmental, social, and economic implications of clean manufacturing, waste management and recycling.

Activities:

1) Show the video, "The Story of Stuff" to introduce students to the cycle of extraction, production, distribution, consumption, and disposal.

2) Topics to be addressed to augment discussion: Statistics on persistence of plastics and other wastes in the environment. Distribute "Some Facts about Trash" (Appendix F.1). Show video "Seas of Plastic." Discuss how the location of landfills and industrial facilities in low-income communities can lead to environmental justice issues (e.g. "Cancer Alley" in Louisiana). Discuss the potential environmental and environmental justice impacts associated with extractive industries (e.g., in New Mexico extractive industries include mining, oil and gas, forestry) and manufacturing. How has electronic waste (E-waste) disposal impacted communities in third world countries? How can we design our consumer products in a way that incorporates "cradle-to-cradle" design? How can source reduction help us to minimize the waste entering our landfills? How can "clean manufacturing" help to minimize waste and hazardous pollutants and conserve energy in the production of our consumer products? What is pollution prevention? Why is buying recycled or "green" products important?

   Materials: laptop, projector, Internet

   Resources:
   - *The Story of Stuff* (Annie Leonard, 2005, 20 min.) www.thestoryofstuff.com
   - *Seas of Plastic* TED Talk (7 min) http://www.tedafrica.org/talks/capt_charles_moore_on_the_seas_of_plastic.html,
   - PVC Waste http://www.greenpeace.org/international/campaigns/toxics/polyvinyl-chloride/pvc-waste/
   - E-Waste Video from Waste Management (4 min.) http://www.thinkgreen.com/students-9-12
   - Video of William McDonough "Cradle to Cradle Design" TED Talk (20 min.) http://www.ted.com/talks/william_mcdonough_on_cradle_to_cradle_design.html
   - Pollution Prevention http://www.epa.gov/p2/
   - New Mexico Recycling Coalition http://recyclenewmexico.com/

Homework: Read and bring one quote and one question to class from "Recycling: The Big Picture" Zeller, *National Geographic*, Jan., 2008
http://ngm.nationalgeographic.com/2008/01/high-tech-trash/recycling-text

Applied Science in Clean Manufacturing
(1 class)

According to the New Mexico Green Jobs Portal, clean manufacturing is defined as the manufacturing of products, materials and equipment that are utilized in reducing the use of energy and creating or storing alternative energy resources.

Clean manufacturing also includes products, materials and equipment that are manufactured in a way that reduces production waste, energy use, and environmental impact.

How are clean manufacturers "greening the supply chain" in the following areas?

- conservation (e.g., energy, water, energy-efficient materials, use of recycled materials in products);
- reduction in emissions (e.g., waste, air, water, gas, chemicals);
- renewability, recyclability, and final disposal of products to maximize life-cycle efficiency of the resources, raw materials, products;
- transportation of goods to markets.

Industrial ecology is a young field of research that takes a multi-disciplinary, systems approach to study of material and energy flows through industrial systems. Life cycle assessment is a technique used to evaluate raw material production, manufacture, distribution, use and disposal including all intervening transportation steps necessary or caused by the product's existence. The approach is used to improve industrial processes, support policy, and form the basis for informed decision making. For example, although solar panels are used to produce clean energy, their production uses large amounts of water and produces some pollution. Life cycle assessment can be used to evaluate these tradeoffs.

Focus Questions:

- How does making manufacturing more efficient and less environmentally harmful affect a business's bottom line and make U.S. manufacturing more competitive?
- How can the "triple bottom line" be employed by companies to balance profits with social and environmental impacts?
- What are the economic and financial downsides of inefficient and polluting manufacturing?
- What are the social and economic impacts of not manufacturing clean technologies here in the U.S.?

Alternative Activities:

1) Invite a guest to your classroom from a clean manufacturing business to discuss green production processes. Refer to New Mexico Green Chamber of Commerce website to identify clean manufacturing businesses in your area (www.nmgreenchamber.com).

2) Watch videos in Resources below and discuss how the clean tech revolution is making production processes more efficient and better for the environment.

3) Field trip to clean manufacturing facility in your community. Refer to New Mexico Green Chamber of Commerce website to identify clean manufacturing businesses in your area (www.nmgreenchamber.com).

Materials: laptop, projector, Internet

Resources:

- Video: Green Tech 101 (5 min.) http://www.youtube.com/watch?v=jisatMsoqhQ&feature=fvwrel
- Video: Nontoxic Business: New Insights For Greening The Supply Chain (16 min) http://video.google.com/videoplay?docid=-9160182174529547638#
- Video: EPA Science Forum on Green Technology (3 min.) http://www.youtube.com/watch?v=f-4BjXwLUKw&feature=related
- Video: CNN EcoSolutions: Pushing Green Technologies (6 min.) http://www.youtube.com/watch?v=2rVGqmcbMgU&feature=related
- Patagonia: The Footprint Chronicles – track the environmental footprint of Patagonia products from design to delivery. Series of videos. http://www.patagonia.com/us/footprint/index.jsp?src=vuca0045
- "The Triple Bottom Line" *The Economist*, November 17, 2009 http://www.economist.com/node/14301663

Applied Science in Waste Management and Recycling
(1 – 2 classes)

1) Solid Waste Management and Recycling in Your Community

Although the national recycling rate is 32.5%, New Mexicans recycle only 14.6% of their waste as of 2009. The NM Recycling Coalition has set a goal of 33% recycling rate by 2012. What materials are recyclable in your community? How does recycling extend the life of your local landfill? What is the cost savings from recycling rather than opening up new cells in the landfill? Where do the recyclables go once they are collected? Does your community recycle electronic waste (E-waste)? Where does the E-waste go for recycling? Does your community properly dispose of household hazardous waste?

Invite a guest from your local solid waste landfill/recycling center to discuss the specifics of how much waste is generated in your community, how much is diverted to reuse or recycling, and the economics of recycling vs. opening up new landfill space.

Homework: Using the worksheet on page 43 in Appendix F.3, have students inventory the grocery, personal care and home products that they have in their household and indicate whether they are durable, disposable, recyclable, or reusable and the reason the product was purchased. Bring worksheet to class for discussion.

2) Packaging: What's at My House?

Discuss the types of packaging most often found in student's homes. How can we reduce the amount of packaging needing to be recycled or disposed of? What products are not durable? Can you identify alternative products that would be more durable?

Materials: completed worksheet

Resources:

- Packaging: Is it a Waste? Exercise 4: What's at My House pages 42 - 44 (Wisconsin Department of Natural Resources) Appendix F.3 or: http://dnr.wi.gov/org/caer/ce/eek/teacher/pdf/recycle/4-8/Packaging.pdf

Laboratory Activity in Waste Management and Recycling
(2 classes)

1) Conduct a Waste Assessment for Your School

Assess the waste generated by your school and make recommendations for how your school could reduce its waste. Do you already have a recycling program? Are all the materials that could be recycled and composted being diverted from the waste stream? Could your school's recycling program be expanded? Does your school have a "buy recycled" policy?

Split your class into teams to conduct a "Walk Through" for one class. Data analysis and development of recommendations can be done in the second class.

Materials: clipboards, data forms, calculators

Resources:

- Waste Assessment Protocols and Forms http://www.epa.gov/epawaste/education/pdfs/toolkit/tools-a.pdf
- School Waste Reduction Toolkit http://www.epa.gov/epawaste/education/toolkit.htm

Employment and Training Prospects in Clean Manufacturing, Waste Management and Recycling

(1 class)

Objective:

The student will identify green jobs in these fields and identify training resources and skill sets necessary for a career in these occupations.

Activities:

Share with students the following information:

Background:

- According to the NM Green Jobs Guidebook, demand for workers in solid waste and wastewater management, treatment, reduction; processing recyclable materials is expected to increase by 14% from 2006 – 2014.
- The NM Green Jobs Guidebook identifies increased demand for traditional jobs, such as drilling and boring machine tools setters, operators and tenders (metal and plastic).

Green Jobs in Clean Manufacturing in New Mexico (from NM Green Jobs Guidebook)

These are jobs in sectors producing clean energy products.

Solar Fabrication Technician
Solar Lab Technician
Solar Hot Water Heater Manufacturing Technician
PV Fabrication and Testing Technician
Wind Turbine Machinist
Wind Turbine Sheet Metal Worker
Wind Turbine Engineering Intern
Wind Farm Electrical Systems Designer
Wind Turbine Electrical Engineer
Wind Turbine Mechanical Engineer
Geothermal Heat Pump Machinist
Geothermal Sheet Metal Worker
Geothermal Engineering Intern
Geothermal electrical engineer
Geothermal Power Generation (Mechanical) Engineer

Green Jobs in Clean Manufacturing in New Mexico

These are traditional jobs that can be involved in manufacturing products in a more efficient and less environmentally harmful manner.

Industrial Engineering Technicians
Industrial Machinery Mechanics
Industrial Production Managers

First-Line Supervisors/Managers of Production and Operating Workers
General and Operations Managers

The Pathway Knowledge and Skills Chart for Manufacturing
This document describes what all/most learners/workers need to know and be able to do to demonstrate competence within career pathways in this cluster.
http://www.careerclusters.org/clusters/16cc.php?cluster=mfg

Green Jobs Videos:

- Green Careers in Supply Chain Management (although this is from Canada, the concepts are applicable to US context)
  http://www.youtube.com/watch?v=xTgHmss8wL4
- E-Waste Recycler - Video
  http://www.youtube.com/watch?v=Bfyyy3_LKro&feature=related
- Sims Recycling Solutions - Electronics and Metals Recycling - Virtual Tour
  http://www.youtube.com/watch?v=6ap2uKzclzU&feature=related
- Safety Officer - Hazardous Waste Clean-up
  http://www.youtube.com/watch?v=GNbQodyAtV4&feature=channel

Materials: laptop, projector, Internet

Resources:

- New Mexico Green Jobs Portal
  www.greenjobs.state.nm.us
- New Mexico Green Jobs Guidebook
  http://newenergyeconomy.org/wp-content/uploads/2011/03/nmGreenJobsGuidebook.pdf
- Green job occupations typical educational requirements - Programs and Courses
  http://www.greenjobs.state.nm.us/programs.html
- NM Green Jobs Educational Opportunities
  http://www.greenjobs.state.nm.us/education.html
- NM Green Certifications
  http://www.greenjobs.state.nm.us/pdf/GreenCertificates.pdf

Formal Weekly Assessment

Objective:

Student will demonstrate with a 70% proficiency or better, his/her understanding of concepts and employment opportunities in this career cluster.

Assessment: weekly assessment based on Weekly Grading Rubric (See Appendix I.8)