IPRO 332: LESSONS IN SUSTAINABILITY

An IIT Interprofessional Project

Prepared by Fall 2009 IPRO Team
The Interprofessional Projects Program
Illinois Institute of Technology
Chicago, Illinois
Jim Braband
Jorge Chavez
Jason Chin
Gina Grande
Ross Johnson
Livia Lay
Declain McCloat
Nam Nguyen
Patrick Olechno
Jennifer Randle
Micheal E. Tyler II
Mayra Vega
Andrew Weiner
Gregory Zajac

November 2009

The Interprofessional Projects (IPRO) Program at the Illinois Institute of Technology

Table of Contents

Acknowledgements

The IPRO 332 team would like to acknowledge all of the people both within the IIT community and outside of it who assisted with the completion of this project. From within IIT, members of the MSED department and the Community Affairs and Outreach Department assisted with this project. From outside of the IIT Community members of the Chicago Center for Green Technology as well as De LaSalle High School were helpful in the completion of this project

MSED Department

Dr. Norman Lederman, Chairman of the MSED Department
Dr. Judith Lederman, Associate Chair of the MSED Department
Dr. Martina Neiswandt, Professor of the MSED Department

Community Affairs and Outreach

Ms. Lisa Montgomery, Managing Director
Joseph Clair, Director of the Office of Campus Energy and Sustainability

Chicago Center for Green Technology

Kelly Reiss, Resource Librarian

De LaSalle High School

Robert Chrupka, Science Instructor

Pershing West

Cheryl Watkins, Instructor

Executive Summary

IPRO 332 is a group of students dedicated to raising the awareness of students, in elementary through high school, about sustainability issues that face our society today. This project set out to accomplish this goal through the use of teaching kits created by the students. A teaching kit is an all inclusive packet which contains the resources a teacher needs to teach and understand a lesson. This is the sixth semester IPRO 332 has been active within the IPRO program. Already multiple teaching kits have been created dealing with issues such as energy usage and tree farming. This is the final semester for IPRO 332 so it is the goal of the team to bring a conclusion to the project by completing the series of teaching kits with one final kit and packaging the material in such a way that if it were to be picked up by an outside organization or another IPRO it would be easily usable by that group.

1. Purpose and Objectives

One of the greatest threats facing our way of life today is the potential that we will run out of energy resources. Currently there are many people who are working on solutions for this problem. Education is the key to solving this problem. By educating the public, especially children, we can ensure that our resources will last longer and that more people will work on a solution to this problem. Teachers in our school system are overworked and do not have time to create teaching modules on topics of sustainability. If provided in depth teaching modules that fit into their required curriculum, teachers will be more willing to educate their students on the many aspects of sustainability

The purpose of this IPRO group was to finish and deliver working teaching modules about sustainability to the community. Each of the three sub-teams, marketing, new module development and module revision created different goals and objectives to complete throughout the semester. The groups were individually responsible for completing these objectives while still maintaining communication with the greater group in order to collaborate on their goals.

The marketing sub-team had multiple objectives each designed to increase the awareness of sustainability and of IPRO 332. The members of this sub-team each designed different ways to promote the teaching kits to teachers within the community and make them readily available for use.

1. To establish an after school program that will teach elementary school students about sustainability with the help of the teaching kits made by IPRO 332.

2. The marketing sub-team also wanted to obtain the endorsement of organizations within IIT, such as the Math and Science Education Department and the Office of Energy and Sustainability, for the efforts of IPRO 332 as well as the Teacher Knowledge Share website (www.teacherknowledgeshare.com). See appendix 1 for contacts.

3. Raise funds for the financial support of creating the teaching modules as well as for the upkeep of the Teacher Knowledge Share website. See appendix 2 for budget.

The new module development sub-team took on the task of incorporating newer ideas in sustainability and forming them into a working teaching module for students. The goal of this was to ensure that students were learning about the ever changing topic of sustainability.

1. Develop and finalize a new and unique sustainability module for IPRO 332 focusing on the zero energy home to be introduced to high school level students. See appendix 3 and 4.

2. Create a well-organized documentation of research for the zero energy home. Research is contained on iGroups.

3. Support findings and final product with concrete data and statistics that define the effectiveness of the new module.

The module revision team had three overarching goals which dictated its progress throughout the semester. Each of these goals was specifically picked in order to enhance the overall classroom experience for students who would be taught this material. This built on the already significant wealth of knowledge handed down from the previous five semesters.

1. Enhance the “Tree Farming” teaching kit to a more sophisticated level for high school students in Chicago by including more scientific information, making the kits more informative

through the use of statistics, and adding more multimedia, visual aids, and in class experiments/activities. See appendix 3 and 4.

2. Demonstrate the effectiveness of the existing teaching kit materials on students and teachers.

3. Develop a unified aspect of the teaching kits to show how they are related to the conservation of energy. See appendix 4.

These were the nine objectives that IPRO 332 felt were necessary to further the mission of distributing effective teaching modules about sustainability to the outside community.

2. Organization and Approach

The IPRO team was broken into three smaller sub-teams. Each of these sub-teams had one student assigned as an overall leader. The three sub-team leaders formed an overall leadership committee which worked together with Professor Braband in order to accomplish the objectives set forth at the beginning of the semester.

To select the members of the different sub-teams students were allowed to decide which team they felt they would work best with. Then based on their own self assessment of their strengths and weaknesses group members selected what part of the project they felt they would best be able to tackle. Each set of goals was discussed within the group with the sub-team leader leading the discussion. The goals were evaluated to ensure that all objectives for the semester were being accomplished by someone.

Member	Strengths	Major	Year	Tasks
Jorge Chavez	AutoCAD, Revit, illustrator, photoshop	Architecture	4	Marketing team
Jason Chin	Editing, Experienced with InDesign,	Communication	4	Marketing team
Gina Grande	organization, research, commitment	Applied Math	4	Coordinate Bake Sale, Marketing Team

Ross Johnson	basic computer programming in multiple languages, Knowledge on LEED	Electrical and Computer Engineering	4	New Module Sub-team leader
Livia Lay	Organization, visual presentation/graphic skills, documentation	Architecture	5	Revise tree farming module and scale up for high school use
Declain McCloat	graphic skills with various media, organization, design of presentation and tools	Architecture	5	Teacher script, analysis of effectiveness for new module
Nam Nguyen	Research, documentation, organization	Civil Engineering	4	HVAC research, comparison to old modules for new module
Patrick Olechno	“hands-on” projects, creating presentations, researching topics, up to date with current topics.	Civil Engineering	4	Waste/Water research for new module
Jennifer Randle	Communication, Oral presentation, documentation, organization, working well within a group	Political Science	3	Research and feedback for previous and updated modules
Micheal Tyler	Hands on Technician, Decent Communication and Presentation Skills, Time Management and Financial Organization, and average on working with people.	Electrical Engineering	4	Module Revision Sub-Team leader, creation of unifying theme
Mayra Vega	Organization, Scheduling, Commitment, AutoCad, Photoshop, Illustrator	Architecture	4	Contacting Schools, Marketing team leader

Andrew Weiner	Planning, organizing and working with people.	Chemistry	5	Revision of Tree Farming Module and liaison with MSED department
Gregory Zajac	Prior IPRO in green technology and able to research new ideas and comprehend them quickly	Electrical and Computer Engineering	4	Electrical Research for New Module

Once each of the teams was formed they developed methods which could be used to complete the objectives which were deemed essential to completing their part of the project.

The marketing sub-team had three major objectives; to establish an after school program, obtain the endorsement of an institution at IIT and raise funds to help support the project and the Teacher Knowledge Share website.

To establish an after school program the sub-team worked with contact lists for different area schools which had been handed down to the current team by past semester IPROs. The goal of this was to get a teacher to pick up the project and work with students who had to stay for after school care. If this didn't work the IPRO team wanted to be allowed to come and work with students who had to stay after school in the hopes of getting the school to establish and after school program. This would be the first step in getting the teaching kits into the community and hopefully, eventually, getting teachers to use them as part of their yearly curriculum plans.

To obtain an endorsement from and IIT institution the marketing sub-team examined the various departments within IIT in order to identify which departments would potentially have a vested interest in supporting IPRO 332. The departments which the team identified as possibly being willing to help the group were the Office of Campus Energy and Sustainability, the Math and Science Education Department, and the Office of Community Affairs and Outreach. If any of these organizations were willing to support the IPRO group then it would add a level of credibility to the project and teachers would be more willing to take the project into their classrooms.

The final goal of the marketing sub-team was to raise funds in order to support the project and the Teacher Knowledge Share website. The team wanted to approach this by holding a bake sale on the IIT campus.

The new module development sub-team had three major objectives; develop and finalize a module on a zero energy home, create documentation of research, support findings with concrete data which would demonstrate the effectiveness of the work on the new module.

To develop the module each of the sub-team members were given a different area of a zero energy home to research. .The research was divided into four main areas; electrical, HVAC, water and waste. This research data was organized into a teacher script and PowerPoint presentation. The teacher script, in addition to research data, contains the applicable curriculum codes for Illinois. The presentation complements the teacher script and includes visual aids to emphasize each idea.

To document the research each member of the sub-team kept track of what sources were used and documented them within the teacher script. These were mostly websites. Since the internet was the primary research tool it was important that each of the sources was validated. To ensure that this happened the groups mainly used government sponsored websites in order to avoid the potential for using false information.

Support findings and final product with concrete data and statistics that define the effectiveness of the new module. To perform this students would be given a pre-test on the material they were about to learn to establish a baseline for how much they will have learned from the presentation. They would then be given a post-test asking them similar questions on the information they heard during the presentation. The pre and post tests would then be compared for each student to see how effective the presentation was. If there were time constraints on the lecture a Jeapordy game was developed in order to at least gauge what knowledge the students had leaving the lecture.

The module revision sub-team had three major objectives; to enhance the Tree Farming kit to a more sophisticated level for high school students, demonstrate the effectiveness of the existing and create a unifying aspect to all of the teacher's kits.

The Tree Farming teaching kit would be enhanced with a more sophisticated level for high school students in Chicago by including more scientific information, making the kits more informative through the use of statistics, and adding more multimedia, visual aids, and in class experiments/activities. It is important to focus on the information and statistics that will be provided to the high school students to help them put the concept of sustainability into perspective. Adding more visuals allows the students to be more engaged in the topic and helps explain important processes or concepts better. The in class activities are needed for the students to understand how sustainability affects everyone, regardless of age or location; they are also fun ways to show how sustainability can be applied to their daily lives. Having interactive activities for students helps the students learn in a fun way by interacting with the teacher and other students.

To demonstrate the effectiveness of the existing teaching kit materials on students and teachers, surveys, pre-tests, and post-tests seemed to be the most effective ways to measure effectiveness. One-on-one interviews with teachers to get their opinions may have also proved to have been helpful. It is beneficial to have a critical review of the teaching kits and other materials to ensure that it will be received by school administrators and teachers.

To develop a unified aspect of the teaching kits to show how they are related to the conservation of energy the current teaching kits would be reviewed to determine where they can be linked together. Students needed to be informed about the effects of sustainability and recycling on the environment around them. It was also important to connect the concept of conserving energy in the zero energy home to that of sustainability, specifically with recycling.

3. Analysis and Findings

Our initial research looked into the impact of the previous IPROs' work. While this was the sixth semester this IPRO has been working there were no team members present from previous semesters. This meant that the review of the work was paramount in our preparation for the semester. We found that the previous team had supplied many in depth teaching modules but had very little organization. Since this is IPRO 332's final semester it would be very important to organize all of the work so that the project can be potentially picked up by either another IPRO or an organization outside of the IPRO department or IIT.

The marketing team found that to obtain an endorsement from IIT it would be necessary to determine what department that endorsement would come from. Once this realization had occurred the team selected the three departments mentioned above. The material did not receive an official approval but many people from within these departments did review the work and comment on it.

An official after school program was very hard to develop. To actually have something like this start it would have been necessary for community teachers to take extra work on themselves. This is an unrealistic goal given the amount of work teachers must complete in their day to day jobs. Instead the IPRO group presented their paper mache making activity along to a group of elementary school students at Pershing West Elementary School. The activity was very well received and the students wanted our group to return in the future. This was not possible due to the time constraints of the semester. See appendix 1

The marketing team did raise approximately $70 through the bake sale. The sale was shut down because an ingredient list was not present at the bake sale. It was not known that this was a requirement until after it was already too late.

The marketing teams' efforts to raise awareness on sustainability were somewhat successful. Our initial methods were electronic; setting up a Facebook account where we have linked up the website of previous semesters; TeacherKnowledgeShare.com, as well as posting an educational video on Climate Change. In the coming days we will also take the existing, updated, and new modules and upload them onto TeacherKnowledgeShare.com in order to reach a national level audience. We have also created a logo that we feel best represents the name/efforts of our IPRO: Lessons in Sustainability. T-shirts were designed to wear for our in-class activities but were not printed out because of the high cost. See appendix 5.

The new module sub-team created a fully functional teacher's kit to describe a zero energy home. This module contained three different areas of research about the home. These were electrical, HVAC and water and waste. Each of these is an integral part of the zero energy home. The overall module was created to be given as either a single presentation or in three different parts. This was done so that teachers could either make a unit of the kit or they could do one single presentation. The single module was presented to a science class at De La Salle High School. The overall module was well received but no documentation of the actual effectiveness could be done due to time constraints. The students did demonstrate knowledge of the material through the Jeapordy game. The overall research was documented and included in the iGroups website for turnover to another group or organization. See appendix 3 and 4.

The module revision sub-team completed the research and completion of an overarching theme module. This kit was used to tie all of the material together to help students understand why they are learning about tree farming, zero energy homes and other sustainability topics. This can be given as a final unit or it can be given at the end of class presentations. See appendix 4.

The module revision sub-team reworked the tree farming module so that it would be applicable at both a high school and elementary school level. This will ensure that the teaching modules have greater penetration into the teaching community. This will also ensure that the material is reinforced so that students will learn the material. The material was updated to use more in depth statistics and a greater wealth of knowledge. See appendix 3.

The three initial tree farming modules were reviewed by Dr. Norman Lederman from the Math and Science Education Department. He made many recommendations on how the modules could be improved. The most important thing he suggested was to include curriculum codes so that teachers know where these kits fit into the material they are required to teach. The modules were also revised to better suit the needs of elementary school students. The original modules were slightly above the ability levels of elementary school students so the modules were revised to reflect this. See appendix 3.

4. Conclusions and Recommendations

Our team recommends that contact be made early with school administrators and teachers. It is important to get them thinking about how they would be able to fit a presentation into their schedule. It is important to be mindful of any standardized testing or holidays that could delay the presentation. Once contact has been made, set up tentative dates and times to give each party some leeway, in the event that a scheduling conflict occurs. Distribute the materials to the teachers before the actual presentation so they have an understanding of what their students will be learning. When making edits to a teaching kit, teacher script, or presentation be aware of the language or vocabulary being used so that it does not become too advance or too simple for a certain grade level. Obtain the feedback from teachers and students as soon as the presentation is complete to have efficient results to be added to the final report. Continue to pursue teaching elementary school students about sustainability so that they will have to opportunity to carry these ideas with them throughout their lives.

This has been a successful semester for IPRO 332. A total of eight teaching kits are ready to be spread into classrooms across Illinois so that students can learn about the sustainability issues facing our society today. The IPRO team feels comfortable turning the material into the hands of either another IPRO or a community group. The material is very self explanatory and easy to understand. Hopefully these teaching kits will assist students in gaining a greater appreciation for energy conservation so that they may help lead the charge to reduce energy usage in our society.

Appendix

1. List of Contacts
2. Budget
3. Teaching Kits
4. Slides for Modules Not in Kits
5. T-Shirt Design
6. Bibliography

1. Appendix 1: List of Contacts

This appendix includes people contacted by both this semesters IPRO team as well as people who have been contacted by IPRO teams from previous semesters. This was included in an attempt to consolidate all of the documentation into one area.

Name	Phone Number	Email	Notes (school, title, etc.)
*Fleck, Jennifer (Not yet contacted)		jafleck@cps.edu	Gage Park HS,
Benz, Emily	[redacted]		Whitney Young HS, Science Department Chair
Chrupka, Bob		chrupkar@dls.org	De La Salle Institute, Girls' Ca Science Instructor
Dillard, Chimille	[redacted]	cdillard@HFHighschool.com	Homewood-Flossmoor HS, Sc Department Chair
Ewing, Eve		elewing@cps.edu	Pershing West Elementary
Felter, Allegra		allegrafelter@gmail.com	
Frank, Linda			De La Salle Institute, Boys' Ca Science Instructor
Hall, Kevin	[redacted]	knhall1@cps.k12.il.us	Area 23 Instructional Office, Sc Coach
Holcomb, (Betty?)	[redacted]		Hyde Park Career Academy, Environmental Science Instruc
Khazen, Kamaal			De La Salle Institute, Science Department Chair
Lane, Anna	[redacted]	annabella03@sbcglobal.net	Kelly High School
Larrieu, Donna	[redacted]	dmlk@sbcglobal.net	Wendell Phillips Academy,
Lederman, Judith	[redacted]	ledermanj@iit.edu	Associate Chair MSED Depart IIT
Lederman, Norman	[redacted]	ledermann@iit.edu	Chairman MSED Department I
Marshall, Theresa			Morgan Park HS,
Neiswandt, Martina	[redacted]	mnieswan@iit.edu	Professor MSED Department
Royster, Aaron	[redacted]	aroyster@cydi.org	Youth Connection Leadership Academy,
Slusinski, Gina	[redacted]	gslusinski@HFHighschool.com	Homewood-Flossmoor HS, AP Science Instructor
Vera, Sera		svera@cps.edu	Pershing West Elementary
Watkins, Cheryl		cdwatkins@cps.k12.il.us	Pershing West Elementary

2. Appendix 2: Budget

Item	Cost
Paper Making Activity	$ 20.00
Paper Mache Activity	$ 40.00
Materials for Bake Sale	$ 60.00
Total	$ 120.00

3. Appendix 3: Teaching Kits

These are the teaching kits from the entire history of IPRO 332. They have almost all been updated and reworked in some way.

Cradle to Cradle

Reduce, Reuse, and Recycle

Illinois Institute of Technology

IPRO 332 Our Energy Future

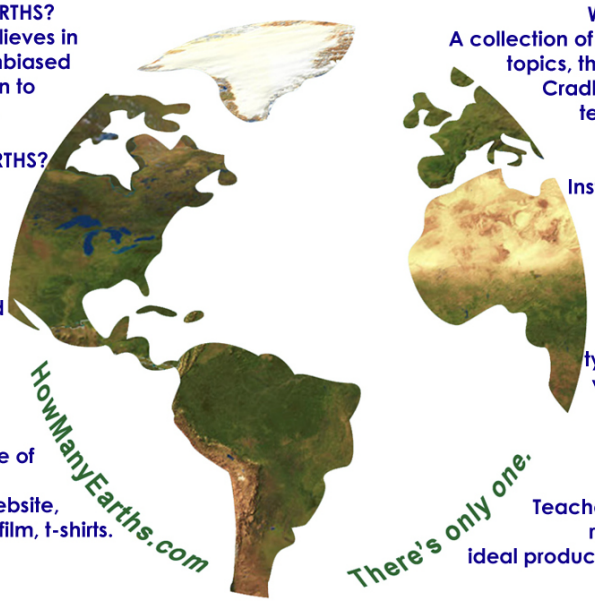
Fall 2008

HOW MANY EARTHS

WHAT IS HOW MANY EARTHS?
An organization that believes in creating & delivering unbiased sustainability information to Chicago area students.

WHO IS HOW MANY EARTHS?
Illinois Institute of Technology students.

WHAT DO WE DO?
Educate:
Teach sustainability and energy consumption curriculums in CPS.
Inform:
Participate in public Chicago events to advocate importance of energy choices.
Create: Teaching kit, website, fundraising, marketing, film, t-shirts.



WHAT IS THE TEACHING KIT?
A collection of materials for teaching two topics, the Ecological Footprint and Cradle-to-Cradle, for educators teaching 6th to 12th grades.

Included are:
Instructional Teaching guides
Digital slide presentations
Discussion topics
Suggested activities

ECOLOGICAL FOOTPRINT
Teaches sources and types of energy, renewable versus non-renewable and the four categories of the ecological footprint.

CRADLE-TO-CRADLE
Teaches the 3 R's: reduce, reuse, recycle and introduces the ideal production/disposal cycle known as Cradle-to-Cradle.

3424 S. State St. Suite 4A7-2 Chicago, IL 60616 | P: 312.567.5002 | ourenergyfuture@gmail.com

THANK YOU!

Your contribution will help us donate How Many Earths 'Teaching Kits' to Chicago-area schools. These materials will aid teachers in learning how to teach sustainable and energy topics in their classrooms.

****Note - check availability of How many earths and work on revising above image.**

Table of Contents

PROCEDURE:

Phase One: Review- During the Review you do not have to use the slides from the ecological footprint. Below are pre-slides so you can understand the relation between Ecological footprint and this module Cradle to Cradle. In order to understand this concept one must understand energy and our energy choices. But remember!! The discussions and questions are real and should be used.

Students Expectations and Materials: IT IS EXPECTED THAT STUDENTS KNOW WHAT ENEGRY IS AND ITS PATH

Step 1: Use the questions above as a bell-ringer. **Warm-Up**

1. What is Energy?

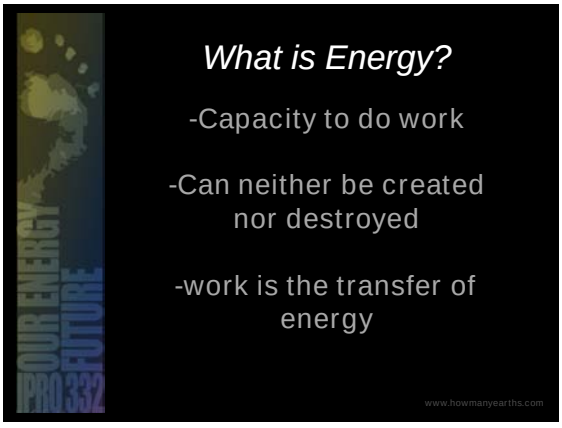
Possible Answers: The capacity to do work. Energy can't be created or destroyed.

2. Where does energy come from? And what is energy's path?

Possible Answers: Energy comes from the sun. Energy's path is from the sun to the resources we use such as oil, gas, coal, and etc…

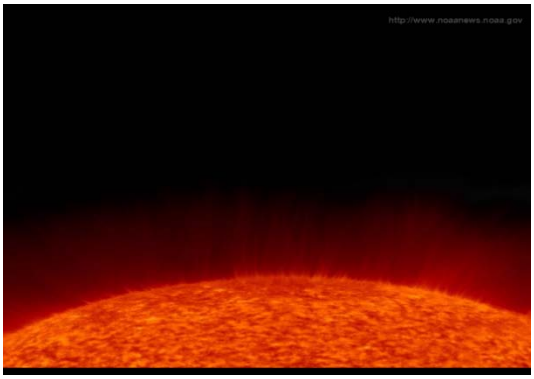
The question from the bell ringer should be discussed aloud. It may be helpful to use a few Pre-slides from ecological footprint module-one before moving into Cradle to Cradle.

Reiterate what energy is?



Pre Slide2:

Reinforce that Energy comes for the sun.



Pre Slide3:

Path of Energy:

The sun shines down on living organisms and the living organisms in turn absorb the energy from the sunlight. Eventually the living organisms die and decompose into the ground. After many, many years, the dead organisms keep getting pushed down further into the Earth as other organisms continue to die and decompose into the Earth as well. Then, at the right amount of temperature and pressure, the decaying organism becomes oil. (*Although these are known as fossil fuels, a can of oil was used for the slide for an easy representation of a source of energy)* This serves as the transition to the next slide.

Explain the Path of Energy as mentioned above

Cradle to Cradle Module focuses on the 3R's of Natural Science

Recycling, Reusing, and Reducing.

Students' Expectations: STUDENTS ARE EXPECTED TO KNOW AND APPLY THE IDEAS OF SUSTAINABILITY AND UNSTAINABLITY

Discussion:

1. What is sustainability and non-sustainability? **(If Elementary may want to use renewable vs. un-renewable)**

You can use these slides to depict the idea or sustainability and non-sustainability.

Warm Up:

Discussion:

Ask students…

What makes the resources in each different from each other? Otherwise what makes solar power sustainable and coal unsustainable?

Phase Two: Cradle-to-Cradle

Slide 1

Cradle to Cradle

How can we as a society increase our sustainability

Discussions, Comments, and Questions:

Based on what we know about re-useable and non-re-useable resources how can we reduce the energy used by society?

Possible Answers: Make a law, re-use stuff like water bottles, and recycle our paper.

**Go to Ford website and show students how turning off the water can save so many gallons of water for the Ford Calculator. (Reference)

??Advanced Thinking??

Put the three R's of science into retrospect.

Slide2

Our Energy Choices

- Fossil Fuels
  - Coal
  - Petroleum
  - Natural Gas
- Alternative Sources
  - Bio Fuels
  - Nuclear
  - Wind
  - Solar
  - Hydropower
  - Geothermal
  - Tidal

**While presenting this slide remind the scholars that these are the same energy resources that were discussed earlier. Slide 3 and Slide 4 are just reminders.

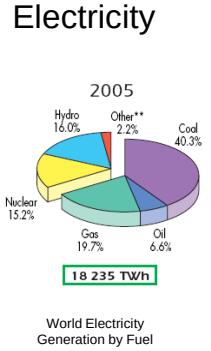
Slide3

Slide4

Insert – Linkage for Zero Energy Home Concept.

- Small illustration on how Sustainable methods of energy production are currently used in Zero Energy constructed homes.

Slide 5



This slide is just an arbitrary representation that 95% of our electricity generation comes from unsustainable sources. **Here is where you can lead the class to discuss more ways in making electricity generation more sustainable** (Idea of 3R's and C2C)**.**

Other Resources:

http://42explore.com/recycle.htm

Slide 6

How can we increase our sustainability now.

- The 3 R's

Reduce

Reuse

Recycle

Discussions, Comments, and Questions:

Have students bring in newspaper articles about The 3 R's of science.

Ask students about what the three words mean to them?

And how can we put the three words out of theory and into practice (slide7)?

Slide 7

How can we increase our sustainability in the future?

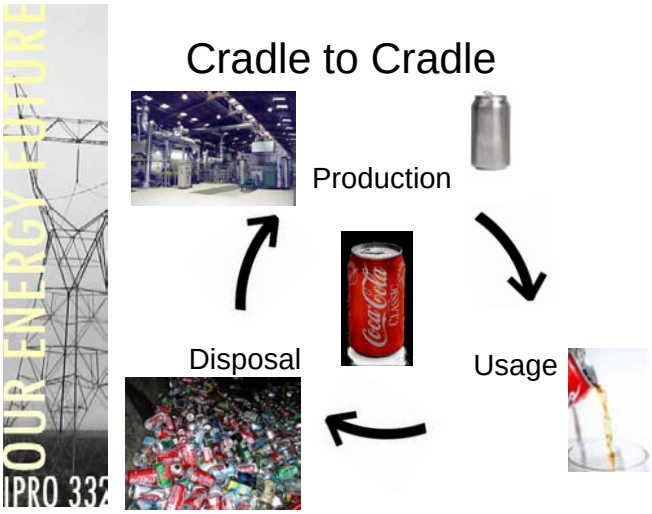
- Dramatically change the way products are manufactured
  - Closed Loop Cycle
    - Cradle to Cradle
  - Linear Cycle
    - Cradle to Grave

Slide 8

2 Design Concepts

**This slide makes reference to Cradle to Cradle and Cradle to Grave

Slide 9



Discussions, Comments, and Questions:

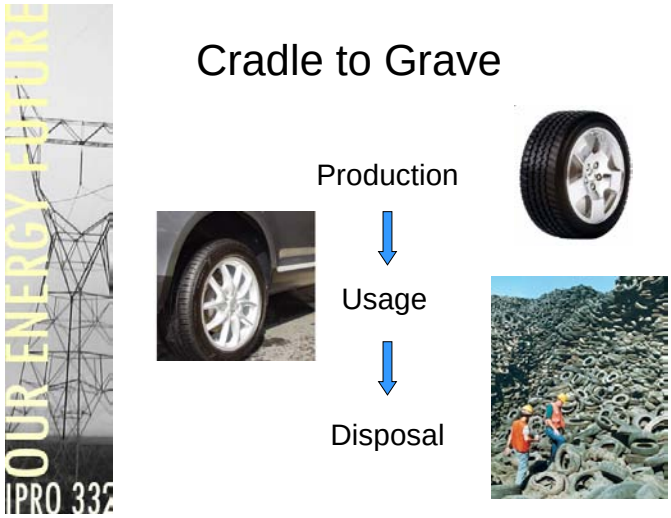
Based on your initial impression in regards to being eco-friendly what do you think the concept of Cradle to Cradle is?

Explain:

Cradle to Cradle Design that models human industry on nature's processes in which materials are viewed as nutrients are productively circulating. The concept suggests that industry must protect and enrich ecosystems. The big idea is for people to be sustainable.

History :"Cradle to Cradle" itself was created by Walter R. Stahel in the 1970's, and the current model is based on a system of the "lifecycle development" initiated by Michael Braungart and colleagues at the Environmental Protection Encouragement Agency (EPEA) in the 1990s.

Slide 10



Cradle to Grave is the opposite concept of Cradle to Cradle.

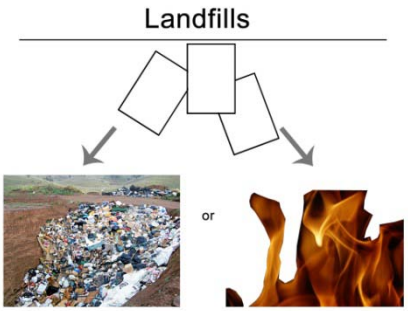
Slide 10 is just a preparation for the examples to be given in regards to the 3R's of Science

Ask students…

What is the difference between Cradle to Cradle and Cradle to Grave? Give examples.

Possible Answers… One is cycle and the other is not.

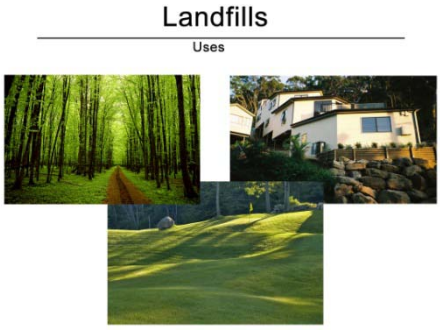
- ***Ask the class*** **- "Where are waste products disposed of in the Cradle to the Cycle?"**



[*Introduce Slide from Prior Tree-Framing Teacher's Kit - slide 4*]

The waste products that are not recycled are thrown out with the rest of the garbage and taken to either a landfill, where it sits for about 2-5 months before it decomposes, or is burned in a process called **incinerating**. However, if the paper was properly recycled, the decomposition process would only take a few days.

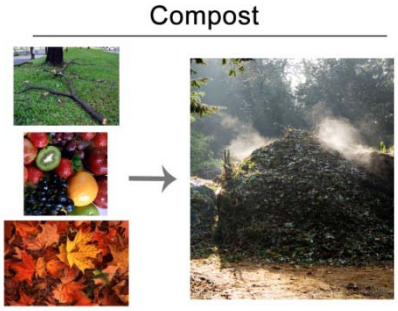
- ***Ask the class*** **– "Do you know what a landfill is and what its uses are?"**



[*Introduce Slide from Prior Tree-Framing Teacher's Kit - slide 5*] A landfill is a piece of land that holds garbage that is thrown away. Usually, landfills are sealed, covered with soil, and used in various ways such as:

- turned into golf courses
- turned into parks
- used to make land higher
- used for new land to build houses on

- ***Ask the class*** **- "What is a compost pile and what it is used for?"**



[*Introduce Slide from Prior Tree-Framing Teacher's Kit - slide 6*] A compost pile is a pile of organic material (i.e. fruit peels, vegetable scraps), usually placed outside in the grass, that allows for the material to be broken down and used for nourishing plants.

Slide 11

The 3 R's

Did you know? – Recycling saves energy and natural resources through conservation. By using materials more than once, we conserve natural resources. Whatever used products we save become the products we do not have to make from another raw or limited source. Recycling also helps control waste disposal problems. Often, recovering used products for recycling can save communities money that they would otherwise have to spend for disposal.

Slide 12

[*show slide of recycling symbol*]. The recycling symbol you see today with three arrows in the triangle shape was designed in 1970 as part of a contest sponsored by the Container Corporation of America (CCA) (now Jefferson Smurfit Corporation) as a special event for the original Earth Day in 1970. This symbol is called the Mobius Loop:

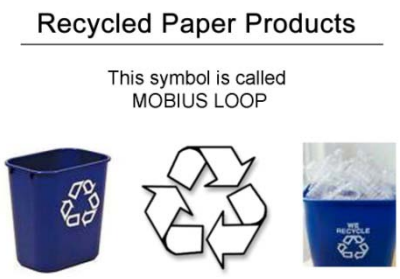
Discussions, Comments, and Questions:

You can have a discussion about their attempts to recycle. Also, ask students about the possible materials that are recyclable.

You might want to record a few 30-45 second commercials that promote students to recycle. They would enjoy it and it is something they can relate to.

****Slide 13 through 16 are just examples of the materials that are recycled. Many of these materials are everyday necessities. Possibly ask students about each of the subtopics and how they can recycle in and out of school.*

Slide13



Kids Corner: Cool Fact!!!

- Aluminum can be recycled for infinity! And for every aluminum can saved equates to 2 hrs of television and 3 hrs of energy for a computer!
- Producing aluminum from raw materials “costs” much more in terms of water than it does when producing aluminum from recycled aluminum.

Slide 14

Slide 15

Paper

The average American uses about 7 trees a year in paper, wood, and other products made from trees.

Kids Corner: Cool Fact!!!

- The average American uses 7 trees
- Every day, people produce about 4.6 pounds of paper waste. In a week, this comes out to 32.2 pounds. And in a year, the amount of paper waste produced is about 650 pounds.

Slide 16

Glass

If all the glass bottles and jars collected trough recycling were laid end to end, they'd reach the moon and back

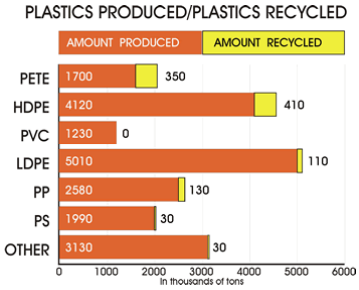
Kids Corner: Cool Fact!!!

- Unlike other substances such as paper, glass can be recycled infinitely without any loss of purity or quality.
- To create new glass, substances such as sand must be heated to 2,600° Fahrenheit, which consumes energy and creates pollution from factories.

Slide 17

Plastic

Recycling plastic saves twice as much energy as burning it in an incinerator.



Kids Corner: Cool Fact!!!

- What are some recycled plastic products?
- More than 1,400 quality products made with or packaged in post-consumer recycled plastics are now commercially available, including single-use cameras, park benches, sweaters, jeans, videocassettes, detergent bottles and children's toys.

Slide 18

Reuse

Reuse is simply reusing certain materials repetitiously.

Ask Students… What are some products that they can reuse?

Possible Answers… Paper and bottled water

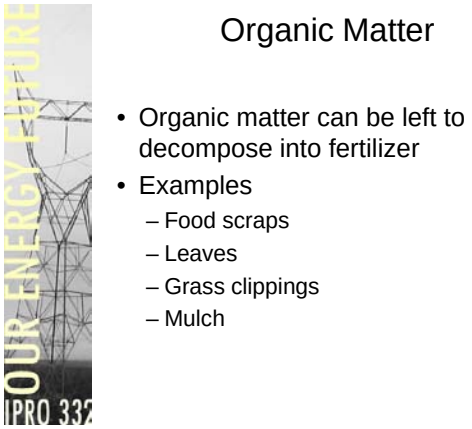
Slide 19

Ask Students… What are different ways to reuse things we throw out?

Possible Answers… Newspapers for shopping bags, saw dust as mdf wood

Extra!!! Other ways schools encourage reuse is by telling students to use both sides of scratch paper. The same idea applies to corporations printing on both slides.

Slide 20



Asks Students… What is the importance of organic matter?

Possible Answers… It can decompose and help nourish the environment— recycling for the soil.

Kids Corner: Cool Fact!!!

Composing can reduce the volume of waste by half that gets sent to the landfill!

Slide 21

Reduce

**Is decreasing the amount waste by reducing the consumption of energy sources.

Slide 22

Limiting Consumption

Fuel Efficient Cars

Conserve Water

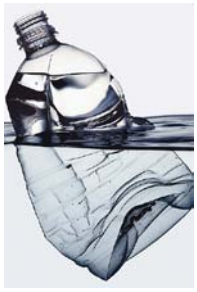
Ask students… What different ways there are to limit consumption?

Possible Answers… Better fuel efficient cars, turning the tap off

Slide 23

Water

- EPA announces that 36 states will anticipate water shortages by 2013



Ask students… Why is slide 21 important in regards to the environment and water?

Possible Answers… We use fresh water and less than 3% of the earth is made up of fresh water.

Ask Students… What are materials can they think of that are non-recyclable?

Possible Answers…Food, Mirrors, Disposable diapers, Clothes.

Mention the food trays. It's an object that students can relate too. If we cannot recycle the hundreds if not thousands of food trays that are served for breakfast and lunch, think about the amount of material and energy being wasted.

Slide 24

How does this make us more sustainable

- We use less raw material
- Requires less energy to produce
- We waste less material

Slide 25

Cradle to Cradle

Conclusion of students' interpretations of Cradle to Cradle

Slide 26

Materials

- 2 Categories
  - Technical Nutrients
  - Biological Nutrients

Activity – Administer after Q & A on Paper.

Supplies:

- notebooks (20 to 30)
- bucket or box

Have the students bring their notebooks up to the front of the class

Take these notebooks and place them in the bucket.

Explain to the students that each notebook represents 1 tree that has been cut down to make paper.

For the first time around, have the students count the number of notebooks in the bucket.

Explain that the number the students counted represent the number of trees that are cut down after paper has been thrown away.

For the second time around, have the students put 1 notebook in the bucket and put 1 notebook aside.

Have the students count the number of notebooks still in the bucket.

Explain that the number of notebooks put aside is the number of trees that would be saved if every other notebook was recycled instead of thrown away.

Also explain that the notebooks in the bucket are the notebooks that would be put into landfills.

Try having the students put aside every 1 in 5, or 1 in 3 notebooks and explain that these represent the number of trees saved when every 1 in 3 or 1 in 5 notebooks have been recycled instead of thrown away.

Have the students compare the number of trees saved when every 1 in 2 notebooks, 1 in 3 notebooks, or 1 in 5 notebooks were "recycled".

Explain that recycling the notebooks keeps more trees from being cut down to make new paper.

Other Sources:

http://www.willyoujoinus.com/takeAction/energyGenerator/

PAPER PRODUCTS AND THE ENVIRONMENT

TEACHER'S SCRIPT

1. CURRICULUM

This module is designed for the high school level. It fits with Illinois State late high school curriculum under item 13.B.5d. This states that students should analyze the costs, benefits and effects of scientific and technological policies at the local, state, national and global levels.

2. OBJECTIVES

General objectives:

- To raise awareness of sustainability issues and pass the knowledge of sustainability to students
- Teach young generation about sustainable solutions to the problems
- Encourage them to participate in future sustainability efforts and nurture their commitment to environmental stewardship

The purpose of this module is to teach students about paper and its impact on the environment. The lesson demonstrates sustainable solutions to problems that we have pertaining the production and consumption of paper products. The focus is how to save the earth from deforestation and pollution caused by paper. Students will learn about trees –the source of much of our paper, the life cycle of paper: paper making and recycling, production and consumption. In the end, students will get a better understanding of sustainability as the underlying theme. Students should better understand how they can participate positively in the life cycle of paper and ultimately be encouraged to recycle.

3. MATERIALS AND PREPARATION

Materials

- For discussion:
  Slides
  Student worksheets: Activities
  Sample objects: paper products, wood pulp, recycled pulp/paper, various tree-free fibers, etc.
- For papermaking activity
  See attachment

Preparations/Directions

Copy enough worksheets for all students to device the activities. Prepare to project included slides, print them out for students. Bring posters, samples, and activity supplies to class. One or two days before this activity is to take place assign the students to bring the materials needed.

Start the lesson with Activity 1. Have students do this in groups. Discuss Activity 1 by entering the lesson discussion slide by slide. Start with the abstract, introduce problems and demonstrate/illustrate facts on trees and paper. Support discussion with facts and data. For elementary students, Activity 2 can be included in the abstract presentation. Ask students to show the paper products they bring to class and review them. Teacher-students should interact by Q&As before discussing of each part. Show slides to review answers and show statistics. At this stage, problems and objectives should be clear to students.

Continue to "Sustainability" discussion. Go through the solutions, explain how they are sustainable and use the props. Do the "did you know"/Q&A activity in each section to present facts and important information. Show samples and posters. Tell students to fill in the worksheets. Students could work in groups.

Italicized text is the additional information for high school students

Do the papermaking experiment. (Activity 3)

For the student response (Activity 4), assign students to do a project or create a display on what they have learned. At specific school events, they could continue the outreach to other students or even the community. Teachers evaluate how much/what they learn.

4. LESSON

Activity 1 : informal quiz or game. This is not necessarily a pre-test for the students. This activity is designed just to measure students' knowledge/awareness of the topic. (TBD)

Discussion

ABSTRACT

Little can happen in life without paper products. The range of possible uses of paper seems almost limitless. New ways of using it are being devised daily. This evolution will continue because paper is an expression of everyday living. It is hard to imagine what life would be like without paper. Most of us use it, in one of its many forms, each and every day. Just take a look around you and see how many uses of paper you can identify in your immediate surroundings.

Start Activity 2: Ask students to show paper products they bring to class and have a discussion

Things that are made out of paper

board games	magazines	postage stamps
Books	maps	puzzles
Boxes	menus	receipts
calendars	newspapers	stickers
Cards	notebooks	tickets
egg cartons	paper towels	tissues
envelopes	photographs	wallpaper
fast-food containers	popcorn bags	wrapping paper

Where do they come from?

Paper and Our Forests

Most paper nowadays is made out of trees. Today, the world consumes about 300 million tons of paper each year. Most of that paper is made from virgin wood pulp. Nearly 4 billion trees worldwide are cut down each year for paper, representing about 35% of all harvested trees. Currently, 50% of the world's paper is made from harvested trees, and the rest is from recovered paper and tree-free paper fibers. There are serious concerns about planetary deforestation, and the pollution released daily from paper mills manufacturing paper. Many environmentalists believe that the world's forests are being cut down faster than they can grow. Before the 1850s paper was not manufactured from wood pulp and tree-free papers were the norm.

PROBLEM

Introduce the problem/concern. "Paper is a significant product of trees with an increasing number of consumption each year. The conventional method of making paper out of virgin wood pulps causes deforestation. The production process through paper mills disperses pollution."

- **Deforestation.**

Making paper out of trees is a waste of the timber, an increasingly valuable environment-friendly raw material, consisting of locked-up carbon dioxide, with many more vital uses. We cannot deny the importance of paper products in our life. However, we should not forget that today paper is made from one of the most valuable resources on this planet – trees. For every sheet of virgin paper used, trees must be cut. Paper products generally have a short life cycle and are thrown away after being used. Trees, on the other hand, take many years to grow.

Forests: General Stats/Facts

- *About 33% of the U.S. land area, or 737 million acres, is forest land.*
- *America's forest products companies have donated over 1 million acres of land (valued at over $400 million) for conservation, recreation, or social causes.*
- *About 47 million acres (6% of all U.S. forest land) is reserved for parks and other wilderness areas - no commercial timber harvests are permitted.*
- *Since 1952, 4% or about 19 million acres of timberland has been reclassified as wilderness or parks and no more commercial harvests are allowed.*
- *The amount of new timber grown is more than the amount of timber harvested by at least 1/3 (54% in 1976, 38% in 1986, and 34% in 1992).*
- *The trees used to make paper in the United States come mostly from softwood forests-mostly pine-in the South and West.*
- *Two-thirds of our freshwater supply originates in forests.*
- *To grow a pound of wood, a typical tree consumes about 1 1/2 pounds of carbon dioxide and releases a little over a pound of oxygen.*
- *Altogether, U.S. forests remove about 9% of the country's total carbon dioxide emissions from the air.*
- *Over 90 percent of the nation's threatened and endangered species have habitat on non-federal forests.*
- *About 28% of all wood cut in the U.S. is used for paper making and according to a 2000 report by PaperCom Alliance the demand for paper worldwide has grown 30% in the past 6 years.*
- *Pulp and paper account for approximately 40% of deforestation worldwide.*

- **Pollution from Paper Mills.**

The processing of virgin wood paper uses harsh chemicals to treat new pulp and create high white finishes. It also wastes more energy and generates greenhouse gas emissions. Paper mills require lots of energy to make paper from wood fiber. Paper fiber called cellulous must be separated from a tree's natural glue called lignin. Several energy intensive steps must be performed to finally produce a paper sheet. Hazardous chlorine is also often used to bleach the pulp. Consider that chemicals used in paper manufacturing produce various types of by-products and gasses. Solid waste material is usually dumped somewhere on the land, liquid waste is generally flushed into streams or the sea and gasses are left in open air contributing to global warming.

Making paper from trees also adds an environmental burden, because:

- it has to use chemical processes to treat new pulp and create high white finishes.
- it is a waste of the timber, an increasingly valuable environment-friendly raw material, consisting of locked-up carbon dioxide, with many more vital uses.

FACTS: Why are trees important?

Trees are important to people and our environment in many ways. They provide precious habitat for birds, squirrels, insects, and other creatures. Their branches provide natural shade for houses, animals, and smaller plants, and they help control erosion by holding soil in place. The leaves they drop in autumn decompose into new soil that's rich in nutrients. Their leaves and roots act as natural filters to cleanse particles from the air and water. And trees remove carbon dioxide from the air while adding valuable oxygen to our atmosphere.

How do trees help our atmosphere?

When petroleum and other fossil fuels are burned, as in automobiles, factories, and your furnace at home, carbon dioxide is released into the atmosphere. Trees improve the quality of our atmosphere by consuming carbon dioxide and releasing oxygen during photosynthesis.

Young, rapidly growing forests are generally the most efficient at absorbing carbon dioxide and producing oxygen. Because older trees do not grow as rapidly, and because dead trees actually use oxygen and release carbon dioxide as they decay, old overcrowded forests tend to use more oxygen than they produce.

Foresters help by systematically thinning overcrowded forests and removing dead and dying trees. This makes forests healthier, and reduces the likelihood of wildfires which can release huge amounts of carbon dioxide and particles into the atmosphere.

FACTS: How Much Paper is in One Tree?

- *It really all depends on the size of the tree. According to paper manufacturer Boise Cascade, however, a cord of wood (wood stacked 4 feet by 4 feet by 8 feet, or 128 cubic feet) produces nearly 90,000 sheets of paper or 2,700 copies of a 35-page newspaper!*
- *Today, the world consumes about 300 million tons of paper each year.*
- Some people say that it takes "17 trees to make a ton of paper." This might make you believe that if a ton less paper were used every year, then at the end of the year, 17 more trees would remain standing.
- *A cord of wood is approximately 8 feet wide, 4 feet deep, and 4 feet high. A cord of air-dried, dense hardwood (oak, hickory, etc.) weighs roughly 2 tons, about 15-20 percent of which is water.*

  It has been estimated that one cord of this wood will yield one of these approximate quantities of products:

- ☐ 1,000-2,000 pounds of paper (depending on the process)
- ☐ 942 100-page, hard-cover books
- ☐ 61,370 No. 10 business envelopes
- ☐ 4,384,000 commemorative-sized postage stamps
- ☐ 460,000 personal checks
- ☐ 1,200 copies of National Geographic
- ☐ 2,700 copies of an average daily newspaper

FACTS: Paper industry, production/consumption

- *Currently, 50% of the world's paper is made from harvested trees, and the rest is from recovered paper and tree-free paper fibers.*
- *Wood pulp is found in rayon material, laundry detergent, camera film, tires, and transmission belts.*
- *Paper and paper products are the largest single component of society's waste stream.*
- *World consumption of paper has grown four hundred percent in the last 40 years. Now nearly 4 billion trees or 35% of the total trees cut around the world are used in paper industries on every continent.*
- *The US is the world's largest consumer of paper by far.*
- *It wasn't until 1843 that ground-wood (or pulp) harvested from trees became the papermakers material of choice.*
- *The U.S., which contains only 5% of the world's population, uses 30% of all paper.*

Paper Industry Statistics:

- *The pulp and paper industry is the largest single industrial wood consumer in the US and in the world. Pulp mills in the US consume more than 12,000 square miles of forest each year; almost half of all trees logged are turned into paper, and the percentage is increasing.*
- How much paper do Americans use in a year?
  Every year, Americans use more than 90 million short tons of paper and paperboard. That's an average of 700 pounds of paper products per person each year. *Every year in America, more than 2 billion books, 350 million magazines, and 24 billion newspapers are published.*
- *How many paper mills are there in the United States? In the world?*
  The U.S. is the world's leading producer of paper and paperboard, with over 500 mills in operation. Worldwide, there are approximately 10,000 paper and paperboard mills in operation.
- *How much paper and paperboard is made in the U.S.? Worldwide?*
  Worldwide, about 300 million metric tons of paper and paperboard are produced each year. The U.S. alone produces about 87 million metric tons of paper and paperboard, representing nearly one-third of the world's total production. In the year 1900, the U.S. Paper industry produced an estimated 14 thousand tons of paper a day. Today's U.S. Paper industry produces over 250 thousand tons of paper and paperboard every day.

Current Method of Making Paper out of Wood Pulp

Paper is made from natural fibers called cellulose. The primary source of cellulose in the U.S. today is wood. Many types of wood can be used to make paper. The two main types are hardwood such as oak, and softwood, such as pine. This slide shows a combination of hardwood and softwood fibers.

Softwood fibers are over twice as long as hardwood fibers. In general, the longer the fiber, the stronger the paper will be. Therefore, softwood fibers are best used for paper or paperboard which requires strength, such as grocery bags and boxes. Short fibers, on the other hand, help make paper smooth. A blend of hardwood and softwood fiber is ideal for making printing and writing paper, which needs to be both strong and smooth.

Pulping

First, wood chips or recovered paper are combined with water and sometimes chemicals and "cooked" until the cellulose fibers separate from each other. This mushy solution of water and fiber is called pulp. This picture shows a handful of dry pulp. Sometimes, fillers and additives are added to the pulp to make the finished paper more glossy, absorbent, or water resistant.

The paper machine

Watery pulp is sprayed from a huge vat called a headbox onto a giant plastic screen which is moving quickly around the front end of the paper machine. The fibers in the pulp bond to each other and form a watery sheet of paper. As the pulp is carried along the screen, water begins to drain out. The sheet of paper is then pressed between a series of felt-covered and heated rollers to remove more water and to make the paper smooth and dry.

The finished roll of paper

A finished roll of paper can measure up to 30 feet long and weigh as much as 20 tons! The rolls of paper are cut into smaller rolls, and are then ready to be converted into paper products like boxes, books, and magazines.

FACTS: History of paper

“Where do you think the word ‘paper’ comes from?”
Actually the word paper comes from the Greek word for papyrus. Papyrus is a reed plant that grew in ancient Egypt. People cut it into thin strips and wove it to create a paper-like surface that they wrote on, they called this papyrus too! There is a difference between papyrus and paper. Papyrus is woven pieces of plant, paper is made of plant fibers that were suspended in water and wove together themselves.

“When do you think paper was invented?”

Actually paper was first made in China in the year 200 A.D.! A man named Ts'ai (Cai) Lun used old fishing nets and rags to make paper. Paper may have been made before him, and like all scientists he built off of previous discoveries but he was the first to record his invention. It took a while but paper spread all over the world but they were still making it out of old rags which were hard to come by.

"How do you think people got the idea for using wood to make paper?"
Actually the idea came from bugs! In the 1700's a man by the name of Rene de Réaumur, was thinking of new materials to make paper out of, when he saw some wasps. They were chewing up wood and spitting it out to make nests. They were making paper. Wood could be chopped up to get plant fibers needed to make paper.
Here in the US the first paper mill was built in 1690 in Germantown, Pennsylvania. It started using wood in 1860. The process of making paper has progressed in years since to meet the demand of today.

Interesting facts:

- *Using wood to make paper is a fairly recent innovation. Linen, straw and hemp were the primary material sources for paper throughout the centuries. It was not until the 1850's when Friedrich Gottlieb Keller created a revolution by crushing wood with a wet grindstone that our vast natural forests began to fall for the production of paper.*

- *The first paper merchant in America was Benjamin Franklin, who helped to start 18 paper mills in Virginia and surrounding areas.*
- *In 1883 Philadelphia resident Charles Stillwell invented a machine to make brown paper bags so folks would have something to carry their groceries home in. Today more than 20 million paper bags are used annually in supermarkets throughout the country.*
- *But did you know that until the middle of the 19th century, the main ingredient of paper was cloth rags?*

BASIS OF FINDING SOLUTIONS: SUSTAINABILITY

Explain on Sustainability:

The idea of sustainability means trying to do what nature does on her own: keep things in balance. Humans have been part of this balance for thousands of years. It wasn't until this century, however, that humans had the machines and the population numbers to begin to throw things out of balance. In other words, we started taking away more than nature could grow back. Now we are trying to keep things in balance again by sustainable use; that is, giving back to nature in order to replace what we remove. We must manage land and resources like trees wisely so they won't be "used up" or depleted. There's more to this balance than just trees and forests; we must consider the economic issues as well.

Sustainability diagram: sustainability can be defined as taking care of the needs of the present generation without compromising the ability to meet the needs of future generations. It also can be defined as the intersection between three principals; environmental stewardship, economic health; and social justice.

SOLUTIONS: WHAT WE CAN DO

SUSTAINABLE ALTERNATIVES TO USING VIRGIN WOOD PULP FROM THE FORESTS

A. Reduce/Conserve

- **Use both sides of the paper.** It's called "duplex printing" and it is the single best way to reduce paper use. So choose copiers, digital printers and multifunction devices that can print on both sides of the paper. Add duplex as your "default" mode.
- **Go digital.** Save on postage by sending electronic files and let your recipient decide whether to print them. Replace paper files with electronic ones using the scan-to-file option on multifunction devices.
- **Be selective: print what you need when you need it.** For example, print only the portion of the report you need, not every page. Preview your print to avoid printing pages with boilerplate. Print on demand. Don't stockpile forms, letterhead, or instructions that will go out of date.
- **Reach for the right paper.** A number of options promote sound environmental practices. For instance, Xerox High Yield Business Paper™ is produced using half the number of trees of conventional paper. Print on papers certified through global organizations, such as the Forest Stewardship Council or the Program for the Endorsement of Forest Certification, both of which have strict international standards for sustainable forestry. Or use paper with recycled content.

B. Tree Farming

Nearly 4 billion trees worldwide are cut down each year for paper, representing about 35% of all harvested trees. Fortunately, many of the trees used for paper come from tree farms which are planted and replenished for that purpose.

The term "tree farming" was first used in the 1940's to introduce the public to sustainable forestry terminology they could easily understand. Farming implies continual stewardship and production of goods year after year. By linking the term "farming" with trees, foresters could communicate the concept of sustainable production of forest products over time. Tree Farming implies commitment to the land and was the philosophical opposite of the "cut-out and get-out" philosophy of the early 20th century.

Trees are a renewable resource, which means that once one is cut down another can be planted in its place. In fact, much of the wood used by paper companies in the U.S. comes from privately owned tree farms where forests are planted, groomed and thinned for harvest in 20 to 35 year cycles, depending on the tree species. Around the world, tree farms supply 16% of all wood used in the paper industry while the bulk comes from second growth forests. Only 9% of the wood used to make paper is harvested from old growth forests, which are impossible to replace because of their maturity.

Yet, while tree farms or plantations help feed the demand for wood, they can't provide the plant and animal diversity found in natural forests. Plus, according to a 1996 report from the U.S. Forest Service,

the rate of harvest for softwood trees in the southern United States outpaced growth for the first time since 1953.

Quick Facts on Tree Farming:

- *It all began in 1941 when the first Tree Farm was designated in Washington State.*
- *There are more trees in America today than there were 70 years ago.*
- *In 1998, over 1.6 billion tree seedlings were planted in the United States.*
- *Each year, the U.S. forest community plants some 1.5 billion seedlings. That's an average of more than 4 million new trees planted every day!*
- *More than 5 new trees are planted each year for every man, woman, and child in America, and millions more regrow naturally from seeds and sprouts.*
- *Around the world, tree farms supply 16% of all wood used in the paper industry while the bulk comes from second growth forests. Only 9% of the wood used to make paper is harvested from old growth forests, which are impossible to replace because of their maturity.*

Cons:

- *Mono-cultures of fast growing conifer plantations support relatively little wildlife and can cause acidification of soil and water courses. They exhibit all the bad features of single-crop agriculture at its worst.*
- *When cropped they are clear-felled and replanted, a practice which badly disrupts the soil structure and natural eco-systems.*
- *Cropping is carried out by large-scale machinery which leaves a scarred and disrupted landscape, and offers employment for very few rural people (contrary to the claims of the industry).*
- *Newly planted trees have difficulty in becoming established in the damaged soil, so herbicides are heavily relied on to prevent competition from other plants.*
- *The 'trees-only' culture ensures a rapid build up of pests, especially insects. With no habitat provided for predators the use of insecticides becomes inevitable, further damaging the environment.*
- *Yet, while tree farms or plantations help feed the demand for wood, they can't provide the plant and animal diversity found in natural forests.*

C. Tree-Free Fibers

Tree-free paper is more environmentally friendly for several reasons. Plant sources used for tree-free papers grow rapidly compared to trees, and the plants do not disrupt ecosystems when harvested. *True forest ecosystems have a mix of species and ages of trees, undergrowth, and bushes that produces oxygen and sustains wildlife. The paper industry generally considers trees to be a renewable resource, but replanted tree farms do not replace a natural forest with its critical, life sustaining characteristics. Using tree-free paper saves on greenhouse gas emissions, energy, solid waste, and the harsh chemicals used in the processing of virgin wood for paper.*

Before the 1850s paper was not manufactured from wood pulp and tree-free papers were the norm. In that time, paper was made from linen, cotton, hemp, straw, flax and animal skins. “Ragmen” would

walk the streets of cities collecting old rags from housewives for paper manufacturing. Today's tree-free papers can be made from many things including kenaf, hemp, bagasse, bamboo, cotton and grasses. By-products from agricultural crops such as straw from rice, wheat, and rye and bagasse from the sugar plant can also be used.

Efforts are being made to make tree-free paper more available to consumers through research and funding. Few socially responsible organizations sell only recycled and tree-free papers in addition to many other green office products for business and home use.

There are four different tree-free fiber sources from which paper can be made:

1. Agricultural Residues*
Examples: Sugar cane husk (also called ""bagasse"); Cereal straws – barley, oat, wheat, rice, rye... Husks and straw left in the fields after harvesting of the main crop. Integrated with soil management, this represents an enormous resource opportunity worldwide.
*TreefreePaper.com believes this to be the most environmentally beneficial source for paper fiber. Your purchase makes use of an existing waste stream and there is plenty of it. As well as providing a diversion from virgin pulp, you are helping to eliminate the greenhouse gas pollution from what would otherwise be burned in the fields!

2. Fiber Crops (also called On-Purpose Cropping)
Examples: Hemp, Kenaf, Jute and Flax. These are crops planted and harvested specifically for their fiber and require dedicated tracts of land and agricultural inputs. It could play a role in responsible eco-agriculture on a large scale, eg. rotating kenaf with corn, soybeans or wheat. There exist dedicated proponents of these methods and TreefreePaper.com will continue to support these eco-pioneers by promoting their efforts as market efficiencies develop.

One of the most promising tree-free alternatives is kenaf. Kenaf is a fast growing plant which yields more fiber per acre than a tree plantation. Kenaf also requires less energy and bleach to produce pulp, making it a more earth-friendly option for a quality paper source. Its fibers are similar to tree pulp fibers but contain less lignin, the plant's natural glue that must be removed before paper making. Industrial hemp is used internationally for a multitude of uses including textiles and paper. However, it has legal obstacles because of its relative, marijuana, an illegal drug. Cotton is used for making paper, but it has some environmental shortcomings with its high demand for water and pesticides for growth. Ideally, scraps from organic harvests and post-consumer cotton can be used to be more eco-friendly.

3. Textile and Cordage Wastes
Examples: Cotton linters after ginning for textiles, cotton and linen scraps, old rope. Already being used in specialty papers, currency, letterhead and, although good, does not represent a large opportunity for additional tree fiber diversion.

4. Wild Plants
Examples: Wild grasses, Sisal, Bamboo... These are some of the oldest and most beautiful types of paper made and are produced primarily on a small scale.

Quick Facts on Tree-Free Fibers

- *Agripulps are processed without the use of chlorine or chlorine derivatives. Bleaching without chlorine or chlorine compounds results in a much less polluting paper-making process.*
- *Agricultural fibers such as hemp and flax are the most progressive choice in fibers for use in paper pulps.*
- *Fiber yield from agricultural fiber cultivation appears to be higher than that from tree farms. The kenaf plant can quickly grow to between 12 - 18 feet in a few months. These plants provide about three-five times more fiber per harvest than southern pine trees, which can take 7-40 years before they can be harvested.*
- *Non-wood fibers from plants like hemp or kenaf make up 7% of the world's total fiber supply.*

Advantages:

- *Using agricultural residues as a fiber source for paper offers clear environmental benefits, making use of an existing waste product while displacing the need for virgin fiber.*
- *Farmers also avoid generating air pollution that results from the widespread alternative practice of burning the residues in the field.*
- *The cultivation of agricultural fibers for a wider range of industrial uses offers hope to farmers as a boost to the economy of rural areas.*
- *Plant sources used for tree-free papers grow rapidly compared to trees, and the plants do not disrupt ecosystems when harvested.*
- *These plants require less energy and chemicals to produce pulp, making it a more earth-friendly option for a quality paper source.*

D. Recycled Paper Fibers

Another source of fiber for papermaking is recovered paper collected for recycling. Recovered paper is a great source of fiber because it is readily available and easily recycled. And, recycling diverts wastepaper from landfills, saving valuable landfill space. Over 40% of the paper which is manufactured in the U. S. today is recovered for recycling by the paper industry.

But recycling will never entirely replace using trees for papermaking. One reason is that there is simply not enough recovered paper to meet the world's demand. Some paper is too contaminated to be reused. Plus, fibers can only be recycled five to seven times before they become too short and weak to be used in papermaking. In time, recycled fibers become so short that they wash out of the pulp during the recycling process.

How is Paper Recycled?

A. Sorting

Successful recycling requires clean recovered paper, so you must keep your paper free from contaminants, such as food, plastic, metal, and other trash, which make paper difficult to recycle. Contaminated paper which cannot be recycled must be composted, burned for energy, or landfilled.

Recycling centers usually ask that you sort your paper by grade, or type of paper. Your local recycling center can tell you how to sort paper for recycling in your community. To locate your nearest dealer, look in the yellow pages of your phone book under "waste paper" or "recycling."

B. Collection and Transportation

You may take your sorted paper to a local recycling center or recycling bin. Often, a paper stock dealer or recycling center will collect recovered paper from your home or office. Your local dealer can tell you the options available in your community.

At the recycling center, the collected paper is wrapped in tight bales and transported to a paper mill, where it will be recycled into new paper.

C. Storage

Paper mill workers unload the recovered paper and put it into warehouses, where it is stored until needed. The various paper grades, such as newspapers and corrugated boxes, are kept separate, because the paper mill uses different grades of recovered paper to make different types of recycled paper products.

When the paper mill is ready to use the paper, forklifts move the paper from the warehouse to large conveyors.

D. Re-pulping and Screening

The paper moves by conveyor to a big vat called a pulper, which contains water and chemicals. The pulper chops the recovered paper into small pieces. Heating the mixture breaks the paper down more quickly into tiny strands of cellulose (organic plant material) called fibers. Eventually, the old paper turns into a mushy mixture called pulp.

The pulp is forced through screens containing holes and slots of various shapes and sizes. The screens remove small contaminants such as bits of plastic and globs of glue. This process is called screening.

E. Cleaning

Mills also clean pulp by spinning it around in large cone-shaped cylinders. Heavy contaminants like staples are thrown to the outside of the cone and fall through the bottom of the cylinder. Lighter contaminants collect in the center of the cone and are removed. This process is called cleaning.

F. Deinking

Sometimes the pulp must undergo a "pulp laundering" operation called deinking (de-inking) to remove printing ink and "stickies" (sticky materials like glue residue and adhesives). Papermakers often use a combination of two deinking processes. Small particles of ink are rinsed from the pulp with water in a process called washing. Larger particles and stickies are removed with air bubbles in another process called flotation.

During flotation deinking, pulp is fed into a large vat called a flotation cell, where air and soap-like chemicals call surfactants are injected into the pulp. The surfactants cause ink and stickies to

loosen from the pulp and stick to the air bubbles as they float to the top of the mixture. The inky air bubbles create foam or froth which is removed from the top, leaving the clean pulp behind.

G. Refining, Bleaching and Color Stripping

During refining, the pulp is beaten to make the recycled fibers swell, making them ideal for papermaking. If the pulp contains any large bundles of fibers, refining separates them into individual fibers. If the recovered paper is colored, color stripping chemicals remove the dyes from the paper.

Then, if white recycled paper is being made, the pulp may need to be bleached with hydrogen peroxide, chlorine dioxide, or oxygen to make it whiter and brighter. If brown recycled paper is being made, such as that used for industrial paper towels, the pulp does not need to be bleached.

H. Papermaking

Now the clean pulp is ready to be made into paper. The recycled fiber can be used alone, or blended with new wood fiber (called virgin fiber) to give it extra strength or smoothness.

The pulp is mixed with water and chemicals to make it 99.5% water. This watery pulp mixture enters the headbox, a giant metal box at the beginning of the paper machine, and then is sprayed in a continuous wide jet onto a huge flat wire screen which is moving very quickly through the paper machine.

On the screen, water starts to drain from the pulp, and the recycled fibers quickly begin to bond together to form a watery sheet. The sheet moves rapidly through a series of felt-covered press rollers which squeeze out more water.

The sheet, which now resembles paper, passes through a series of heated metal rollers which dry the paper. If coated paper is being made, a coating mixture can be applied near the end of the process, or in a separate process after the papermaking is completed. Coating gives paper a smooth, glossy surface for printing.

Finally, the finished paper is wound into a giant roll and removed from the paper machine. One roll can be as wide as 30 feet and weigh as much as 20 tons! The roll of paper is cut into smaller rolls, or sometimes into sheets, before being shipped to a converting plant where it will be printed or made into products such as envelopes, paper bags, or boxes.

Advantages:

- *It saves more than 40% of the energy resources.*
- *It requires less water.*
- *Saves on landfill space and helps keep methane, a greenhouse gas, from escaping from landfills.*
- *Manufacturing of recycled papers requires fewer chemicals and bleaching materials as compared to the virgin paper production.*
- *Recycled paper production significantly decreases air and water pollution.*
- *Consider that chemicals used in paper manufacturing produce various types of by-products and gasses. Solid waste material is usually dumped somewhere on the land, liquid waste is generally flushed into*

streams or the sea and gasses are left in open air contributing to global warming. Recycled paper companies are comparatively more earth-friendly. They not only produce less waste but are also reducing the need to landfill or incinerate our paper waste.

- *Paper recycling helps conserve our precious, remaining forests.*
- *Recycled paper is the choice for the present and future. If we use recycled paper products it will not only save more trees but ultimately help save our planet from accelerated global warming. It is said that most of the paper mills plant a new tree to replace the harvested one, but cutting a tree down takes one hour and growing a tree can take 10 years; this is an unsustainable system and very damaging to the planet.*

Why Recycle?

Landfill and the throwaway society

Another serious problem is what to do with our waste if we don't recycle it. Already land-fill is becoming a planning no-go area, and incineration adds to the problems of atmospheric pollution. Paper left to rot still releases the carbon dioxide in its fiber into the air, so re-use is a far better option. Indeed, do we have any alternative other than to recycle? If not, then we must insist on buying products made from recycled materials whenever we can.

Advantages

Paper from waste needs only half the energy and water required to make it from wood pulp. So it reduces both carbon dioxide emissions (from the fuel) and water borne pollution at the same time.

Recycled papers benefit our environment

Paper mills require lots of energy to make paper from wood fiber. Paper fiber called cellulous must be separated from a tree's natural glue called lignin. Several energy intensive steps must be performed to finally produce a paper sheet. Hazardous chlorine is also often used to bleach the pulp. Paper mills fulfill some of their energy needs by burning coal, oil, wood scraps and also often must purchase additional energy from the local power companies. An abundance of water is also required to manufacture paper.

MORE STATISTICS

Facts on Recycling:

- *Actually post-consumer recycled paper comprises only about 10-percent of the printing and stationary market. 90-percent of these industries still use virgin paper.*
- *Forty-five percent (45%) of the world's total paper production is produced using recovered paper and board, also known as recovered fiber or paper. In the U.S., roughly 80% of America's paper mills rely on paper recycling to make some or all of their products. One hundred and forty mills use only recovered paper to manufacture new products.*
- *Recycling one ton of paper saves 17 trees, 79 gallons of oil, 7,000 gallons of water, 4000 KWH of electricity (enough to power the average U.S. home for five months), and 3.3 cubic yards of landfill space.*
- *Paper recycling prevents more than 115 million metric tons of carbon dioxide from entering the atmosphere.*
- *More paper is recovered in the U.S. than sent to landfills*
- *53.4% of all paper products are recycled (as of 2006)*
- *8,660 curbside recycling programs exist in U.S.*
- *Largest category of recycled paper goods is newspapers*
- *Approximately 60% less energy is needed to make recycled paper than producing paper from raw*

materials

- *It was difficult to find a percentage on the number of people who recycle but some sources reported that 23% of Americans **do not** recycle*
- *In 2008, the amount of paper recovered for recycling averaged 340 pounds for every person in the U.S.*
- *In 2008, a record-high 57.4 percent of the paper consumed in the U.S. was recovered for recycling.*
- *By 2012, the paper industry's goal is to recover 60 percent of all the paper Americans consume for recycling, which is approximately 60 million tons of paper.*
- *The decomposition rate of paper is 2 ½ months*

Pros	***Cons***
Approximately 60% less energy is needed to make recycled paper than producing paper from raw materials	***People should be informed on which products are recyclable and those that are not***
Recycling about half of the world's paper could save about 20 million acres of forest	***It takes 75,000 tress to produce one Sunday edition of the New York Times***
The recycling of 1 ton of paper material will save about 3 cubic meters of landfill space	
The United States EPA has found that using recycled materials in paper production causes 35% less water pollution and 74% less air pollution	***Produces a polluting by-product called sludge***
Supplies valuable raw materials to industry	
Prevents emissions of many greenhouse gases and water pollutants	
Stimulates the growth of greener technologies	

Group activity : see appendices

5. STUDENT RESPONSE

This is to replace post-tests. An informal interactive way to record/assess how much they have learned/what they think about the lesson.

6. SOURCES/ACKNOWLEDGEMENTS

http://www.tappi.org/paperu/all_about_paper/earth_answers/earthAnswers.htm
http://www.livingtreepaper.com/about_enviro.html
http://www.articlesbase.com/nature-articles/save-trees-use-paper-the-facts-483801.html
http://www.worldwatch.org/
http://treefreepaper.com/treefree101.php
http://www.handpapermaking.org/beginner/beg85.htm
http://www.paperrecycles.org/paper_environment/index.html
http://www.greenlinepaper.com//about-green-products-use-recycled-products-/info_6.html

http://ecology.com/features/paperchase/
http://www.treefarmsystem.org/cms/pages/20_5.html
http://www.articlesbase.com/business-articles/information-about-treefree-paper-879664.html
http://www.paper.org.uk/information/pages/information.html
http://www.epa.gov/epawaste/education/teens/games.htm
http://www.ecokids.ca/pub/fun_n_games/printables/activities/assets/science_nature/paper_making.pdf
http://earth911.com/paper/paper-recycling

APPENDIX A: Activity for Elementary students

"Recycling Rangers"

Objective: To help children recognize the similarities and differences among common recyclable items.
Activity description: Students play a sorting game and put different recyclables into the appropriate bin.

Materials Needed:
• Four recycling bins
• Recyclable materials listed below:

-Cardboard
-Newspapers
-Magazines
-Plastic soda bottles
-Plastic milk containers
-Glass jars of bottles
-Aluminum cans
-Steel food cans
-Other materials recycled in your community

Step 1: Set up the four bins in the classroom and label them "Paper," "Glass," "Plastic," and "Metals." Make a pile of all of the recyclable items on the floor and ask the students to gather around them in a circle.

Step 2: Explain to students that by the end of the lesson they will become "Recycling Rangers" and learn how to recycle different items. Discuss with the students how different "garbage" items can be recycled into new products. Note that it is important to separate these items into different categories before they are used to make new products.

Step 3: Ask the students to look at the different recyclable materials and discuss how they are alike and how they are different. Ask them to compare the colors, textures, and weight of the different objects. When handling the glass bottles, take great care not to accidentally break the containers. Also, note that some metal containers have sharp edges that can cause injury to the children.

Step 4: Moving through the pile one item at a time, ask the students to identify the material that each item is made from. Then, choose a student volunteer to place the item in the appropriate bin. Ask the student volunteer to also name another product that is made from that same material. If a student, for example, is holding a glass jelly jar, he or she could note that soda bottles are also made of glass.

Step 5: After the lesson is concluded, encourage students to go home that night and share what they learned with their family.

Assessment

1. Ask students to name some examples of recyclable items.

2. Have students explain why it is important to sort the different recyclable items.

3. Ask students what kinds of materials recyclable items are made from.

Creative Activity:

1. Organize the class into teams of four children and give each group a different recyclable item. Ask the students to make a new object from the recycled items such as a crayon holder or paper plane.

NOTE: Suggested to be use for K-2 students, but can be used at a higher elementary grade level

Source: http://www.teachervision.fen.com/tv/printables/EPA_Recycling-Unit.pdf

APPENDIX B: Activity for High school students

"Handmade Recycled Paper Planters"

Objective: To show students how easy it can be to make products from recycled items.
Activity description: Students will make planters from recycled paper.

Materials needed:
- Large stack of newspapers
- Scissors
- Three to five 2-gallon buckets
- Water
- Egg beaters
- Magnifying glass
- Plant seeds for each student
- Planting soil
- Paper drinking cups

Step 1: Introduce the concepts of recycling and decomposition to the class. Explain that making items from recyclables rather than virgin materials benefits the environment by saving natural resources.

Step 2: Discuss with the class how paper is made. Explain that most paper is made from only trees, while other paper is made from a combination of trees and old newspaper or used office paper (in addition, a small percentage of paper is made from other fibrous materials such as cotton, papyrus, or rags). Discuss how when recycled paper is used to make new paper, less trees need to be cut down. Help students explore the environmental implications of this.

Step 2: Have each student cut up two full pages of newspaper into ½- to 1-inch square pieces.

Step 3: Ask a few student volunteers to fill the buckets 1/3 full with paper and the remaining 2/3 with water (1 part paper to 2 parts water).

To show students how easy it can be to make products from recycled items.

Students will make planters from recycled paper.

Step 4: Let the mixture sit overnight. By the next day, the newspaper fibers will be soft and ready to pulp.

Step 5: On the second day, have students take turns pulping the fibers with the hand beater until the paper and water look like mush. Explain that the pulping process breaks down the fibers into a form that can be bonded together again to make recycled paper. Have students look at the pulp with a magnifying glass to see the loose wood fibers.

Step 6: Give each student a plastic cup-shaped container. Instruct them to mold the pulp to the inside of the cup, squeezing out as much of the water as possible. The pulp should be1/4- to 1/2-inch thick on the inside of the cup.

Step 7: Let the pulp dry completely over the next 3 days.

Step 8: After the pulp has dried, take the handmade recycled paper cup out of the drinking cup.

Step 9: Give each student a seed and instruct them to plant it in the cup using the planting soil. Keep the planters in the classroom and have the students care for the plants. Discuss how much sunlight and water their plants need.

Step 10: Send the students home with their planters when the seedlings have sprouted and are ready to be planted in the ground. Instruct the students to place the whole cup with the plant in it into the ground.

NOTE: Suggested to be used for 2-6 grade but this project may be too advanced for them.

Source: http://www.teachervision.fen.com/tv/printables/EPA_Recycling-Unit.pdf

2. Survey for Students' Response (Can be used for either high school or elementary.)

INTRODUCTION: Many items present in household waste are recyclable provided that the householder has the initiative to recycle and a convenient outlet exists for the recycled materials. It has been estimated that recycling takes only a few minutes each day. While over 50% of residential waste is recyclable, only about one percent is presently recycled in Pennsylvania.

Some communities collect recyclable materials with regular garbage collection. Some communities rely on householders to transport recyclables to a collection center. Some collection centers pay for certain recyclable materials.

Recycling helps to conserve energy and natural resources, contributes to the economy, and reduces the amount of municipal waste requiring disposal. Recycling also promotes an awareness of the finiteness of our natural resources and offers an environmentally acceptable method of municipal waste management.

PROCEDURE:

1. Engage the class in a discussion on the subject of recycling. Survey the class to determine whether any students assist in a family recycling effort, or recycle on their own. Ask for descriptions of how recycling is accomplished and what materials are recycled. Why do they recycle? Is money earned from the effort? Have any students visited a recycling center? Solicit descriptions and impressions.

2. Suggest to the class that it would be interesting to discover how others feel about recycling. A survey could be conducted which would also determine how many others in the school and community recycle.

3. Have the class brainstorm a list of questions that they might ask to others about recycling. Suggestions include:

- Do you know the meaning of the term "recycle"?

- Do you recycle? Why?

- Why don't you recycle?

- Do you think you should recycle?

- What materials do you recycle?

- How do you recycle?

- Where do you recycle?

- Do you get paid for recycled materials?

- How much time is devoted to recycling each day or week?

- Do you think you could recycle more?

Assemble the questions selected into a logical order and an easily presentable format. Allow sufficient space for answers. A single page survey form limited to ten or fewer questions is suggested.

4. Duplicate the survey form and distribute one or several forms to each student. Ask the students to interview students in other classes, or teachers, neighbors, friends, relatives, etc., completing a survey form for each interview. Allow several days or a weekend for the survey.

5. Collect the survey forms. List the questions or numbers of the questions on the chalkboard and compile the results. Develop percentages for each response.

6. Discuss the results with the class. Are certain materials recycled more frequently th
others? Why? What is the recycling participation rate? Do any recyclers recycle more
item? Do non- recyclers suggest common reasons for not recycling? Are the reasons v
do people recycle?

Source: http://www.theteachersguide.com/Recyclinglessonplans.htm

Elementary Module Lesson 1

Tree Farms

Creation

Curriculum

This module fits with the Illinois state curriculum under both the early and late elementary education. For early elementary education it fits under item 13.B.1e which states that students should demonstrate ways to reduce, reuse and recycle. For later elementary education it fits under item 13.B.2f which states students should analyze how specific personal and societal choices that humans make affect local, regional and global ecosystems. It also fits under item 13.B.2d which states that students should compare the relative effectiveness of reducing, reusing and recycling in actual situations.

Objectives

1. Students will discover where paper comes from (13.B. 1e).
2. Students will describe what a tree farm is (13. B. 2f).
3. Students will analyze how tree farms help our environment (13. B. 2d.).

Introduction

During this lesson, students will discover tree farms–the source of much of our paper. Students will better understand where paper comes from and how they can positively participate in the life cycle of paper products.

Upon completion of this lesson, students will be able to describe trees as a renewable resource, analyze the consequences of large tree farms, and explain the origin of most paper. These topics will be reemphasized through an activity in which students will plant a seed in a cup, monitoring growth over several days.

Materials per student

For Discussion:

- 1 pre/post-test (included)
- Slides (included)
- 2 Colored Pencils

For Activity:

- 1 clear plastic cup
- 1 cotton ball
- 1 seed (tree or other)

Preparation

Copy enough pre/post tests for all students. Prepare to project included slides, print them out for students, or draw them on the board. Purchase activity supplies (cups, cotton balls, seeds) and prepare them for distribution.

Lesson

(Green is notes and black is the teacher script)

Pre-test

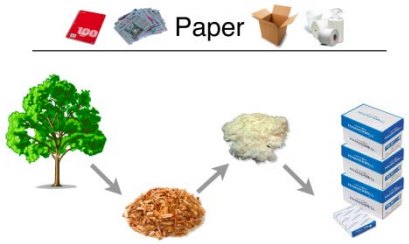
Administer pre-test. This should take no more than 10 minutes. The pre/post test should be the same test but should be conducted independently of each other so that learning can be quantified.

Discussion

*Teacher: This lesson explains the **Creation** segment of the Cycle of a tree. The growth and development of a tree enables the production of paper. Ask the class* "Can you think of things that are made out of paper?" [*As a class make a list on the board of correct responses*]

board games	Magazines	postage stamps
books	Maps	Puzzles
boxes	Menus	Receipts
calendars	Newspapers	Stickers
cards	Notebooks	Tickets

egg cartons	paper towels	Tissues
envelopes	Photographs	Wallpaper
fast-food containers	popcorn bags	wrapping paper



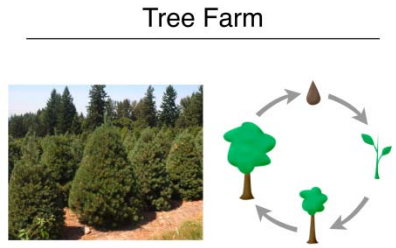
[*Show slide 1*] Paper is a very useful material that affects us every day. Most paper is made from trees. Because we can grow new trees, wood is a **renewable** resource. But it is still important to not waste paper and cause more trees to be cut down. We can **reduce** the amount of paper we use. For example we can use the internet.

We can **reuse** some paper several times. For example, we can use both sides of a sheet of paper. And we can **recycle** our paper.

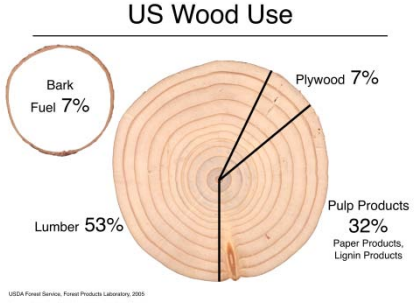
History

Until about 70 years ago most wood was taken from natural forests across the United States. Loggers–workers who cut down trees–would cut down huge forests to get tees. If they continued like this eventually we would have no more forests left–and no wood for things like building homes or making paper. Now we have laws to try to stop this. Loggers began cutting down small patches of trees, and planting new trees to replace them. They also began growing trees on tree farms. Today nearly a lot of land is used to grow trees.

Tree Farms



[*Show slide 2*] The trees used to make paper can come from a forest or a tree farm. It's important to take care of forests because they are the homes for many animals, they give off oxygen for us to breath, and they are beautiful places to visit. Instead of cutting down trees in a forest, many trees are grown on special farms. Just like how food farmers grow plants, sell them, and plant new ones for the next season, tree farmers do the same thing with trees. They begin by planting a seed. Once the seed has become a large tree, they cut it down and sell the wood. This usually takes many years; it might take a tree 15 years to grow to 20 feet tall.



[*Show slide 3*] When trees are harvested the parts can be used to create many different products. Some of the wood is cut into to make wood to build houses. There are often tiny scraps which are given to paper mills and turned into paper. Tree bark can be

used in your garden or to power paper and lumber mills. Some trees can even be used for medicine.

Some tree farms grow smaller trees that do not take as long to become full grown. These smaller trees are very good for making paper. Once the tree farmers cut down a tree, they often plant two seeds in its place. This makes sure that there will be plenty of trees in the future. In the US, an average of 5 trees per year are planted for every American. While a food farmer often has an empty field at the end of the season, tree farmers can mix new and old trees together. A tree farm can look just like a wild forest.

One medium size tree often makes about 8,000 pieces of paper. That is a lot, but we use a lot of paper, too. The average American uses 8 trees worth of paper each year. If we recycle paper, it is sent to paper mills and mixed with the fibers from trees that have been cut down. By recycling paper, we can cut down fewer trees. This means that more forests will continue to provide homes for animals, produce air for us, and remain beautiful.

Activity

Supplies:

- clear plastic cups
- cotton balls
- seeds

Planting Seeds

Trees and other plants create seeds that grow into new plants.

[*Show slide 4*] To grow, seeds need water, air, and sunlight. We will be planting our seeds in cups, instead of dirt outside, so that we can watch them begin to grow, or **sprout**. The seed has food inside to help it grow its first leaves and roots. Once its leaves have formed it will use energy from the sun to produce its own food, but it will need to be placed in dirt to get food–nutrients and minerals–from the soil.

[*Provide each student with a seed, a cotton ball, and a plastic cup. Have the students write their names on their cups. Have the students soak their cotton balls in water, place one in a clear plastic cup, and then place the seed on top of the cotton ball. Over the next few days, have students check on the seeds and draw what is happening. Repeat regularly as the seed sprouts. Once germination is complete suggest students plant the seed at home in either a pot of dirt near a window or outside.*]

Once the seed gets water the outer shell will become soft. Then a root can break through and find its way down towards water and nutrients. Then a stem will start to

grow upward, searching for light. Once it finds light, it can start to produce its own food using energy from sunlight. It continues to grow taller to get more sun, and the roots grow deeper to get more water and nutrients. Eventually it will be a full size plant just like a tree. It will make new seeds that can become new trees.

Post-test

Administer post-test, then collect.
Review information and provide answers to post-test.

To answer any questions refer to the sources:

http://www.tappi.org/paperu
http://www.treefarmsystem.org
http://www.fao.org
http://www.idahoforests.org/wood_you.htm
http://www.appalachianwood.org
http://www.seedbiology.de
http://www.abundantforests.org

Test KEY

Tree Farms

Circle the correct answer. Use a **different color** the two times you take this test.

This is the _____ time you are taking this test.

1st 2nd

Can very large trees grow from very small seeds?

Yes No

About how many years does it take for a tree to grow 20 feet tall?

1 15 100 1000

Are we cutting down more trees in the United States than we are planting?

Yes No

How many pieces of paper do you think one medium size tree can make?

80 800 8,000 80,000 800,000

About how many trees does an average American need to make all his or her paper products in 1 year?

Less than 1 tree 8 trees 80 trees 800 trees

Test

Tree Farms

Circle the correct answer. Use a **different color** the two times you take this test.

This is the _____ time you are taking this test.

1st 2nd

Can very large trees grow from very small seeds?

Yes No

About how many years does it take for a tree to grow 20 feet tall?

1 15 100 1000

Are we cutting down more trees in the United States than we are planting?

Yes No

How many pieces of paper do you think one medium size tree can make?

80 800 8,000 80,000 800,000

About how many trees does an average American need to make all his or her paper products in 1 year?

Less than 1 tree 8 trees 80 trees 800 trees

Test

Tree Farms

Circle the correct answer. Use a **different color** the two times you take this test.

This is the _____ time you are taking this test.

1st 2nd

Can very large trees grow from very small seeds?

Yes No

About how many years does it take for a tree to grow 20 feet tall?

1 15 100 1000

Are we cutting down more trees in the United States than we are planting?

Yes No

How many pieces of paper do you think one medium size tree can make?

80 800 8,000 80,000 800,000

About how many trees does an average American need to make all his or her paper products in 1 year?

Less than 1 tree 8 trees 80 trees 800 trees

Elementary Module Lesson 2

Making Paper

Usage

Curriculum

This module fits with the Illinois state curriculum under both the early and late elementary education. For early elementary education it fits under item 13.B.1e which states that students should demonstrate ways to reduce, reuse and recycle. For later elementary education it fits under item 13.B.2f which states students should analyze how specific personal and societal choices that humans make affect local, regional and global ecosystems. It also fits under item 13.B.2d which states that students should compare the relative effectiveness of reducing, reusing and recycling in actual situations.

Objectives

1. Teach students history of paper
2. Teach students how paper is made
3. Teach students how recycled paper is made
4. Have students make paper

Introduction

This lesson focuses on the materials required and the process used for making paper. Paper is a valuable resource in our society. It is used to make many products; from newspapers to refrigerator boxes. The goal of this lesson is to give students an understanding of the materials and energy used to create paper. By understanding the work needed to make paper, one can appreciate it, and ultimately be encouraged to recycle. The lesson starts with a discussion of the history of paper, followed by an explanation of the current production processes accompanied by slides which can be projected or drawn on the board. Finally there is an activity of actually making paper which reinforces the information learned in the lesson.

Materials

For Discussion:

- 1 pre-test (included) per student
- 1 post-test (included) per student
- Slides (included)

For Activity:

- Blender
- Water
- Corn Starch
- Mesh in frame
- Old news papers or other used paper
- Rolling Pin

Optional:

- Iron
- Food coloring
- Glitter

Preparation

Copy enough tests for all students. Prepare to project included slides, print them out for students, or draw them on the board. Purchase activity supplies and prepare for distribution. One or two days before this activity is to take place assign the students to bring used newspapers or other used paper products (worksheets, newspapers, cereal boxes etc.), but nothing too dense or that cannot be torn easily.

Lesson

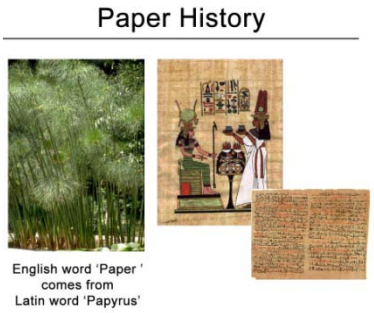
Pre-test

Administer pre-test, then collect. To reduce the use of paper, have students use two different color writing utensils for the pre-test and post-test. Color Number 1 for pre-test and color Number 2 for the post-test.

Discussion: History

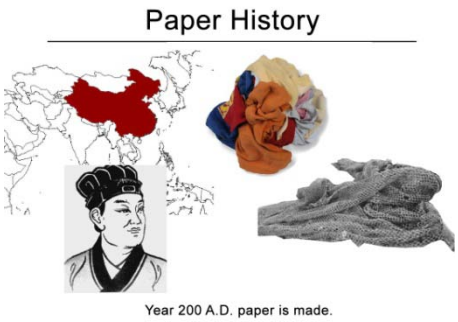
Teacher: Ask the class the questions listed below. Gather multiple answers, then show the corresponding slide and read the answer listed.

Ask the class "Where do you think the word 'paper' comes from?"



[Show slide 1] Actually the word paper comes from the Greek word for papyrus. Papyrus is a reed plant that grew in ancient Egypt. People cut it into thin strips and wove it to create a paper-like surface that they wrote on, they called this papyrus too! There is a difference between papyrus and paper. Papyrus is woven pieces of plant, paper is made of plant fibers that were suspended in water and wove together themselves.

Ask the class "when do you think paper was invented?"



[Show slide 2] Actually paper was first made in China in the year 200 A.D.! A man named Ts'ai (Cai) Lun used old fishing nets and rags to make paper. Paper may have been made before him, and like all scientists he built off of previous discoveries but he was the first to record his invention. It took a while but paper spread all over the world but they were still making it out of old rags which were hard to come by.

Ask the class "how do you think people got the idea for using wood to make paper?"

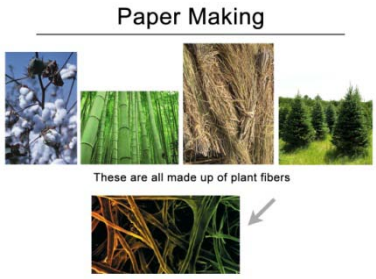
[Show slide 3] Actually the idea came from bugs! In the 1700's a man by the name of Rene de Réaumur, was thinking of new materials to make paper out of, when he saw some wasps. They were chewing up wood and spitting it out to make nests. They were making paper. Wood could be chopped up to get plant fibers needed to make paper.

Here in the US the first paper mill was built in 1690 in Germantown, Pennsylvania. It started using wood in 1860. The process of making paper has progressed in years since to meet the demand of today. Now let's learn about the processes used today.

Making Paper

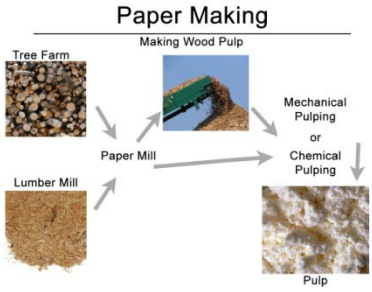
Teacher: This part of the lesson can be done in a few ways. The explanation and slides of the paper making process can be presented followed by the activity of making paper. Or the activity can be omitted and be replaced by students drawing the process in their notebooks during the following explanation and slides.

Paper is Made of Fibers



[*Show slide 4*] Paper has always been made of natural plant fibers called cellulose. Paper has been made from the fibers from plants like cotton(rags), eucalyptus, straw, bamboo and trees. [Tell students to tear a piece of paper.] Look at the little hairs sticking out from the tear. These are cellulose or fibers. Today paper is made primarily from wood fibers and recycled fibers (from recycled paper products.) We'll start by talking about the processes used to make paper from wood.

Making Wood Pulp



[*Show slide 5*] Wood fibers come from two places, from small trees harvested in tree farms or from scrap material produced when making lumber. When logs from small trees come to the paper mill they are put in the chipper. This is the first machine used. It chops and chips the logs into wood chips. Next those chips are turned into pulp. Pulp can be made in two ways: mechanically or chemically. In a mechanical pulper, the wood chips or logs and hot water are torn apart by rotating steel discs. The product is a mass of individual wood fibers.

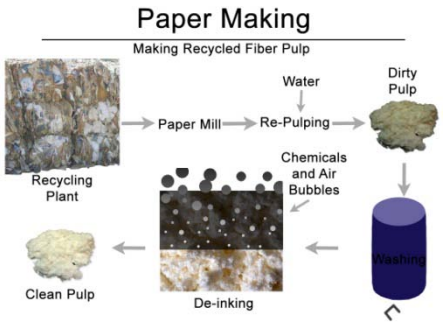
In chemical pulping wood chips are put into chemical baths under pressure. This dissolves the chips and breaks them down into individual wood fibers.

So which is better, mechanical or chemical pulping? The answer is that both have their advantages and disadvantages.

Mechanical is cheaper, but uses more energy. There is almost no fiber lost (only 10-20%) in the process but the fibers are weaker and discolor over time.

Chemical is more expensive, but can create energy. More fibers are lost (about 40 to 50%), but the fibers keep their strength and do not discolor as much.

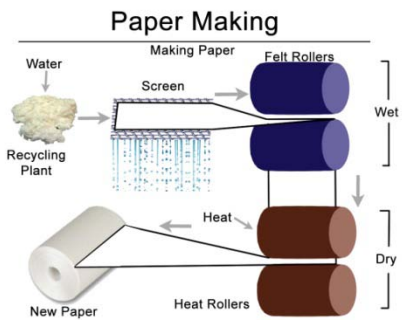
Making Recycled Fiber Pulp



[*Show slide 6*] Now let's talk about how to turn recycled paper into fibers. The recycling plant tightly bales paper and sends it to the paper mill. It is put into a re-pulper with water. The pulper tears the used paper and shreds it into fibers. Now the used paper is in the same state as the wood, they are broken down into fibers, but the used paper pulp is dirty with ink glue and staples and other contaminants. To clean it is spun around in a cylinder called a cleaner, where the heavier things in the pulp like staples fall to the bottom. Next the pulp is de-inked in a process that removes the ink. First it is rinsed to remove ink; this process is called washing. Next it is put into a vat and chemicals are mixed in. These chemicals act like soap and make the ink loosen from the fibers. Air is injected next and the ink attaches to the bubbles and floats to the top. The inky bubbles create a foam on the top, then is scooped away and the clean fibers are left on the bottom. Now the fibers are clean and can be mixed with wood fibers or can be used alone to create 100% recycled paper.

The rest of the process is the same for both recycled fibers and wood fibers. Next, the pulp goes to a machine called a refiner. Here the pulp is beaten to make the fibers swell. Any clumps of fibers break up. Here the pulp is bleached to make white paper. Now the pulp is ready to be made into paper!

Making Paper



[*Show slide 7*]A paper making machine has a wet end and a dry end. Water is added to the pulp to create a mixture of 99% water and 1% pulp; starches can also be added to make the paper stiffer. The mixture is sprayed onto a fast moving screen at the wet end of the machine.

Once the mixture hits the screen water starts to drip off. It is collected below and used again and again. As it is moved toward the dry end of the machine it is becoming paper: the fibers are bonding together, but it is very moist and weak. It is passed through big rollers covered in felt that absorb water. Now the paper is at the dry end of the machine where it is rolled between heated rollers. There can be many hot rollers

used, all which dry the paper and bond the fibers together. At the end the newly made paper is rolled (the paper can be up to 30 feet wide!) and cut, then sent off to be made into other products like books, bags and boxes.

Activity

This activity can be done individually, in small groups, as a large group or as a demonstration.

Supplies:

- Blender
- Water
- Corn Starch
- Mesh in frame (see figure 1)
- Old News Paper or other used paper (brought in by students)
- Rolling Pin
- Plastic bin (cake pan, storage container, washing bin ect.)

Optional:

- Iron
- Food coloring
- Glitter

Making Paper

Step 1: Tear used paper into small pieces. (Save two sheets for blotting paper for each sheet of paper to be made.)

Step 2: Put torn paper in blender with water (warm water works best.) There should be more water than paper in the blender.

Step 3: Blend the paper until is becomes pulpy.

Explain to students that the blender is pulping the used paper, it is playing the role of a re-pulper, it is tearing the paper and breaking down into fibers. Ask students if they can remember what other types of pulping there are. (Answer: mechanical and chemical.)

Step 4: The resulting pulp can be rinsed to simulate the washing process, part of de-inking. Rinse by draining the water in the blender and adding more, drain and add again. The pulp should be less gray.

Step 5: Starch can be added to the pulp and water mixture to make stiffer paper as well as food coloring to make colored paper. Blend again to mix and to make the fibers swell a bit.

Explain to students that this is the refining process.

Step 6: Pour the mix into the plastic bin. (glitter can be added to make sparkly paper)

Step 7: Lay one sheet of blotting paper next to the bin.

Step 8: Dip mesh into mixture. The front edge should enter the mixture first. Raise mesh evenly and let water drain through it.

Explain to students that this is the first part of the wet section of a paper making machine.

Step 9: Carefully flip the wet paper on to the blotting paper. Cover with the other sheet of blotting paper and squeeze out water with the rolling pin.

Explain to students that this is like the felt covered rollers in the wet end of the paper making machine.

Step 10 (optional): Keep the blotting paper on (or replace with a dry one) and pass the iron over it.

Explain to students that this is like heated rollers at the dry end of the paper making machine.

Step 11: Take off the top blotting paper and let the new paper dry overnight before moving or using.

During the activity while children are working or waiting for their turn, you can discuss or simply mention some of these facts:

The first paper made was made from recycled material (rags and fishing nets as described in the 'history' section.)

Post-test

Administer post-test, then collect.
Review information and provide answers to post-test.
To answer any questions refer to the sources:
http://www.tappi.org/paperu
http://www.paper.org.uk/information/
http://en.wikipedia.org

Test KEY

Paper Making

Circle the correct answer. Use a **different color** each time you take this test.

This is the _____ time you are taking this test.

1st 2nd

The first paper made was made of recycled material?

Yes No

Which is not a type of pulping used when making paper?

Mechanical Orange Chemical Re-pulping

Plants are made up of tiny strands of cellulose called fiber?

Yes No

What are the two parts of a paper making machine called?

Wet & Dry Hot & Cold Left & Right New & Recycled

A papermaking machine can produce paper at?

5mph 20mph 60mph 100mph

Test

Paper Making

Circle the correct answer. Use a **different color** each time you take this test.

This is the _____ time you are taking this test.

1st 2nd

The first paper made was made of recycled material?

Yes No

Which is not a type of pulping used when making paper?

Mechanical Orange Chemical Re-pulping

Plants are made up of tiny strands of cellulose called fiber?

Yes No

What are the two parts of a paper making machine called?

Wet & Dry Hot & Cold Left & Right New & Recycled

A papermaking machine can produce paper at?

5mph 20mph 60mph 100mph

Test

Paper Making

Circle the correct answer. Use a **different color** each time you take this test.

This is the _____ time you are taking this test.

1st 2nd

The first paper made was made of recycled material?

Yes No

Which is not a type of pulping used when making paper?

Mechanical Orange Chemical Re-pulping

Plants are made up of tiny strands of cellulose called fiber?

Yes No

What are the two parts of a paper making machine called?

Wet & Dry Hot & Cold Left & Right New & Recycled

A papermaking machine can produce paper at?

5mph 20mph 60mph 100mph

Continuous Life Cycles or End Life

Reduce, Recycle, Reuse

Curriculum

This module fits with the Illinois state curriculum under both the early and late elementary education. For early elementary education it fits under item 13.B.1e which states that students should demonstrate ways to reduce, reuse and recycle. For later elementary education it fits under item 13.B.2f which states students should analyze how specific personal and societal choices that humans make affect local, regional and global ecosystems. It also fits under item 13.B.2d which states that students should compare the relative effectiveness of reducing, reusing and recycling in actual situations.

Objectives

1. Teach students how paper is wasted 13.B.2d
2. Teach students effect of paper waste 13.B.2d
3. Teach students how to recycle paper 13.B.2d, 12.B.1e
4. Teach students benefits of recycling paper 13.B.2d

Introduction

This lesson will teach students what happens after paper is used, focusing on two directions: waste and reuse/recycling. Students should better understand what happens to paper when they are done using it and learn alternate solutions that can reduce waste. An activity will follow, involving counting notebooks as a representation of trees used in various ways.

Materials

For Discussion:

- 1 pre/post-test per student (included)
- Slides (included) – optional
- 2 colored pens or pencils (2 per student)

For Activity:

- 20 to 30 notebooks
- 1 bucket or box (large to medium size)

Preparation

Print out any necessary materials needed in the lesson. Collect notebooks to be used in the activity (the notebooks can be student's notebooks) and a bucket or box to hold the notebooks. Prepare a space to perform the activity.

Lesson

Pre-test

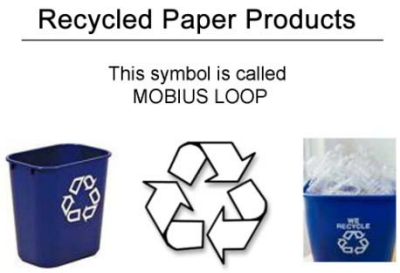
Administer pre-test, then collect. To reduce the use of paper have students use two different color writing utensils for the pre-test and post-test. Color Number 1 for pre-test and color Number 2 for the post-test. Tests should be done independently of one another.

Introduction

Paper is something that is used everyday. It is used in many ways, like in books that we read, notebooks we do homework in, and as arts and crafts materials. There are more than 5,000 products made from paper and papermaking by-products. In the U.S., most paper is made from trees.

There are two things that can happen after paper is used; paper can either be thrown away or it can be recycled and reused.

Recycling it is taking old paper and remaking it into new paper products. Paper that can be used for recycling is called **scrap paper**. There is a special bin that is used for recycling paper with a recycle symbol

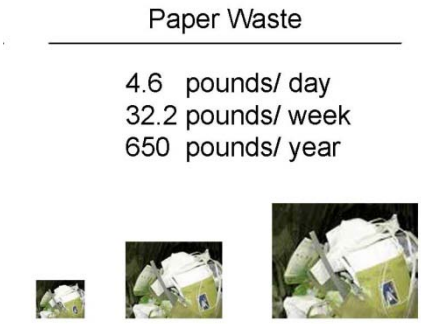


[*show slide of recycling symbol*]. The recycling symbol you see today with three arrows in the triangle shape was designed in 1970 during earth day. This symbol is called the Mobius Loop:

Recycling saves energy and nature by something we call conservation. By using things more than once, we save nature. In the case of paper, recycling saves trees and water. By recycling paper, fewer trees need to be cut down to make new paper. Whatever paper we save is the paper we do not have to make from another cut-down tree. Recycling also helps control waste disposal problems. Often, recovering paper for recycling can save communities money that they would otherwise have to spend for disposal.

Discussion

Teacher: Ask the class the questions listed below. Gather multiple answers, then show the corresponding slide and read the answer listed.



Ask the class “Do you know how many pounds of paper waste is produced in a day, a week, or a year?”

[*Show slide 1*] Every day, people produce about 4.6 pounds of paper waste. In a week, this comes out to 32.2 pounds. And in a year, the amount of paper waste produced is about 650 pounds. Think about how much you weigh.

Ask the class “Can you think of products that are made of paper that are disposed in the trash bin every day?”

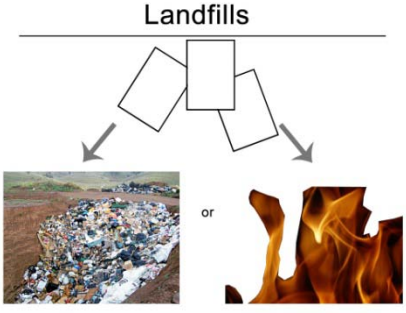
[*Show slide 2*] There are many products made of paper that turn into waste. These include:

- paper cups and plates
- napkins and towel paper
- newspaper and magazines
- coloring books
- wrapping paper
- boxes
- construction paper
- notebooks
- and many others

Ask the class "How much paper do you think can be recycled and how much do you think actually is?" only for older students

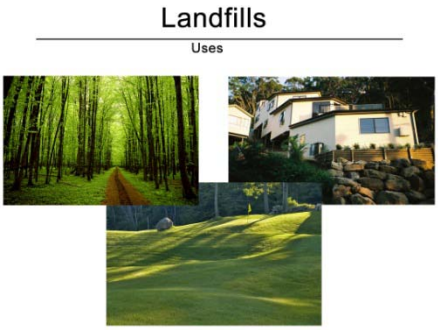
[*Show slide 3*] Most paper can be recycled but only just over half is actually recycled.

Ask the class "What happens to paper that is not recycled?"



[*Show slide 4*]The paper that is not recycled is garbage and taken to thrown out with the rest of the either a landfill, or is burned.

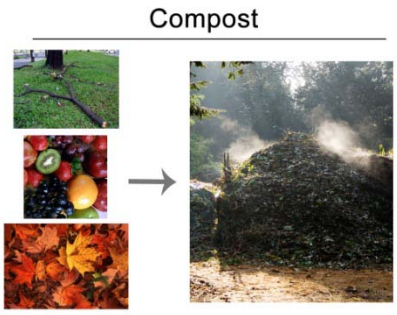
Ask the class “Do you know what a landfill is and what its uses are?”



[*Show slide 5*] A landfill is a piece of land that holds garbage that is thrown away. Usually, landfills are sealed, covered with soil, and used in various ways such as:

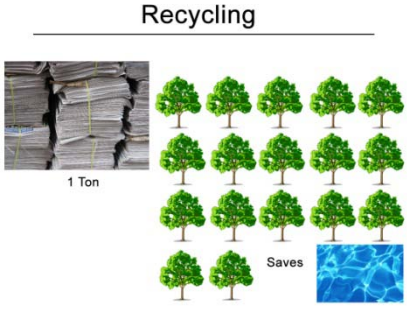
- turned into golf courses
- turned into parks
- used to make land higher
- used for new land to build houses on

Ask the class “What is a compost pile and what it is used for?”



[*Show slide 6*] A compost pile is a pile trash such as, fruit peels and vegetable scraps, usually placed outside in the grass, that allows for the material to be broken down and used for nourishing plants.

Ask the class “Do you think recycling saves trees?”



[*Show slide 7*] By recycling paper, resources such as water and trees are conserved. A ton of paper that comes from recycled paper saves up to 17 trees and uses 50 percent less water.

Ask the class “Can you name some products that are made of recycled paper?”

[*Show slide 8*] There are many products that are made from recycled paper. These things include:

- newspaper and magazines
- books
- paper cups and plates
- napkins
- towel paper
- wrapping paper
- boxes and bags
- construction paper
- notebooks
- greeting cards
- paying cards
- board games
- furniture…

Activity

Supplies:

- notebooks (20 to 30)
- bucket or box

Have the students bring their notebooks up to the front of the class

Take these notebooks and place them in the bucket.

Explain to the students that each notebook represents 1 tree that has been cut down to make paper.

For the first time around, have the students count the number of notebooks in the bucket.

Explain that the number the students counted represent the number of trees that are cut down after paper has been thrown away.

For the second time around, have the students put 1 notebook in the bucket and put 1 notebook aside.

Have the students count the number of notebooks still in the bucket.

Explain that the number of notebooks put aside is the number of trees that would be saved if every other notebook was recycled instead of thrown away.

Also explain that the notebooks in the bucket are the notebooks that would be put into landfills.

Try having the students put aside every 1 in 5, or 1 in 3 notebooks and explain that these represent the number of trees saved when every 1 in 3 or 1 in 5 notebooks have been recycled instead of thrown away.

Have the students compare the number of trees saved when every 1 in 2 notebooks, 1 in 3 notebooks, or 1 in 5 notebooks were "recycled".

Explain that recycling the notebooks keeps more trees from being cut down to make new paper.

Post-test

Administer post-test, then collect.
Review information and provide answers to post-test.
To answer any questions refer to the sources:

http://kids.niehs.nih.gov/recycle.htm

http://www.depweb.state.pa.us/justforkids/site/default.asp

http://www.eia.doe.gov/kids/energyfacts/saving/

http://www.tappi.org/paperu/all_about_paper/earth_answers/Whyrec1.htm

Test KEY

Continuous Life Cycle of Paper

Circle the correct answer. Use a **different color** the two times you take this test.
This is the _____ time you are taking this test.
1st 2nd

1. Do you use products that are made of paper every-day?
Yes No
2. Can paper be recycled?
Yes No
3. What percent of used paper can be recycled?
100% 80% 60%
4. When recycling a paper we _____.
Extend its life End its life
5. To make a book of recycled paper rather than to make a book of a new paper is:
Saving a Part of Tree from being cut down Cutting down another Tree
6. What is the logo of recycling?



7. What is a landfill?
Site for waste disposal Big lake

Test

Continuous Life Cycle of Paper

Circle the correct answer. Use a **different color** the two times you take this test.
This is the _____ time you are taking this test.
1st 2nd

1. Do you use products that are made of paper every-day?
Yes No
2. Can paper be recycled?
Yes No
3. What percent of used paper can be recycled?
100% 80% 60%
4. When recycling a paper we _____.
Extend its life End its life
5. To make a book of recycled paper rather than to make a book of a new paper is:
Saving a Part of Tree from being cut down Cutting down another Tree
6. What is the logo of recycling?



Test

Continuous Life Cycle of Paper

Circle the correct answer. Use a **different color** the two times you take this test.

This is the _____ time you are taking this test.

1st 2nd

1. Do you use products that are made of paper every-day?

Yes No

2. Can paper be recycled?

Yes No

3. What percent of used paper can be recycled?

100% 80% 60%

4. When recycling a paper we _____.

Extend its life End its life

5. To make a book of recycled paper rather than to make a book of a new paper is:

Saving a Part of Tree from being cut down Cutting down another Tree

6. What is the logo of recycling?



7. What is a landfill?

Site for waste disposal Big lake

High School Module Lesson 1

Zero Energy House

Curriculum

This module fits with the Illinois state curriculum under both the early and late high school education. For early high school education it fits under items 13.B.4b, 13.B.4c, and 13.B.4d. 13.B.4b states that the curriculum should analyze a particular occupation to identify decisions that may be influenced by a knowledge or science. 13.B.4c states that the curriculum should analyze ways that resource management and technology can be used to accommodate population trends. 13.B.4d states that the curriculum should analyze local examples of resource use, technology use, or conservation programs; document findings, and make recommendations for improvement. For later high school education the module fits under items 13.B.5b and 13.B.5c. 13.B.5b states that the provided curriculum should analyze and describe the processes and effects of scientific and technological breakthroughs. 13.B.5c states that the curriculum should design and conduct an environmental impact study, analyze findings, and justify recommendations.

Objectives

1. Students will learn about topics addressed by engineers and architects in their respective fields involving implementation of the science and technology of sustainable energy solutions (13.B.4b).

2. Students will become familiar with green technological trends and resource management practices that are compatible with our current society and environmental circumstances (13.B.4c).
3. Students will analyze current and local examples of resource use and technology use as applied within a zero energy house (13.B.4d).
4. Students will be capable of analyzing and describing processes and effects of current technology in the field of energy conservation (13.B.5b).
5. Students will understand some impacts that current house systems have on our environment and develop a more clear conception of what is currently being done and what can possibly be done in the future (13.B.5c).

Introduction to IPPRO 332

IPRO 332 is a research development program involved with educating various members of our community, specifically elementary and high school level students. The issues addressed by IPRO 332 regard our energy future in relation to topics such as sustainability, energy conservation, and recycling.
IPRO 332 has developed this module to introduce the idea of a "zero energy" house to high school students. This module delivers the facts in an unbiased fashion and educates high school students about simple actions they can take to save energy. IPRO 332 is looking to advertise to a large market of teachers, administrators, and superintendents to gain awareness of what the IPRO has accomplished and in hopes they will use it in their districts. The program was developed with the intent that teachers themselves would soon be able to include some of these issues in their classroom teachings.

Our primary concerns are about our environment, our earth, and the current condition of our energy reserve. We believe that it is important to increase awareness among our youth in order for them to behave in more responsible ways. Also, our work is intended to spark an interest among the youth and encouraging their involvement with our natural world now and in the near future.

Materials per student

For Discussion:

- 1 pre/post-test (included)
- Slides for presentation (included)

For Activity:

- Slides for game (included)

Preparation

Copy enough pre/post tests for all students. Prepare to project included slides, print them out for students, or draw them on the board.

Lesson
(Green is notes and black is the teacher script)

Pre-test

Administer pre-test. This should take no more than 10 minutes. The pre/post test should be the same test but should be conducted independently of each other so that learning can be quantified.

Discussion

Teacher: This lesson explains why a zero energy house is important to how we impact the environment locally and globally through the use of the systems within a house. The components of a zero energy house are the focus of the lesson.

The Zero Energy House Module

[*Show slide 1*] The Zero Energy House is a critical aspect in terms of our energy future. Our effort to mitigate carbon emissions and implement sustainable strategies begins at home. All houses consume energy one way or another. Houses of earlier construction typically consume more energy that newer construction because the systems over time become inefficient and often ignored. However, new buildings commonly use methods of construction that have been around for over thirty years and, until recently, rarely implement new technologies and system strategies that reduce energy consumption. Current statistics show that buildings consume approximately 39% of total energy used in the U.S. (industry: 33%, transportation: 28%) Furthermore, residential buildings consume 21% of the total energy used in the U.S., 3% more than typically larger commercial buildings. Another reason that buildings need attention today is because they are not sustainable. This means that the methods we apply to constructing our lifestyles should not be carried out in such a way that our resources may become damaged or depleted. This means that resources are used in ways that meet our current needs for energy use without jeopardizing the needs for energy use of future generations (13.B.4d).

[*Show slide 2*] The core concept of the Zero Energy House is that it balances input and output. The house consumes net zero energy and produces zero carbon emissions. The house is able to put back into the public grid what it has consumed. This requires that the house produce energy or reduce overall consumption. It also means that the house should be designed in such a way that a minimum amount of energy is used in the houses fundamental functions involving electricity, plumbing, heating, ventilation, air conditioning (MEP: mechanical, electrical, plumbing). Specific attention must be paid to how these systems may interact with each other or complement each other. Each component of the house must be designed to use as little energy as possible or produce as little waste as possible while efficiently performing its task

Components of the Module

[*Show slide 3*] The Zero Energy House can be divided into three primary components: water, electricity, and HVAC (heating/ ventilation/ air-conditioning).

- The water component of the house is comprised of all systems that use water. These systems range from sewage/ waste systems, cleaning systems, drainage systems, and irrigation systems. These systems have potential to have less of an impact on environmental and infrastructural systems, and use less water in order to reduce strain on a limited resource.
- Electricity is a critical component of the Zero Energy House. Our lifestyle depends greatly on electricity to power our everyday activities. Plants that produce our electricity also create a large amount of carbon emissions that are harmful for the environment. However, there are alternatives for producing electricity that are being put into practice today and sustainable strategies which have potential to create regenerating sources of energy.
- HVAC systems are another important component of the Zero Energy House. Large amounts of energy are used to run our heating and air conditioning systems in order to create comfortable environments within our houses. Ventilation is also important in order to keep fresh air cycling through the building to negate stagnant, unhealthy air. HVAC systems can become inefficient if they are not carefully thought out, and therefore can become a large source of energy loss.

Water [*Show slide 4*]

[*Show slide 5*] Did you know?

- Less than 1% of water on earth is usable freshwater.
- The average person uses between 50 to 300 gallons of water per day.
- 43.5 million people in the US have their own water supply (about 15% of population).
- About 80% of freshwater is taken from surface sources (lakes, rivers) while the rest is taken from groundwater.

[*Show slide 6*] Collecting Water

- Instead of being drained into sewer system, it is collected from the roofs of the home and stored for later use.
- Water can be collected in large cisterns or even small rain barrels.
- This water can be easily filtered using little electricity (enough from solar panels).
- Can be used for:
    - Watering Plants
    - Washing car
    - Used for cleaning
    - Drinking (requires UV filtration)

One of the most effective methods for water conservation is collecting water in barrels or cisterns. This kind of setup can be either installed in an existing home, or it can be planned ahead and integrated as part of an entire new home. This water is currently not intended to be used for drinking, but in future homes with more advanced filtering it may allow for such use. While the water from the sky may seem clean, it often is slightly polluted due to particles in the air and can also be slightly acidic. The best use for the average household user is to use it to water the lawn and garden.

Mention to the students that some cities (including Chicago) have ongoing programs that allow a resident to obtain a rain barrel, for free or a small cost, and be able to use it in their own home. They may want to look into it if they are interested.

[*Show slide 7*] Just how much water?

- Typical rain per year in Chicago = 36 in.
- Typical home roof area
  = 1,200 sq. ft.
- 3600 cubic ft of water / year
  = 27,000 gallons / year
- One 55 gallon rain barrel can support a 40 sq ft garden per week.

The picture on the right shows an example of how rain barrels can be connected to collect water. Note how the pipe connecting the two barrels only allows water to flow into the next barrel once the first barrel is filled. It is very useful to use water from a full barrel compared to a one only half full since the higher the water level the higher the water pressure from the hose. The last barrel also has an overflow pipe to allow the water to flow out in a controlled manner once all barrels are filled. Also note that the hose connector is almost all the way at the bottom in order to allow all the water in the barrel to be used once the valve is open. It is also important to have covers over the barrel in order to prevent mosquitoes from laying eggs in the barrel since they prefer stagnant water puddles.

[*Show slide 8*] Comparing Water Usage

	Gallons Used (regular)	Gallons Used (water saving)	Gallons Saved
Toilet flushing	5-7 per flush	1.5-3.5 per flush	3.5
Shower	7-10 per minute	2-4 per minute	6

Bath	50	30	30
Laundry Machine	60	42	18
Dishwasher	15	7.5	7.5
Dish washing by hand	30	10	20
Shaving	20	2	18
Brushing Teeth	10	2	8
Washing Hands	2	1	1

The table presented here shows the average amounts of water that are used by people for various activities around the house that involve water. You can calculate the amount of water that you use every day by just finding the actives you normally do from the table, multiplying how many times you do them per day, and then adding the total up. As you can see from the last column there are substantial savings of water by using new water friendly technologies as compared to the old style systems.

Ask the students to take a minute to write down how much water they currently use every day by using the first column, and then have them compare with others. Discuss the findings.

[*Show slide 9*] What is Low Flow?

- Fixtures that reduce the amount of water needed while performing its job.
- Faucets must use 2.75 gal/min or less
- Showers must use 2.5 gal/min or less
- Can help save up to 70 % of water normally used in everyday tasks.

Low flow is used to describe water attachments or fixtures that help reduce the amount of water being used by them. The information above is the minimum standard that allows pictures to be called low flow, but many of those fixtures sometimes only use 1.6 gal/min. This technology has already been in use for the last two decades, but recent improvements have made it easier to use such fixtures. In the past people sometimes complained that there was not enough water for properly flushing a toilet, or not enough pressure when taking a shower, so there is still apprehension in using such devises. Manufactures have taken this into account, and within the last few years have come up with new designs to help the fixtures work exactly the same, if not better, then in the initial versions of design.

[*Show slide 10*] Examples of Low Flow

Air bubbles are being introduced into the water.

This is done to help keep pressure and to remove debris while still using substantially less water.

Looking at the pictures you can see how the water coming out is not a continues stream, but instead has air pockets between them. This allows air to take up space instead of water, and thus lowering the amount of water being used for the same task. The picture at the bottom shows a toilet flushing switch. It is separated into a left and right half. By pressing the left side of the switch only half of the water is used for light needs. When the right side is pressed it allows all the water to flush for when solids may be present.

Show students the pictures of what low and aerated water looks like

[*Show slide 11*] Does it really help?... Yes!

By replacing all the fixtures in a single building the water usage dropped by 84%

For those of you who may be weary of believing whether or not Low Flow and water aerators work, here is proof that it really does. The data shown here is for a building that was retrofitted entirely for low water usage. The graph in dark blue shows the monthly costs for water before the retrofit, and the graph in green shows the monthly costs after the retrofit. The table below shows a total average of water usage by the building before and after. This was done on a medium to large sized building, so the water usage savings would be less for a regular home. But the percentage saving would be relatively the same as in this example.

[*Show slide 12*] Water Heaters

- Electric
    - Electric water heater does not store water in a tank, so heat does not dissipate into the air.
    - Produces hot water on demand in a matter of seconds.
    - Its small size means it can be mounted in many areas, even inside the washroom.

[*Show slide 13*]

- Active solar heater
    - Uses panels mounted on the roof which look very similar to electric-solar panels.
    - Water is run constantly in a loop starting on the roof mounted panel and going into the storage tank in the home.

[*Show slide 14*]

- Passive solar heater (“Black Barrel”)
    - Dark colored barrel mounted on roof absorbs the suns energy to heat the water.
    - Excess heated water stored in storage tank in home.

A major problem with conventional water heaters is that much of the heated water is able to slowly escape into the room where the water heater is stored. This is very similar how a hot cup of coffee will eventually cool down to room temperature when left to sit in a room for a period of time. This means that conventional water heaters need to constantly keep adding energy into the water in order to keep the water warm, even when it is not being used.

When most people think of using the suns energy the first think that pops into there mind is electrical solar panels. It is important to remember that the sun also is able to heat up things through the radiant heat it generates. Your house not only needs to heat the room you are in, but also needs to heat the water when taking a shower. Both the passive and active water heaters take advantage of the suns heating ability and use it to heat water. They are both mounted on the roof of the home so that they are able to absorb as much direct heat as possible. Even though this still allows the water to cool down eventually when not in use, the constant heat generated from the sun easily replenishes that.

An eclectic "tankless" water heater has the benefit of not having to store a large amount of water, but instead heats it up on demand. This means there is no stored energy in the water that will eventually cause heat loss, meaning all the energy that is put into the water to heat it stays in the water the whole time.

Ask students if they see any potential problems that might arise with the passive and active water heaters. The problem is that if there is no sunlight the water cannot be heated. Explain that this kind of system would need to have some kind of secondary source of heat, such as a "tankless" water heater or a backup conventional water heater.

Different Water Heaters-

Show students the pictured diagrams of how the water heaters are set up, and mention again what each one is called.

[*Show slide 15*] What can you do today?

- Install Low Flow attachments and aerators
- Set up rain barrels
- Fill toilet reservoir up with bricks to use less water per flush.
- Wash laundry in full loads
- Check your home water meter to find leaks

Much of what was talked about up to this point is applicable for rather large projects that would most likely be used in new home constructions or an extensive remodeling. But here are a few things that you can start doing when you get home today. Low flow attachments are very inexpensive (ranging somewhere from $1-$10 for each attachment), and can be installed within a matter of minutes. You can get them at any

home improvement store with installation instructions already on the box. These attachments often pay back there cost of purchase in water savings within a month or two. If you have an old style toilet (older then 5 years) then you can place a brick or a soda bottle filled with water into the reservoir tank to help save water on each flush. Older toilets were designed with much more water usage due to the fact that no one really thought that water usage was worth considering. Most toilets can easily handle any kind of flushing needs with much less water. And if it doesn't work, you can easily remove it. If you want to see if there are any water leaks in your home you can go to the water meter located in or around your house and check to see is it is running. Make sure you have all the faucets turned of and that the washing machines are not being used when this is done. If you find the water meter moving this most likely means that water is slowly leaking and you should find where it is leaking and have it fixed.

Ask students if they know any other ways to conserve water in their home, or what they may already be doing at their home.

[*Show slide 16*] Managing Waste

[*Show slide 17*] Where does it come from?

- Water waste comes from simply flushing the water down the drain, taking with it dirt, debris, and sometimes chemicals.

- Solid waste comes mostly leftover food and packaging.

[*Show slide 18*] Where does it go?

- Water waste goes to the water treatment plant to be cleaned and then goes back to the lakes.

- Solid waste goes to the landfill where it is left to sit or made into artificial land.

[*Show slide 19*] How to eliminate waste

- Separate garbage into different bins for proper reuse (recycling).
- Reuse containers from products (glass bottles, plastic bags)
- Have multiple garbage bins for different products. For example:
    - Organic material (such as left over food)
    - Recycling material (paper, glass, plastic)
    - General waste (plastic wrap, metals)

Eliminating waste is both easy and tricky at the same time. Almost every activity we do produces waste, whether it is wrapping paper debris from a gift or leftover food scraps from dinner. The most effective way to eliminate waste is to prevent it in the first place. By making smart purchases, such as buying products that come with little to no unnecessary packaging, you prevent the need for excessive material that will be thrown in the trash anyway in a matter of minutes. Another important thing to keep in mind is to come up with new and different ideas on how to use products or its packaging for different purposes after it is already used, such as for compost or containers. Recycling doesn't only mean that you throw your plastic and paper in the blue trash containers with the logo on it, but you can also recycle it for different uses around the home.

Ask students to come up with other ways to reuse old materials in new ways, such as glass bottles or plastic milk containers.

[*Show slide 20*] Greywater and Blackwater

- This is dirty water that comes out of washing machines, sinks, showers...
- This water can be filtered and reused around the house and garden

- Comes from toilets and other organic contamination sources.
- Can not be reused for human contact.
- Can be used to work in machines or other equipment such as for cooling or toilet flushing.

Greywater recycling is still its infancy form today, but is just one of the many new technologies that may become commonplace in the future. Almost all of the water that we use around the house eventually gets drained into the sewer system, other then for drinking the water or watering the lawn. Most of the water that is drained is actually wasted clean water that gets contamined when it comes in contact with the dirty water. Think about how much water is wasted when taking a shower since a significant portion of the water doesnt even touch your body but instead just goes straigth into a drain. Greaywater recycling collects all of the water that goes into the drain, filters the water, and then uses the water for additional purposes. For now it is only used for situations such as waterina lawn, but in the future techonlgoy may be good enough for filtering the water to good as new quality and reusing it around the home. The difference with Blackwater is that it is much more concentrated with contaminates and very unsafe to reuses. This water, after filtering, may be reused again in machinery but should not come in contact with humans. This water recycilng system uses the same idea of reuse just as the NASA space shuttle is able to reuses much of the water during its trips.

[*Show slide 21*] Greywater System Setup

Show students picture of greywater system setup.

First the water is collected from its initial use, such as showers or the laundry. It then goes into a septic tank which allows larger particles to settle to the bottom while the water and smaller particles continue down the filtration process. The water then goes through a finer filtration process, such as a sand or carbon filter, where the smaller particles are able to be filtered out. The water is then pumped to its intended location for use. The water is then fed to plants of the lawn, while the excess water goes into the ground.

[*Show slide 22*] Filtration Technology

- Chemical- most widely used today, mainly chlorine.
- Ozone- Uses gas produced from UV rays
- Reverse Osmosis- High pressure forces water through a "one way" filter.
- Carbon filter- Porous grains that have a large surface area which traps the contaminates.
- Naturally filtering the water in multiple steps, and letting the sediments sink to the ground and the rest absorbed by plants and organisms.

In order to be able to properly use this new technology of recycling water and waste it is essential that we have a way to filter out bacteria and contaminates. All of these filtration technologies are already being used today, but it is important to know what are the pros and cons of using each type. Chemical filtration cost the least and is very effective at killing bacteria, but too much of this chemical can lead severe poisoning or damage the body. Ozone and Reveres Osmosis are also very effective at filtering, but are expensive to install and use, so they are often only found in laboratory's or large scale filtering facilities. Carbon filters are also very good filters but can not kill bacteria, and require frequent filter changes. If the filter is not changed in time it will do more harm then good, and will contaminate the water further from the dirt already caught in the filter. The natural filtration process is often used for water that is being partially cleaned before being released back into a river or lake. It needs little maintenance and can run itself continually once it is set up. This type of filtration has no current use for homes, but it is being further looked into to be integrated into future home designs.

[*Show slide 23*] Throw your trash in here!

Accepts most food scraps, just throw it in like a trash can.
- Can produce up to 120 lbs of compost per month.
- Takes 2 weeks to turn from food waste to compost.
    - Compost comes out ready to be used for plants, flowers, lawn, ...
    - Uses only 5kwh / month (that's about 50 cents a month)

There are many companies that are coming up with new technology for recycling your old waste. One such invention is a compost machine shown here. It works by throwing

in your left over food scraps into the top just as you would a garbage bin. It then automatically mixes the scraps while also increasing temperature to help break down the food quicker. There is also a carbon filter which prevents any smelly odors from escaping the bin. It only takes a few weeks for the food to transfer from old banana peals into dark nutrition rich compost soil.

Electricity

[*Show slide 24*] Electricity for the home

Another key component of a zero energy home is creating clean electricity and using it wisely.

[*Show slide 25*] Electricity on the Environment

Ask students if they know why excess carbon dioxide in the atmosphere is harmful to the planet.
Possible answer: global warming.

Follow up by asking students if they know why carbon dioxide in the atmosphere is a new problem and 30 years ago it was not.
Possible answer: humans are emitting carbon dioxide into the atmosphere at a faster rate than plants and oceans can absorb it.

[*Show slide 26*] Electricity in a zero energy home

A zero energy home is self sustainable home, and has the ability to create enough electricity to run everyday household items. Even thought the zero energy home does not need the typical electricity a normal receives from a power company, they are still connected to the main power. The idea of zero energy is an idealistic concept that in the home it is not possible. Ideally if the world could function without consuming energy, the earth would not be in the state it is.

[*Show slide 27*] Zero Energy Advantages

Reliability:

Possible question: What is a scenario that it would be better to have your own energy than rely on the city's power?

Possible answer :Blackout, Storm, Down Power Lines

Sustainability:

With every kilowatt hour that is created by clean energy is one less pound of coal burned.

Price Security:

Electric prices are relatively stable, but if there were ever to be a dramatic increase, the zero energy house is unaffected.

[*Show slide 28*] Household Consumption

It is true that having an alternative energy source is a key role in creating the ideal zero energy home, but what's more effective and more economical is choosing the right appliances/lighting sources that cut down on energy consumption

Ask students what appliance uses the most electricity yearly than all other appliances. The answer to this question is the refrigerator.

[*Show slide 29*] Yearly Household Consumption

The typical average household consumes around 10,000 kWh of electricity per year. The pie chart below shows the approximate break down.

[*Show slide 30*] The Light Bulb

Incandescent light bulbs run current run through a wire filament and heats the filament until it starts to glow.

In a CFL, an electric current is driven through a tube containing argon and a small amount of mercury vapor.

A CFL takes more electricity to start, but in the end a CFL uses 75 percent less energy than incandescent bulbs

[*Show slide 31*] The Difference it Makes

Question: what are some of the notable differences between the two lightbulbs?
Answer: Bulb lifetime, overall cost in the end, kilowatt usage.

Big Picture: Less coal burned over the 13 year period of the CFL than that of the Incandescent Bulb

[*Show slide 32*] Household Appliances

Question: Where can the label be seen?
Possible answers:

- *Dishwashers*
- *Clothes Washers*
- *Refrigerators*
- *Room AC*
- *Home Audio*
- *Televisions*
- *Computers*
- *Printers*
- *Lightbulbs*

[*Show slide 33*] Energy Star

In 1992 the US Environmental Protection Agency (EPA) introduced ENERGY STAR. ENERGY STAR label is now on major appliances, office equipment, lighting, home electronics and can now be applied to buildings. An Energy star building is the idea of a zero energy facility. Buildings such as Hospitals, Hotels, and Schools can earn the Energy Star Rating. ENERGY STAR has successfully delivered energy and cost savings across the country. This has saved businesses, organizations, and consumers about $19 billion in 2008 alone.

The table is taken off of two refrigerators that are currently being sold in local stores

The standard Refrigerator:

The Energy Star rate Refrigerator:

[*Show slide 34*] The Dangers of Standby Mode

Possible Question: What are some electronics that have standby modes?
Possible Answers:

- *Video Games*
- *Televisions*
- *Computers*
- *DVD*

Standby mode electronics typically have an LED light that changes to a different color than that of when the electronic is in use, and tells you that the product is still plugged

into a power source. The LED light needs an electrical current to emit this light, even though the light does not use that much electricity it is still wasted electricity. With several products in standby, the amount of wasted electricity adds up. This is something a zero energy home cannot overcome by itself, it takes the owners to be aware of these products and their actions to prevent wasted energy use.

[*Show slide 35*] Alternative Energy Solutions

Ask students if they know some possible energy solutions for a household
Possible Answers:

Solar Energy
Wind Energy
Bio Fuels

[*Show slide 36*] Solar Energy

Solar cells can last a lifetime and require very little maintenance. One of the most crucial parts of a solar panel is the angle.

Question: What is the best angle for a solar panel for Chicago: an angle around 30˚ or 40˚?
Answer: They are both right depending on what time of season it is.

During the summer months, it's ideal to have solar panels closer to being horizontal to absorb all of the suns direct rays, the angle during the summer months should be around 27 degrees. In the winter months, it's necessary to increase the angle to absorb the sun's rays that are not as direct. The angle is then increased to 42.

[*Show slide 37*] Double Duty Panels

Solar panels can be installed on the sides of buildings as awnings to keep rooms cool. In some cases the solar awnings can be efficient enough where the home does not need to run the air conditioning unit as often.

[*Show slide 38*] Wind Energy

The wind turbine is most ideal for a rural home than that of an urban home. For a home wind turbine system that could create enough power to a household has a blade diameter of 20 to 25 feet and need to sit on tower 100 feet tall.

[*Show slide 39*] New Technology Used Today

Occupancy sensor lighting comes in two forms ultrasonic and infrared. Ultrasonic sensors detect sound. Infrared sensors detect heat and motion. The motion of washing dishes can turn on an infrared sensor.

Ask students if they can think of a place where ultrasonic sensors would be ideal. Possible answers include any large rooms such as a living room.

Smart meters can track how much electricity a consumer uses and when it is used. The meters send power usage information directly to power companies via the Internet. The smart meter allows a consumer to see more information than ever about their daily electricity consumption and can help find areas that can be improved upon

[*Show slide 40*] The idea of creating zero energy homes is something that could be done around the world if money wasn't a factor.

The cost of a small turbine is approximately: $25,000 - $35,000

The cost for solar panel system for a home: $20,000.

These rough estimates are to have a home run solely on alternative energy, there are small and more economical solutions that still help cut down the use of fossil fuels

[*Show slide 41*] Return On Investment (ROI)

The return on investment is an equation that can be used to determine how long it will take for a product to save enough money that is equal to that of the initial cost

[*Show slide 42*] What can you do right now?

- Turning off the lights when leaving the room. It's a simple solution that can help the environment
- Plug electronics that go into standby mode into a power strip. When they are not in use turn the power strip off, these prevents the waste of electricity
- Energy Star products are the leaders in energy efficiency, and lower the amount of used electricity
- Cell phone chargers left in the socket when not charging a cell phone also drain power like that of a standby mode electronic

HVAC (Heating/ Ventilation/ Air-Conditioning)

[*Show slide 43*] What makes a zero energy home when it comes to heating, ventilation, and air-conditioning:

-Well insulated home
-Taking advantage of natural resources
-Efficient appliances
-Efficient lighting practices
-Efficient heating and cooling

There are many ways to create a zero energy home by reducing the level of energy used in the house. A well insulated house is significantly important to reduce the amount of heat losses. We can also use natural resources such as wind, solar, and rain to generate electricity in order to create heating and cooling within a space.

[*Show slide 44*] Interesting facts:

-4% savings on A/C energy use for every 1 degree increase
-10% of energy consumption can be used through standby power
-70% of energy use is by refrigerator and heating and cooling unit

[*Show slide 45*] There are many methods of heating and cooling available for houses that can reduce energy use:

-Geothermal
-Chilled Beams
-Heat Sink

These are a few energy efficient methods that can be used to supplement HVAC or reduce the load on the system (the amount of work the system has to do). The lower corner picture shows an example of heat sink, the top picture is the example of the chilled-beam method.

[*Show slide 46*] Geothermal:

Power extracted from heat stored in the earth

☐ Cold water is pumped into the Earth Crust, then heated up and raised to the surface. The steam is captured to drive an electric generator.

[*Show slide 47*] A geothermal power plant can be built based on simple fact: pulling the heat from the earth. The cold water is bumped into the earth's center. Due to high temperature of the earth center, the water is heated up. Heated water is pulled back to the surface. The steam from the heated water can be used to drive an electric generator. There are 3 common methods to convert the steam into energy:

-Dry Steam
-Flash Steam
-Binary System

The simplest way is Dry Steam, where steam goes directly through the turbine, then into a condenser where the steam is converted into water. The second method is Flash Steam; very hot water is depressurized or "flashed" into steam, which can then be used to drive the turbine. In the third approach, the binary system, the hot water is passed through a heat exchanger, where it heats a second liquid—such as isobutene—in a closed loop. The isobutene boils at a lower temperature than water, so it is more easily converted into steam to run the turbine. The steam and water are carried around the house to through the heat exchanger.

[*Show slide 48*] Why Geothermal?

☐ A geothermal heat pump can produce up to $5.00 worth of heat for every $1.00 on your electric bill. Also, it is a healthy solution for the environment by reducing the CO_2 emissions. According to the U.S. Environmental Protection Agency, geothermal system saved about 30-70% heating cost and 20-50 % cooling cost opposed to the conventional heating and cooling system. It also requires less maintenance and lasts for decades. Geothermal systems also produce less CO_2 emission than other heating resources such as natural gas and coal. The graph shows how much emission of CO_2 the eco-friendly geothermal system creates compared to emissions from natural gas, oil, and coal.

[*Show slide 49*] Chilled Beams

Chilled beams use water in order to heat or cool a space. It is located in the space between the ceiling and the floor above it within a building. The main advantage of chilled beams is that they reduce the amount of fans and energy used in a building to control interior air conditions.

☐ There are three types of chilled beams:

1) Chilled Ceiling

Chilled ceiling is an alternative to conventional VAV (variable air volume) systems which control air flow within an HVAC system. This cooling device separates ventilation and dehumidification. It is made of copper tubing and bonded to aluminum fins. It requires chilled water or heated water for cooling and heating. Chilled beam are used as the radiator, with recirculation of water. The air rises to the ceiling, is heated or cooled, then falls back to the floor. It can also connect to a central air unit in order to help provide more efficient heating and cooling. The chilled ceiling is the old model of the chilled beam that does not include the ability to control the humidity of the room, so it must be paired with a ventilation system.

[*Show slide 50*] 2) Passive Chilled Beam:

–No primary air required
–Silent cooling
–Perimeter and make up cooling
–Bundle multiple coils to boost capacity

[*Show slide 51*] 3) Active Chilled Beam

–Two and four pipe beams available
–Typical 1:3 to 1:5 airflow ratio
–Temperature regulation accomplished by the change in water flow and induction rate
–Control via Zone or per beam

[*Show slide 52*] Thermal Mass

☐ Other names include heat capacity and thermal capacitance.

Thermal Mass helps to delay heat from the sunlight and releases it during the night.

Post-test

Administer post-test, then collect.
Review information and provide answers to post-test.

To answer any questions refer to the sources:

http://www.wateruseitwisely.com/

http://www.harvesth2o.com/zerowater.shtml

Net-Zero water usage
http://www.100khouse.com/2009/08/27/net-zero-water/

http://www.greenbuilder.com/

http://www.bae.ncsu.edu/programs/extension/publicat/wqwm/he419.html

http://www.ecoearth.info/

http://www.greywater.com/

epa guidelines for water reuse

http://epa.gov/nrmrl/pubs/625r04108/625r04108chap1.pdf
aerator attachments

http://www.eartheasy.com/live_lowflow_aerators.htm

greywater/blackwater

http://www.oasisdesign.net/greywater/misinfo/index.htm

water usage data

http://ga.water.usgs.gov/edu/wateruse2000.html

GE zero E home info

http://www.genewscenter.com/content/detail.aspx?releaseid=7272&newsareaid=2

General zero e info

http://www.absoluteastronomy.com/topics/Zero_energy_building

water heater recycling

http://www.ecoinnovation.ca/en/residential-solutions/how-the-eco-gfx-works.html

epa water information

http://www.epa.gov/OW/

tips on reducing waste

http://www.thisland.illinois.edu/57ways/57ways_27.html

http://www.recyclingfactsguide.com/water/water-recycling/

actual zero-E home

http://www.zeroenergyhomedallas.com/features.html

http://www.h2ouse.org/tour/rain-harvesting.cfm#7

http://www.sustainablecolorado.org/center/tour_water_efficiency.php#photo

http://ga.water.usgs.gov/edu/earthwherewater.html

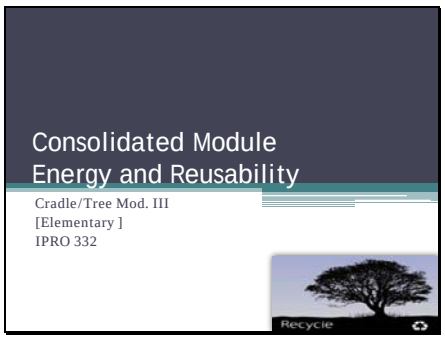
http://www.fs.fed.us/r5/publications/water_resources/html/water_use_facts.html

http://www.zerowasteamerica.org/Statistics.htm

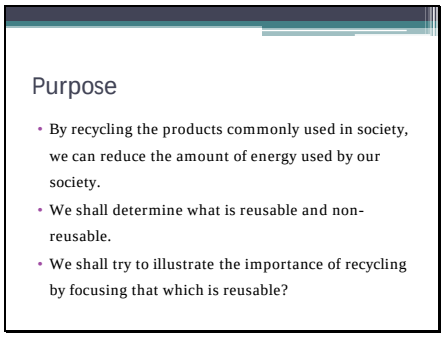
4. Appendix 4: Slides Not Included in Teaching Kits

Slides for overarching theme.

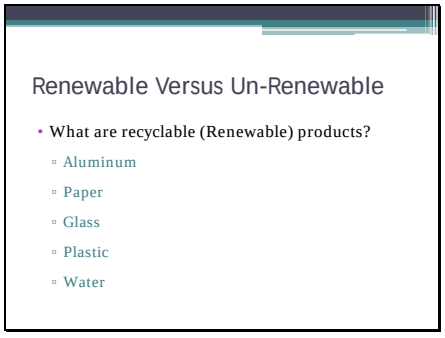
Slide 1



Slide 2



Slide 3



Slide 4

Renewable Versus Un-Renewable

- What are not recyclable (Un-Renewable) products?
  - Food
  - Disposable diapers
  - Clothes
  - Mirrors

Slide 5

Raw Materials

- What are some raw materials?
  - Ore (Steel or Iron)
  - Coal
  - Timber (Wood)
  - Oil
  - Etc.

Slide 6

Energy Used to Create a Product

- Imagine a glass bottle of Mr. Pure Juice (Fruit Punch for instance).
- How is the glass bottle created?
  - To create new glass, substances such as sand must be heated to 2,600° Fahrenheit, which consumes energy and creates pollution from factories.

Slide 7

Energy Production

- Where does heat needed to create glass come from?
- Raw Materials such as:
  - Coal
  - Petroleum
  - Natural Gas

Slide 8

Waste Produced

- How many pounds of paper would you think is wasted within a year?
  - Every day, people produce about 4.6 pounds of paper waste. In a week, this comes out to 32.2 pounds. And in a year, the amount of paper waste produced is about 650 pounds.

Slide 9

Why Recycle?

- By recycling we can:
  - Reduce the amount of raw material need to create products.
  - Reduce the amount of energy needed to create products.
  - Reduce the amount of waste produced.

Slide 10

What are some steps towards Recycling?

- Try to deposit used renewable products into their respective recycling bins for proper collection.
- [Point out notes on various locations that can offer more information on recycling]

Slide 11

The Continuous Life Cycles

Slide 12

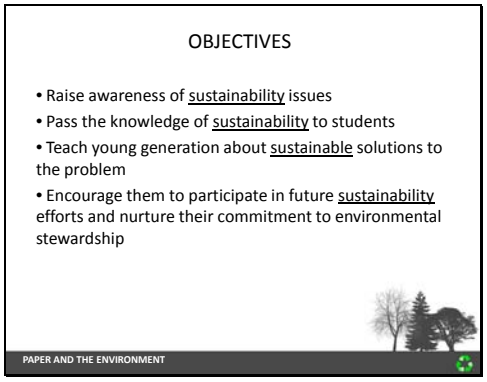
Conclusion

- Recycling saves energy and natural resources through conservation.
- By using materials more than once we conserve natural resources.
- Recycling also helps control waste disposal problems.

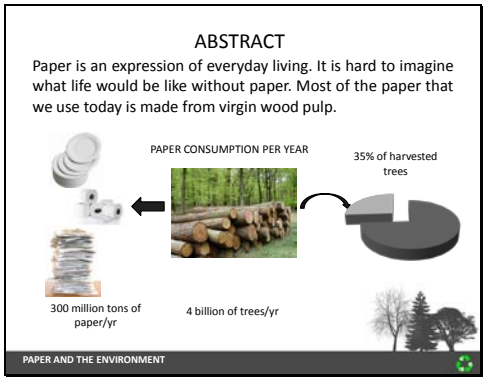
New Elementary School Version for Tree Farming Module

Slide 1

Slide 2



Slide 3



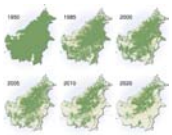
Slide 4

PROBLEM

• Planetary deforestation

Growing a tree: 10 years

Cutting a tree: 1 hour



Deforestation rate over 70 years

•Pulp and paper account for approximately 40% of deforestation worldwide.

•World consumption of paper has grown 400% in the last 40 years

PAPER AND THE ENVIRONMENT

Slide 5

PROBLEM

• Planetary deforestation (diagram)

PAPER AND THE ENVIRONMENT

Slide 6

PROBLEM

• Pollution released from paper mills

The processing of virgin wood paper uses harsh chemicals. It also wastes more energy and generates greenhouse gas emissions. Solid waste material is usually dumped on the land, liquid waste is generally flushed into streams or the sea and gases are left in open air contributing to global warming.

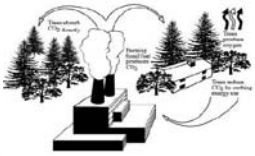
PAPER AND THE ENVIRONMENT

Slide 7

FACTS

Why are trees important?

- They provide precious habitat for animals
- They help control erosion by holding soil in place
- Trees remove carbon dioxide from the air while adding valuable oxygen to our atmosphere.
- The leaves they drop in autumn decompose into new soil that's rich in nutrients.
- Trees determine rainfall and replenish the atmosphere
- Trees cool and regulate the earth's climate, prevent global warming

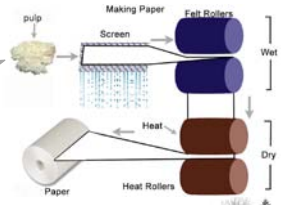


PAPER AND THE ENVIRONMENT

Slide 8

FACTS

How to make paper out of wood?



PAPER AND THE ENVIRONMENT

Slide 9

SOLUTIONS

alternatives that we can do

PAPER AND THE ENVIRONMENT

Slide 10

A. REDUCE/CONSERVE

- **Use both sides of the paper.** It's called "duplex printing"
- **Go digital.** Save on postage by sending electronic files
- **Be selective: print what you need when you need it.**
- **Reach for the right paper.** Use paper with recycled content.




Slide 11

B. TREE FARMING

- Wood is a renewable resource, we can grow new trees on a tree farm by planting seeds.
- Much of the wood used by paper companies in the U.S. comes from privately owned tree farms where forests are planted, groomed and thinned for harvest in 20 to 35 year cycles.
- Today, an average of 5 trees/year are planted for every American.


Slide 12

C. TREE-FREE FIBERS

4 Tree-Free Fiber Sources

- **Agricultural Residues**


Bagasse (Sugarcane)

Straw

- **Textile and Cordage Wastes**
  - Cotton linters after ginning for textiles, cotton and linen scraps, old rope


Cotton linters

These plants require less energy and chemicals to produce pulps, making it a more earth-friendly option.

Slide 13

C. TREE-FREE FIBERS

- **Wild Plants -** Wild grasses, Sisal, Bamboo

Sisal

Bamboo

- **Fiber Crops** -
The most promising is kenaf. Kenaf is a fast growing plant which yields more fiber per acre than a tree plantation

Hemp

Kenaf

Plant sources used for tree-free papers grow rapidly compared to trees

PAPER AND THE ENVIRONMENT

Slide 14

D. RECYCLED PAPER FIBERS

How is paper recycled?

1. **Sorting :** Sort your paper by grade, or type of paper

2. Collection and Transportation
Sorted paper is taken to a recycling center, then transported to a paper mill.

PAPER AND THE ENVIRONMENT

Slide 15

D. RECYCLED PAPER FIBERS

How is paper recycled?

3. Storage

When the paper mill is ready to use the paper, forklifts move the paper from the warehouse to large conveyors.

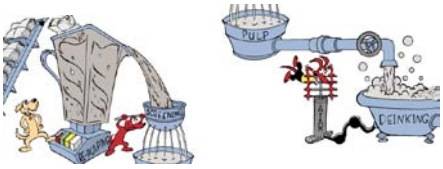
PAPER AND THE ENVIRONMENT

Slide 16

D. RECYCLED PAPER FIBERS

How is paper recycled?

What's next?



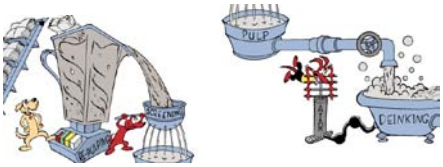
What do you think they're doing?

PAPER AND THE ENVIRONMENT

Slide 17

D. RECYCLED PAPER FIBERS

How is paper recycled?



4. Re-Pulping and Screening
The paper moves by conveyor to a big vat called a pulper

5. Cleaning
Mills also clean pulp by spinning it around in cylinders.

PAPER AND THE ENVIRONMENT

Slide 18

D. RECYCLED PAPER FIBERS

How is paper recycled?

What's next?

What do you think they're doing?

PAPER AND THE ENVIRONMENT

Slide 19

D. RECYCLED PAPER FIBERS

How is paper recycled?

6. Deinking

The pulp must undergo a "pulp laundering" to remove printing ink and "stickies"

7. Refining, Bleaching and Color Stripping

Slide 20

D. RECYCLED PAPER FIBERS

How is paper recycled?

Last steps?

8. Papermaking – Wet End

9. Papermaking – Dry End

Slide 21

CONCLUSION

These more earth-friendly options (Reduce, Recycle, Tree-free fibers and Tree farming) help the environment by:

- Conserving our natural resources, our precious forests – or even growing more by tree farming
- Energy conservation – saving on landfills space, keeping down the pollution generated by mills and incineration
- Keeping ecosystems in balance
- If we use recycled paper products it will not only save more trees but ultimately help save our planet from accelerated global warming.

Slides for HVAC Portion of Zero Energy House

Slide 1

Slide 2

Slide 3

Slide 4

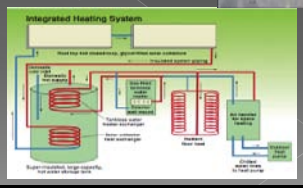
Central Air

- Furnace: a heating device.
- Air conditioner: cooling device
- Heat Pump

Slide 5

HVAC

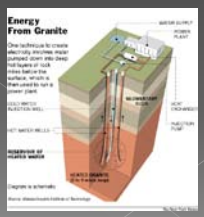
- Many methods of heating and cooling:
  - Geothermal
  - Chilledbeams
  - Solar heating



Slide 6

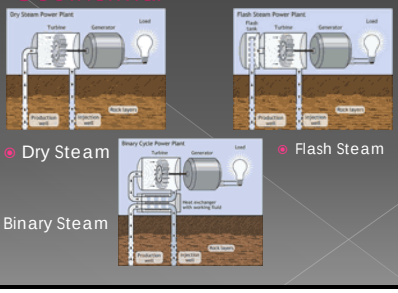
GeoThermal

- Power extracted from heat stored in the earth
- Cold water is bumped into the Earth Crust, then heated up and risen to the surface. The steam are captured to drive electric generator



Slide 7

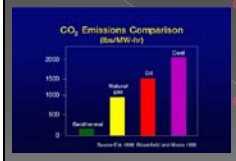
Geothermal



- Dry Steam
- Flash Steam
- Binary Steam

Slide 8

Why Geothermal?

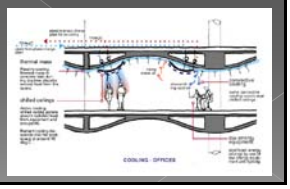


- Geothermal heat pump can produce up to $5 worth of heat for $1 on your electric bills
- Saving the world as the same time by reducing the CO2 emissions.

Slide 9

Chilledbeams

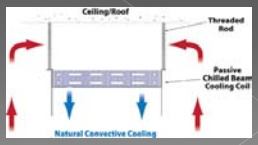
- Using water for heating or cooling space
- Placed in the ceiling
- Reduced the amount of fans and energy used.
- 3 types of chilledbeams
  - Chilled Ceiling



Slide 10

Chilled Beam

- Passive Chilled Beam:
  - Second generation
  - Increased the heating and cooling capacity

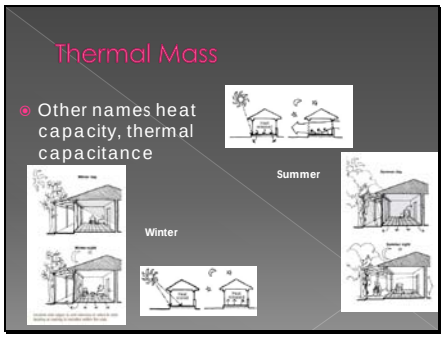


Slide 11

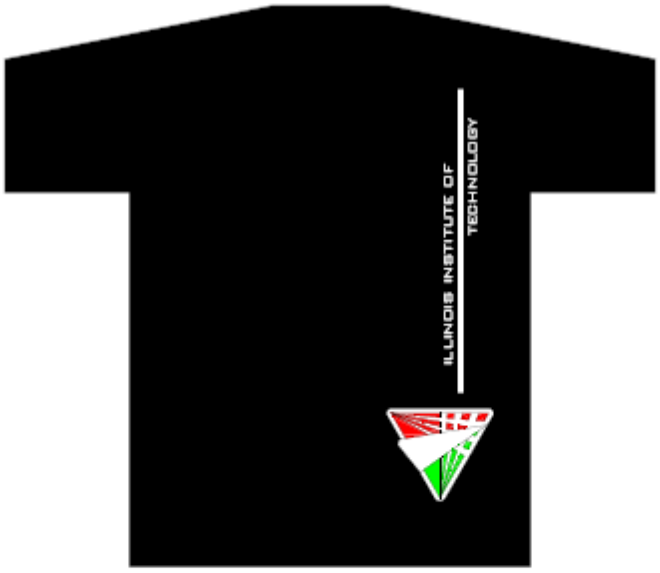
Chilled Beam

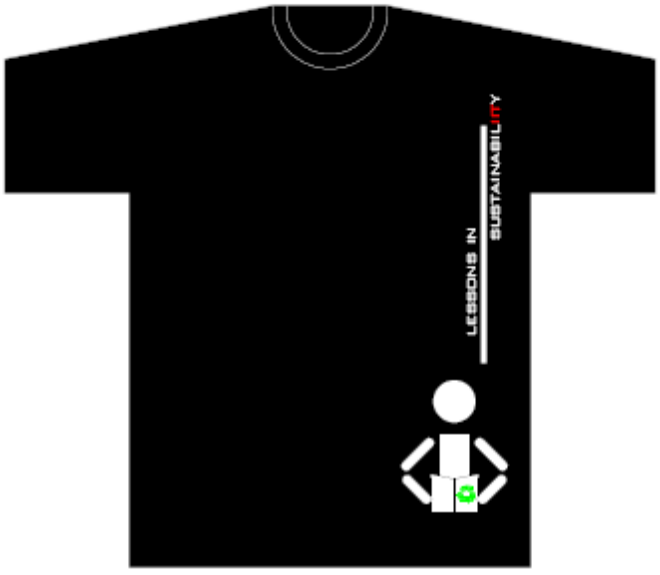
- Active Chilled Beam
  - Third generation
  - Two and four pipe beams available
  - Temperature regulation accomplished by the change in water flow and induction rate

Slide 12


Thermal Mass
Other names heat capacity, thermal capacitance
Summer
Winter

5. Appendix 5: T-Shirt Design





6. Appendix 6: Bibliography

NOTE: At the time of preparation this was the knowledge at hand. The document preparer inserted the references to the best of his knowledge.

Ludwig, Art. "Common Grey Water Errors and Preferred Practices." *OasisDesign*. 2009. Web. 6 Dec 2009. <http://www.oasisdesign.net/greywater/misinfo/index.htm>.

Lumia, Deborah, Kristin Linsey, and Nancy Barber. "Water Science for Schools." *U.S. Geological Survey*. 13 05 2009. USGS, Web. 6 Dec 2009. <http://ga.water.usgs.gov/edu/wateruse2000.html>.

Freeman, Kim. "GE Targets Net Zero Energy Homes by 2015 ." *GE Press Releases*. 14 07 2009. GE, Web. 6 Dec 2009. <http://www.genewscenter.com/content/detail.aspx?releaseid=7272&newsareaid=2>.

"How Does the ThermoDrain Work?" *EcoInnovation*. 2009. Web. 6 Dec 2009. <http://www.ecoinnovation.ca/en/residential-solutions/how-the-eco-gfx-works.html>.

"EPA Water News." *U.S. Environmental Protection Agency Office of Water*. 23 06 2009. U.S. EPA, Web. 6 Dec 2009. <http://www.epa.gov/OW/>.

"27. Reduce Household Waste." *57 Ways to Protect your Home Environment (and Yourself)*. 2009. University of Illinois Extension College of Agricultural, Consumer, and Environmental Sciences, Web. 6 Dec 2009. <http://www.thisland.illinois.edu/57ways/57ways_27.html>.

"Water Recycling: Making Use of Rainwater." *Everything You Always Wanted to Know about Recycling*. 2009. Recycling Facts Guide, Web. 6 Dec 2009. <http://www.recyclingfactsguide.com/water/water-recycling/>.

"Zero Energy Home Dallas." *AndersonSargent*. 2009. Web. 6 Dec 2009. <http://www.zeroenergyhomedallas.com/features.html>.

"Rain Harvesting & Greywater Irrigation." *H2Ouse*. 2009. California Urban Water Conservation Council, Web. 6 Dec 2009. <http://www.h2ouse.org/tour/rain-harvesting.cfm#7>.

"Building Tour: Water Efficiency." *Alliance for Sustainable Colorado*. 2009. Alliance for Sustainable Colorado, Web. 6 Dec 2009. <http://www.sustainablecolorado.org/center/tour_water_efficiency.php#photo>.

"Facts about Water ." *Water Use Facts*. USDA Forest Service, Southwest Region, Web. 6 Dec 2009.<http://www.fs.fed.us/r5/publications/water_resources/html/water_use_facts.html>.

"WASTE & RECYCLING: DATA, MAPS, & GRAPHS." *Zero Waste America*. Web. 6 Dec 2009. <http://www.zerowasteamerica.org/Statistics.htm>.

"Reduce, Reuse, and Recycle." *NIEHS Kids' Pages*. 08 10 2008. National Institute of Environmental Health Sciences, Web. 6 Dec 2009. <http://kids.niehs.nih.gov/recycle.htm>.

"Using & Saving Energy." *Energy Kids*. Energy Information Administration, Web. 6 Dec 2009. <http://tonto.eia.doe.gov/kids/energy.cfm?page=3>.

Earth911. Finding Recycling Centers and Learn how to Recycle. 11 2009 <http://www.earth911.org>.

Module, IPRO 332 Prior. Cradle to Cradle. Chicago: Illinois Institute of Technology / Spring 2009 team, 2009.

—. Tree Farming Module III. Chicago: Illinois Institute of Technology / Spring 2009 team, 2009.

Recycle Arizona. Recycling Plastic, Glass, and Paper. 10 2009 <http://www.recyclearizona.net/recyclingmaterials.html>.

6. EcoEarth.Info. Environment Portal & Search Engine. Empowering the Environmental Sustainability Movement. 1999-2009. Ecological Internet. http://www.ecoearth.info/

7. Lindstrom, Carl. “GREYWATER what it is . . . how to treat it . . . how to use it.” 2000. http://www.greywater.com/

8. US EPA, Office of Research and Development. US EPA Guidelines for Water Reuse. http://epa.gov/nrmrl/pubs/625r04108/625r04108chap1.pdf

9. Low Flow Aerators. Eartheasy. 2000 - 2009. http://www.eartheasy.com/live_lowflow_aerators.htm

10. Ludwig, Art. "Common Grey Water Errors and Preferred Practices
An ongoing effort to counter the tidal wave of grey water misinformation on the web." Oasis Design. 1997 - 2009. http://www.oasisdesign.net/greywater/misinfo/index.htm

"About Green Products: Use Recycled Products!" *Recycled Paper Product, Environmental Paper, Recycled Envelopes*. GreenLine Paper Company, Inc. Web. 07 Dec. 2009. <http://www.greenlinepaper.com/about-green-products-use-recycled-products-/info_6.html>.

"About Tree Farming:What is Tree Farming?" *American Tree Farm System*. American Forest Foundation, 2004. Web. 07 Dec. 2009. <http://www.treefarmsystem.org/cms/pages/20_5.html>.

Martin, Sam. "Natural Resources and Sustainability: Paper Chase." *The Ecology Global Network | Ecology News and Information for Residents of Planet Earth*. Ecology Global Networ, 2008. Web. 07 Dec. 2009. <http://ecology.com/features/paperchase/>.

"Paper & the Environment." *Paperrecycles.org - Paper Industry Association Council*. Paper Industry Association Council. Web. 07 Dec. 2009. <http://www.paperrecycles.org/paper_environment/index.html>.

"Sustainable Papermaking Practices." *Hand Papermaking Home Page*. Hand Papermaking, Inc., 2009. Web. 07 Dec. 2009. <http://www.handpapermaking.org/beginner/beg85.htm>.

Hand Papermaking Inc. Hand Papermaking. 1 January 2009. 20 November 2009 <http://www.handpapermaking.org/beginner/beg85.htm>.
Omari, Patrick. Article Base. 14 July 2008. 20 Novermber 2009 <http://www.articlesbase.com/nature-articles/save-trees-use-paper-the-facts-483801.html>.
Paper Industry Association Council. PaperRecycles. 1 January 2009. 20 November 2009 <http://www.paperrecycles.org/paper_environment/index.html>.
TreeFreePaper. Tree Free Paper. 1 January 2006. 20 November 2009 <http://treefreepaper.com/treefree101.php>.
Worldwatch Institute. Worldwatch Institute: Vision for a Sustainable World. 9 May 2008. 20 November 2009 <http://www.worldwatch.org/>

"Living Tree Paper | Paper & Environment." Living Tree Paper | About Us. Web. 07 Dec. 2009. <http://www.livingtreepaper.com/about_enviro.html>.

Park & Co., "Water Use It Wisely". Park & Co.. 12/06/09 <http://www.wateruseitwisely.com/#_blank>.

2. Pushard, Doug. "A Benchmark for Zero Water Use in Commercial Building: Melbourne's 60L". HarvestH2O. 12/06/09 <http://www.harvesth2o.com/zerowater.shtml#_blank>.

3. Ludeman, Chad. "Net Zero Water". PostGreen. 12/06/09 <http://www.100khouse.com/2009/08/27/net-zero-water/#_blank>.

4. Christensen, Bill. "Sustainable Sources". Sustainable Sources. 12/06/09 <http://www.greenbuilder.com/#_blank>.

5. Herman, Glenda M.. "Water Quality & Waste Management". North Carolina Cooperative Extension Service. 12/06/09 <http://www.bae.ncsu.edu/programs/extension/publicat/wqwm/he419.html#_blank>.

Worldwatch Institute | Vision for a Sustainable World. Web. 07 Dec. 2009. <http://www.worldwatch.org/>.

TAPPI. Earth Answers - Why Recycle? 11 2009

<http://www.tappi.org/paperu/all_about_paper/earth_answers/Whyrec1.htm>.

General zero e info

http://www.absoluteastronomy.com/topics/Zero_energy_building wikipedia

http://www.depweb.state.pa.us/justforkids/site/default.asp does not exist

http://www.paper.org.uk/information/ does not exist
http://www.treefarmsystem.org
"American Tree Farm System." *Tree Farm System*. 2009. Web. 6 Dec 2009. <http://www.treefarmsystem.org/>.
http://www.fao.org
"FAO Home." *Food and Agriculture Organization of the United Nations*. 2009. FAO, Web. 7 Dec 2009. <http://www.fao.org/>.
http://www.idahoforests.org/wood_you.htm
"Wood You Believe We Get So Much From Trees?." *Idaho Forest Products Commission*. 2009. Web. 7 Dec 2009. <http://www.idahoforests.org/wood_you.htm>.
http://www.appalachianwood.org
Appalachian Hardwood Manufacturers, Inc.. 2009. Web. 7 Dec 2009. <http://www.appalachianwood.org/>.
http://www.seedbiology.de
Leubner, Gerhard. *The Seed Biology Place*. 05 12 2009. University Freiburg, Web. 7 Dec 2009. <http://www.seedbiology.de/>.
http://www.abundantforests.org
Abundant Forests. Abundant Forests Alliance, Web. 7 Dec 2009. <http://www.abundantforests.org/>.
http://www.theteachersguide.com/Recyclinglessonplans.htm

"Recycling." *The Teacher's Guide*. Web. 7 Dec 2009. <http://www.theteachersguide.com/Recyclinglessonplans.htm>.

http://www.teachervision.fen.com/tv/printables/EPA_Recycling-Unit.pdf
"TeacherVision." *Recycling Unit: Environment Activities for the Classroom*. Web. 7 Dec 2009. <http://www.teachervision.fen.com/recycling/printable/63734.html>.
http://www.paper.org.uk/information/pages/information.html
"Information." *Confederation of Paper Industries*. Web. 7 Dec 2009. <http://www.paper.org.uk/information/pages/information.html>.
http://www.epa.gov/epawaste/education/teens/games.htm
"Games: Your Environment. Your Choice." EPA, Web. 7 Dec 2009. <http://www.epa.gov/epawaste/education/teens/games.htm>.
http://www.ecokids.ca/pub/fun_n_games/printables/activities/assets/science_nature/paper_making.pdf
"Save Trees by Making Your Own Recycled Paper." *Ecokids Club*. Web. 7 Dec 2009. <http://www.ecokids.ca/pub/fun_n_games/printables/activities/assets/science_nature/paper_making pdf>.
http://www.willyoujoinus.com/takeAction/energyGenerator/
"Energy Generator." *Will You Join Us*. 2009. Web. 7 Dec 2009. <http://www.willyoujoinus.com/takeAction/energyGenerator/>.

http://42explore.com/recycle.htm

Lamb, Annette, and Larry Johnson. "The Topic: Recycle-Reduce-Reuse." 2002. Web. 7 Dec 2009. <http://42explore.com/recycle.htm>.