**Lesson Plan Title:** “Energy Efficient” light bulbs

<table>
<thead>
<tr>
<th>Teacher Name: Becky Burke</th>
<th>School: Lewis Cass Jr-Sr High School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject: Business Math</td>
<td>Grade Level: 10-11</td>
</tr>
</tbody>
</table>

**Problem statement, Standards, Data and Technology**

**Asking questions and defining problems**
Establish driving question for the lesson plan or define problem students will be solving.

Attach any documents used to establish the driving question or define the problem.

How do we know if we are being energy efficient with our lighting?

**Incorporating Next Generation Science Standards, Common Core, or State Standards**
State the standards that will be covered during this lesson plan. Include all standards which may apply (NGSS, Common Core, or State Standards).


  Domain – Math Concepts
  Core Standard 3 Students analyze and interpret data using common probability and statistical procedures to solve problems for a variety of business situations.
  Standards BMH-3.1 Construct, read, and interpret tables, charts, and graphs

  Domain – Accounting Principles
  Core Standard 4 Students apply math concepts to analyze and solve problems related to accounting principles for business.
  BMH-4.3 Calculate cost of goods sold, gross profit, operating expenses, and net profit

**Obtaining and evaluating information**
How will students be obtaining and/or collecting the information?

- Students will be asked to obtain information from internet sources with detailed information on lightbulbs.
  - Suggest that they use [www.menards.com](http://www.menards.com), [www.lowes.com](http://www.lowes.com), or another local store website for light bulb specifications.
  - This information will be used for calculations of Kilowatt-hours, efficiency, yearly cost, and coal equivalency.
We will use a Kill A Meter to determine how much power the light bulbs use and other devices that the students will be bringing in to check.

Students will research the internet for ideas on how to conserve energy in their homes and here at school.

Guest speaker from local energy company, Miami-Cass County REMC to speak on ways to conserve energy. [http://www.mcremc.coop](http://www.mcremc.coop)

Other information will be obtained from students evaluating their own homes and our school and for ways to conserve energy.

**Analyzing and interpreting data**

How will students be analyzing and interpreting the collected data?

They will use the information on light bulb specifications they gathered from the internet to make calculations based on if the light bulb were on for a full year. They will determine the efficiency, kilowatt-hours used, the yearly cost, and how much coal was needed to produce the electricity.

They will then create a graph to visually illustrate the comparisons. They are free to create a graph of their choosing that shows areas that concern them the most.

They will answer story problems relating to the calculations they performed.

They will make recommendations to conserve energy for their homes and the school.

**Use of technology and software**

Indicate the type of technology and software students will be using in order to implement this lesson plan.

A kill a watt power meter will be used to read the wattage on the different types of light bulbs on display. I will ask the students to bring in chargers or other devices that they want to check the power usage on.

They will use the internet to research the light bulb specifications and ideas of ways to conserve.

**Collaboration, critical thinking and communication**
| **Collaboration** | Students will work in groups of three to find information on light bulbs.  
They will work collectively on a group discussion on two questions –  
What would cause you to be more concerned about saving energy?  
Why do you think people do not choose the most energy efficient product, such as people still purchasing incandescent light bulbs? |
|---|---|
| **Critical Thinking** | They will research specifications on light bulbs and work out one year operating calculations. They will graph the results to visibly display what they have learned. Then they will take that information and use it to answer some story problems, relating to which light bulb will save the most energy and which will cost the least to operate. Also some scenarios with a number of fixtures in the house and how much could be saved by replacing incandescent with energy efficient choices.  
They will also be asked to make energy saving suggestions for their home and for our school at the completion of this lesson. |
| **Communication** | On the first day of the lesson, the students will turn in their home energy checklists and discuss why this is important to them. Homework will be to answer the following questions on an online collaborative discussion board.  
*What would cause you to be more concerned about saving energy?*  
*Why do you think people do not choose the most energy efficient product, such as people still purchasing incandescent light bulbs?*  
On the second day, students will continue to work together during the class period. Their homework will be to complete their chart on different types of light bulbs, their graphs, and the story problems. This will be due at the beginning of class on the third day.  
On the third day, after hearing the REMC representative talk, the students will look around their own homes and give recommendations on how they can make their own home and our school more energy efficient. The suggestions will be consolidated and given to the principle. |

**References**
<table>
<thead>
<tr>
<th>Teacher’s References</th>
<th>Student’s References</th>
<th>Assessment Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Include all references used to develop and implement this lesson plan.</td>
<td>Include all references students will need to complete this lesson plan.</td>
<td>The ultimate assessment for this lesson is for students to be able to give recommendation for conserving energy in their homes. Students will both share this information with classmates and the principal. Most of these assessments are subjective as students are free to select different light bulbs and will be graded as “effort”. The calculations must be correct. The following are the formal assessments: The Home Energy Checklist Discussion Board Questions Light Bulb comparison chart Story Problems Graph Recommendations for Energy Conservation</td>
</tr>
<tr>
<td>Student’s References</td>
<td>Assessment Plan</td>
<td></td>
</tr>
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<td></td>
</tr>
</tbody>
</table>
## Resources and Costs

<table>
<thead>
<tr>
<th>Resources Needed</th>
<th>Computer</th>
<th>Display with five types of light bulbs: Incandescent, LED, Halogen, HID, and Fluorescent.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Projector</td>
<td>Light Bulb Comparison worksheet</td>
</tr>
<tr>
<td></td>
<td>Internet</td>
<td>Story Problem Worksheet</td>
</tr>
</tbody>
</table>

### Resources

List all the resources needed (equipment, facilities, materials or any other resources).

- **Computer**
  - Computer Display with five types of light bulbs: Incandescent, LED, Halogen, HID, and Fluorescent.
- **Projector**
- **Internet**

### Costs

List the estimated cost of implementing this lesson plan.

Include all costs related to equipment, materials and any resource critical to the implementation of the lesson plan.

- **Plastic Trouble Light** $5.97 x 5 = $29.85

- **Kill A Watt EZ Meter** $28.97
  - [http://www.homedepot.com/p/P3-International-Kill-A-Watt-EZ-Meter-P4460/202196388?cm_mmc=Shopping%7cTHD%7cG%7c0%7cG-BASE-PLA-D27E-Electrical%7c&gclid=CJzBnZWEve0CFOEdaQodPykFZQ&gclsrc=aw.ds](http://www.homedepot.com/p/P3-International-Kill-A-Watt-EZ-Meter-P4460/202196388?cm_mmc=Shopping%7cTHD%7cG%7c0%7cG-BASE-PLA-D27E-Electrical%7c&gclid=CJzBnZWEve0CFOEdaQodPykFZQ&gclsrc=aw.ds)

- **Westinghouse 100W A19 Incandescent** 2.39

- **Feit 72 Watt Clear Energy Saving Halogen Neodymium A-Shape Bulb Medium Base Light Bulb (2-Pack)** $3.84

- **Polaroid 100-Watt Equivalent 5000K Dimmable LED Light Bulb** $8.97

- **Sylvania 35-Watt E17 HID Light Bulb** $15.89
## Implementation Plan

### Implementation Plan Timeline

Establish the timeline to implement the lesson plan.

Provide an estimate of time and days in order to complete the lesson plan.

<table>
<thead>
<tr>
<th>This is a three day lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>On the first day,</strong> the students will learn how they can save energy with different lighting choices.</td>
</tr>
<tr>
<td><strong>On the second day,</strong> the students will continue to research the light bulbs, charts, and graphs.</td>
</tr>
<tr>
<td><strong>On the third day,</strong> the students hear a guest speaker from a local energy company.</td>
</tr>
</tbody>
</table>

### About one week prior to lesson


- Make sure students know when it is due and give reminders often.
Day 1 – Light Bulbs

Before Class

- Set up light bulb display
  - Hang “Do Not Touch” signs
  - Screw a different type of light bulb into each trouble light holder
  - Hang or display in an area that heat will not affect
  - Turn on before students enter the room to allow time to heat up

Introduction

- We hear every day that we need to conserve energy, but how do we do it?
- Today, we are going to focus on just one way to conserve energy through our lightbulbs. Tomorrow, we will learn about more ways to save energy and money.
- How do you know that your “energy efficient” lightbulb is really saving energy? If it is saving energy, is it also saving you money?

Household Energy Usage

- Note that Lighting accounts for 11% of the electric usage in an average home

Why are we picking on light bulbs when it is only 11% why not appliances?

From Alliance to Save Energy website - https://www.ase.org/resources/lesson-plan-which-light-bulb-really-cheaper-6-9

WHY ENERGY EFFICIENCY

Why wait? Our energy future can be decided NOW. Development and implementation of energy-efficient products, technologies, and services:

- saves consumers and businesses money,
- drives innovation and productivity,
supports a cleaner environment, and
- reduces dependence on imported oil.

Importantly, it does so without sacrifice - energy efficiency enables us to do more while using less energy.

The last line sums it up – we can do it without any sacrifice

Electric Bill
- Show slide of electric bill
  ![Electric Bill Image]
- Have students calculate how much is 11% of this bill ($28.16)
- Have students find how much energy was used (1836 KWH)
- Have students find what is the units are used to measure electric usage (KWH – Kilowatt-hours)
- Have students find how much was charged for energy usage ($229.65)
- Have students calculate how much each Kilowatt-hour costs ($0.125 per Kilowatt-hour)

Light bulb Display
- Caution student not to touch the light bulbs
- Have students hold hands over the light bulbs to feel the heat lost for certain types
- Explain to the students that power is conserved. When a light bulb produces both light and heat, the heat is wasted energy.
- Ask them to guess which light bulb is the most efficient based on heat and which is the least efficient.
- Use the Kill a Meter to determine the best and the worst bulbs for efficiency.
- Offer to students to bring in chargers or other devices that they would like to check with the Kill a Meter.

Light bulb comparisons
- Have students get on their computers and go to [www.menards.com](http://www.menards.com)
- In the Search box, have students type in light bulb
• This will bring them to a page that shows different types of light bulbs

• Ask them to click on the incandescent light bulbs

• Then click on the Sylvania 75 Watt A19 5000K LED Light Bulb (last one on top row) and scroll down to the “Specifications”
• Notice that the Light bulb is listed as a 75 Watt light bulb and in the specifications at the bottom of the first row it lists the “Wattage Equivalency” as 75 Watts. On the second line under specifications is a category for “Total Wattage”, which is 12 Watts. This is the actual amount of power this light bulb draws.

• Have the students to notice the “Light Output”

• Explain lumens - a measure of the total quantity of visible light emitted by a source or simply “brightness”

• Watch Video on Lumens - https://www.consumer.ftc.gov/articles/0164-shopping-light-bulbs

• Look at wattage – lumen chart on same webpage https://www.consumer.ftc.gov/articles/0164-shopping-light-bulbs
- Have students notice “Average Bulb Life”
- How many entire 24 hour days could you leave this light bulb on?

Worksheet – “Cost Comparison of Different Types of Light Bulbs”
- Pass out Worksheet

<table>
<thead>
<tr>
<th>Equivalent</th>
<th>Type of Light bulb</th>
<th>Actual Lumen</th>
<th>Luminous Life in Hours</th>
<th>Cost per Bulb</th>
<th>Kilowatts used per Hour</th>
<th>Cost for operating 1 year</th>
<th>Total cost of 1 year</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>CF 25 CF 25</td>
<td>190</td>
<td>2500</td>
<td>$0.125</td>
<td>0.025</td>
<td>$27.40</td>
<td>$27.40</td>
</tr>
<tr>
<td>40</td>
<td>CF 40 CF 40</td>
<td>400</td>
<td>6000</td>
<td>$0.250</td>
<td>0.060</td>
<td>$160</td>
<td>$160</td>
</tr>
<tr>
<td>75</td>
<td>CF 75 CF 75</td>
<td>750</td>
<td>8000</td>
<td>$0.375</td>
<td>0.112</td>
<td>$336</td>
<td>$336</td>
</tr>
<tr>
<td>100</td>
<td>CF 100 CF 100</td>
<td>1000</td>
<td>10000</td>
<td>$0.500</td>
<td>0.166</td>
<td>$600</td>
<td>$600</td>
</tr>
</tbody>
</table>

- Ask students if they remember how much each Kilowatt-hour of electricity cost.
- Fill in bottom line with answer ($0.125 per Kilowatt-hour)
- Remind students how to convert watts to kilowatts by dividing by 1000
- Make sure students know that not all types of light bulbs are available in all wattages or lumens.
- May need to divide package price to get individual light bulb price
- Try to use the same style of light bulb for comparisons, ie regular, dimmable, or 3-way
- Work through two or three of the different types of light bulbs with the students to get them started
  - We can calculate the efficiency of a light bulb by calculating the lumens divided by the watts. 190 lumens / 25 watts = 7.5 lumens per watt
  - The next calculation is how many Kilowatt-hours would you need to keep the light bulb turned on for a full year. First convert the watts to kilowatts by dividing by 1000, then multiply by the number of hours in a year. (25/1000)*8766 = 219.15 kwh
  - Then we calculate the amount of coal it would take to produce 219.15 kwh. Electricity generated by coal is 2,460 kwh/ton 1.23 kwh/pound so divide 219.15 kwh by 1.23 kwh/pound to get 178.17 pounds of coal
    http://science.howstuffworks.com/environmental/energy/question481.htm
  - Now we are going to calculate how much the 219.15 kwh of electricity will cost us. Multiply 219.15 kwh by the cost per kwh from the energy company $0.125, which will cost $27.40 per year.
The yearly cost of the physical light bulb is found by taking the number of hours in a year. \(365.25\) day in a year * \(24\) hours in a day = \(8766\) hours in a year. If our light bulb is good for approximately \(2500\) hours then we take \(8766\) hours per year and divide by \(2500\) hours, so we will need \(3.5064\) light bulbs per year. Multiply \(3.5064\) by the cost of \($0.57\). The yearly cost of the physical light bulb is \($2.00\).

The total yearly cost of this light bulb is calculated by adding the yearly physical cost and the yearly kwh cost. \($27.40 + $2.00 = $29.40\).

Group Work

- Have students work on worksheet in groups of three to finish filling out the chart and complete the calculations.
- Then they will make a graph to visually show the comparison between different types of light bulbs. The students can make the graph anyway they want. They need to make it convincing to use more energy efficient light bulbs. The graphs will be displayed on the walls.
- Finally answer some story problems based on their findings.
- They probably will not finish this the first day and will continue the second day.
- For students that finish early, have them to research ways to make their home more energy efficient.

Day 2 – Work Day

Continue working on Chart, Graph, and Worksheet. Allow students to check their chargers and devices with the Kill a Meter.

Day 3 – Guest Speaker

Guest Speaker from REMC to talk to students about energy conservation in our homes and school.

- Introduce Speaker
- Allow question time
- Thank speaker

Previous days homework – if time permitting, if guest speaker takes the entire period, then lesson will continue on the fourth day.

- Ask students to get out their homework from the previous day
- Ask them which type of light bulb is the best and why.
Ask students that researched ways to make their home more energy efficient to share what they had learned
Collect Homework

Homework
- Look around your home and school to find three or four ways to conserve energy that is not already being done and write them down – they will need a few days to research this and come up with some ideas.
# Home Energy Inspection

Print this checklist and do this inspection with an adult. Post your completed checklist to remind your family how to save energy.

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NOT YET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you turn off lights and computers when you are not using them?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you have compact fluorescent lights in your home?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you wash most of your laundry in cold water?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you have energy- and water-saving showerheads?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you do full loads in your dishwasher, clothes washer, and dryer?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you use the “Air Dry” or “No-Heat Dry” setting on your dishwasher?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you close draperies or blinds to keep out summer sun or winter cold?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do your doors and windows have weatherstripping and caulk to block drafts?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has your family unplugged appliances you rarely use, such as a second refrigerator or freezer?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is regular maintenance done on your heating and cooling system—cleaning or replacing filters monthly and a yearly tune-up?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Score 5 points for every “Yes,” 0 points for every “Not Yet.”*

0-15 Fair............... There’s a lot more you can do to save energy.

20-35 Good.. You have some good savings, with room for improvement.

40-50 Excellent.......... Congratulations on your super energy savings!
How electricity is used by the U.S. residential sector, 2014

Notes:
1. Includes consumption for heat and operating furnace fans and boiler pumps.
2. Includes miscellaneous appliances, clothes washers and dryers, computers and related equipment, stoves, dishwashers, heating elements, and motors not included in the uses listed above.

WHY ENERGY EFFICIENCY

Why wait? Our energy future can be decided NOW. Development and implementation of energy-efficient products, technologies, and services:

- saves consumers and businesses money,
- drives innovation and productivity,
- supports a cleaner environment, and
- reduces dependence on imported oil.

Importantly, it does so without sacrifice - energy efficiency enables us to do more while using less energy.

https://www.ase.org/resources/lesson-plan-which-light-bulb-really-cheaper-6-9
<table>
<thead>
<tr>
<th>Meter Number</th>
<th>Service Dates</th>
<th>Present Reading</th>
<th>Previous Reading</th>
<th>No. of Days</th>
<th>Multiplier</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>7347590</td>
<td>05/01/2016 to 06/01/2016</td>
<td>57953</td>
<td>56117</td>
<td>31</td>
<td>1.0000</td>
<td>1836</td>
</tr>
</tbody>
</table>

**Activity Since Last Bill**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Amount</th>
<th>Current Billing Detail</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREVIOUS BALANCE</td>
<td>346.37</td>
<td>BALANCE FORWARD</td>
<td>0.00</td>
</tr>
<tr>
<td>PAYMENTS</td>
<td>-346.37</td>
<td>ENERGY CHARGE 1836 KWH</td>
<td>229.65</td>
</tr>
<tr>
<td>MEMBERSHIP/DEPOSIT</td>
<td>0.00</td>
<td>SECURITY LIGHT</td>
<td>9.60</td>
</tr>
<tr>
<td>ADJUSTMENTS</td>
<td>0.00</td>
<td>STATE TAX</td>
<td>16.75</td>
</tr>
<tr>
<td>BALANCE FORWARD</td>
<td>0.00</td>
<td>TOTAL CURRENT CHARGES</td>
<td>256.00</td>
</tr>
</tbody>
</table>

**Operation Round-up Donations Made This Year**

3.32

MIAMI CO 4H FAIR: JUNE 20-24TH. CASS CO FAIR JULY 10-16TH. OFFICE CLOSED JULY 4TH. ANNUAL MEETING JULY 21ST AT PERU HIGH SCHOOL.

NEW! GO PAPERLESS! GO GREEN! GET THE NEW E-BILL, SAVE A TREE. SIGN UP ONLINE.

Due Date: 06/27/2016 | Net Amount Due: 256.00
After Due Date Gross Amount Due: 263.39

PLEASE SEE THE BACK SIDE OF THIS BILL FOR IMPORTANT ACCOUNT INFORMATION
$13.32  
You Save: $1.65  
After Mail-in Rebate

$8.89  
You Save: $1.10  
After Mail-in Rebate

$4.44  
You Save: $5.44  
After Sale Price & Mail-in Rebate

$6.64  
You Save: $0.68  
After Mail-in Rebate
STEM Energy Lesson Plan Elements Inclusion
Purdue University
2016 Duke Energy Academy

Sylvania 75 Watt A19 5000K LED Light Bulb
Model Number: 78283 | Menards® SKU: 3531373

Brand Name: Sylvania

Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color Temperature:</td>
<td>5000 Kelvin</td>
</tr>
<tr>
<td>Average Bulb Life:</td>
<td>11000 hour</td>
</tr>
<tr>
<td>Total Wattage:</td>
<td>12 watt</td>
</tr>
<tr>
<td>Color Rendering Index (CRI):</td>
<td>82</td>
</tr>
<tr>
<td>Base Type: E26</td>
<td></td>
</tr>
<tr>
<td>Bulb Color: Frosted</td>
<td></td>
</tr>
<tr>
<td>Light Color Temperature:</td>
<td>5000</td>
</tr>
<tr>
<td>Light Output: 1100 lumen</td>
<td></td>
</tr>
<tr>
<td>Listing Agency Standards: ETL</td>
<td></td>
</tr>
<tr>
<td>Overall Dimensions: 2.37 inch</td>
<td></td>
</tr>
<tr>
<td>Wattage Equivalency: 75</td>
<td></td>
</tr>
<tr>
<td>Package Quantity: 1</td>
<td></td>
</tr>
</tbody>
</table>

Please Note: Prices, promotions, styles and availability may vary by store and online. While we do our best to provide accurate item availability information, we cannot guarantee in-stock status and availability as inventory is sold and received continuously throughout the day. Inventory last updated 6/21/2016 at 5:00am EST. Online orders and products purchased in-store qualify for rebate redemption. Rebates are provided in the form of a merchandise credit check which can only be used in a Menards® store.
### Lumens (brightness)

<table>
<thead>
<tr>
<th>Watts (energy)</th>
<th>Lumens</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 w</td>
<td>2600 lm</td>
</tr>
<tr>
<td>100 w</td>
<td>1600 lm</td>
</tr>
<tr>
<td>75 w</td>
<td>1100 lm</td>
</tr>
<tr>
<td>60 w</td>
<td>800 lm</td>
</tr>
<tr>
<td>40 w</td>
<td>450 lm</td>
</tr>
</tbody>
</table>

*This chart shows the number of lumens produced by common incandescent bulbs. If you’re looking to buy a bulb that will give you the amount of light you used to get from a 60-watt bulb, you’ll now look for 800 lumens.*
## Cost Comparison of Different Types of Light Bulbs

<table>
<thead>
<tr>
<th>Equivalent Wattage</th>
<th>Type of Light Bulb</th>
<th>Actual Wattage</th>
<th>Lumens</th>
<th>Average Life in hours</th>
<th>Cost per bulb</th>
<th>Kilowatts used each hour</th>
<th>Efficiency of bulb ~ lumens/watts</th>
<th>Kilowatt-hours used for one year of continuous use</th>
<th>Amount of coal needed to produce the electricity</th>
<th>Cost of the actual physical light bulb for one year</th>
<th>Cost of the electricity for one year of continuous use</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 watts ≤ 175 lm</td>
<td>Incandescent</td>
<td>LED</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Halogen</td>
<td></td>
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<tr>
<td></td>
<td></td>
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Cost of Electricity in Kilowatt-hour: ___________________________
This is a drawing of our house in need of energy conservation.

In one room it has a hanging light with 5 Mini-Candelabra lights – 25 watts each. This light is on about 1 hour a day.

In the next room is a ceiling fan with 4 standard 60 watt light bulbs. This light is on about 4 hours a day.

The kitchen has several lights and they are all on about 8 hours a day. It has a ceiling fan with 3 Mini-Candelabra lights – 40 watts each.

Calculate how much it would cost to have incandescent light bulb vs your choice of energy efficient ones.

How much coal could we save by using a different light bulb.