Lesson Plan Title: Using Smart Meters and Electric Monitors to Analyze the Energy Use in your Home

Teacher Name: Mark Frantz  
School: Holt High School

Subject: Energy Industry Fundamentals  
Grade Level: 12

As a citizen of planet Earth, you are responsible for using energy wisely, reducing energy use and establishing ways that you cut down pollution from the energy you use. What kinds changes can you do or recommend your family can do to ensure a bright future and the health of our planet? What kinds of things can you do right now to learn about how your appliances and habits affect your energy use?

How can you use your home’s SMART meter and your energy company’s online “Energy Use Details” as well as an Electricity Monitor (Kill a Watt EZ Meter from Home depot) to……..
1) Discover what household items use the most energy and how much,
2) Make your home more energy efficient,
3) Calculate energy used by different items, and predict savings if those items can be eliminated or reduced.
4) Reduce your home energy use by changing consumption habits
5) Find the times of peak energy use in your home.

Incorporating Next Generation Science Standards, Common Core, or State Standards
State the standards that will be covered during this lesson plan.

<table>
<thead>
<tr>
<th>Incorporating Next Generation Science Standards, Common Core, or State Standards</th>
<th><a href="https://www.nextgenscience.org">https://www.nextgenscience.org</a></th>
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</thead>
<tbody>
<tr>
<td>HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* [Clarification Statement: Emphasis]</td>
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Include all standards which may apply (NGSS, Common Core, or State Standards).

Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]


Quantities ★ n-Q Reason quantitatively and use units to solve problems.
1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
2. Define appropriate quantities for the purpose of descriptive modeling.

Interpreting Categorical and Quantitative data ◇ S-Id Summarize, represent, and interpret data on a single count or measurement variable
1. Represent data with plots on the real number line (dot plots, histograms, and box plots).
2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
The main goal is to determine where the power purchased in the students’ home is used. There are two different ways that students can investigate this.

First, students will be looking at the energy analysis page on their parents’ online electric bill. They will also have to learn about and keep track of when and how certain items of the house are typically in use. For example, HVAC, hot water, laundry, dishwasher, coffee maker, refrigeration/freezers, oven, phantom use.

Below is an example of the report that I can get from my utility company showing my home’s electricity use May 22nd 2018.

Second, Students can investigate some appliances specifically with a Electricity Monitor, they can plug the appliance into it in and figure out how much energy it uses. Depending on price, some monitors can make monthly or yearly usage and cost predictions.

Below is a link to two different energy monitors that can be purchased at the local Home Depot.

Below is a link to a thermal imaging camera.
https://www.globaltestsupply.com/product/flir-tg165-imaging-ir-thermometer?gclid=EAIaIQobChMIMlJkJSmte2wIVAImGCh8mAe2EAYYAiABEgLauPD_BwE
### Analyzing and interpreting data
How will students be analyzing and interpreting the collected data?

Students will find patterns in the electric and or gas usage graphs produced by their home’s online page. They should be able to see trends and patterns in peak and nonpeak times though the day, week, and year. The Consumers website gives homeowners the ability to see the electric consumption by the hour, day, or month. The goal is for students to investigate the items in their household and make connections to the times and amount of energy used on the charts.

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

The students will need a computer with an internet connection and their parents’ permission to access the home’s energy website if it has the ability to display the “real time” data.

A set of Electric Monitors will also need to be purchased or donated so students can investigate the usage of appliances.

A thermal imaging camera would also be nice to have to test students’ homes for energy leaks. These can be checked out from our local library, but would be a liability with the higher price tag.

### Collaboration, critical thinking and communication

#### Collaboration
Indicate how students will be collaborating during the implementation of the lesson plan

Students will compare the data from their homes with the data from the homes of classmates. They can make and test conjectures of why the data may be similar or different in some ways. Possible things to compare would be:

1) Is the house empty for certain parts of the day?
2) Are the main appliances gas or electric? And how does that make a difference between students’ data?
3) How large is the home?
4) How many people live in the home?
5) Are there any habits that would contribute to energy use or savings by the household? Appliance settings?
6) Are there energy leaks in the home. For example, drafty windows or insufficient insulation.
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<td>How will the students evaluate the question or defined problem to reach an objective conclusion? How will the students be using the learned content and collected data to be able to critically think about the established question and/or problem on this lesson plan?</td>
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<td>Students will come up with a possible energy savings plan based on their research and collaboration with others. The plan will include current energy use estimates with a breakdown of how the students think the energy use is spread throughout the house. There should be visual aids to show daily, weekly, monthly, or yearly trends and predictions. Next the plan will include recommendations for energy use reductions and savings. This will include the estimated saving in both units of energy and money. The plan could recommend the implementation of upgrading to efficient appliances, changing habits or amount of use, or both. Implementing the use of programmable thermostat or smart appliances.</td>
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<td>How will the students communicate their findings and conclusion regarding the established question and/or problem?</td>
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<td>Students will create their own home energy use report. I will include the home’s current data with an emphasis on where the energy is being used and when it is being used. Include with this should be the students’ opinion of how energy is being wasted, how much is wasted and where it is being wasted. Next, the report should have recommendations of how to save both energy and money. It should pinpoint particular appliances, with a recommendation for each. For example, maybe a student investigates the water heater and finds that the temperature is at the highest setting. For a week they decide to turn the water heater down. After that week, they could investigate the data from their smart meter and make a recommendation for their hot water settings if significant savings are found. A second example, could have a student explore how much energy their garage refrigerator uses and make a recommendation whether or not it really needs to stay plugged in to keep a few cans of soda cold.</td>
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<tr>
<td>Teacher’s References</td>
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<tr>
<td>Include all references used to develop and implement this lesson plan.</td>
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<td><a href="https://www.consumersenergy.com/">https://www.consumersenergy.com/</a></td>
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<td>homedepot.com</td>
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### Assessment Plan

**Student’s References**
Include all references students will need to complete this lesson plan.

**Assessment Plan**
How will the students be assessed during and/or at the end of the lesson plan?

Include resources that will be used to assess the students for the lesson plan.

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<td>1) Students will need to investigate at least three different items in their home they believe could make a significant difference in energy use if eliminated or reduced. They should also calculate the overall contribution to the energy used for the month. They can investigate using the energy monitor or they can use an hourly report from their smart meter.</td>
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<td>2) Students will need to make some sort of visual aid and/or report of the impact of the items. The report should contain both the units of energy and cost analysis.</td>
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<td>3) Next there should be recommendations that would result in energy and cost saving for the family’s electric and or gas bill. Recommendations could range from changing habits, limiting or eliminating use of some items, all the way to the purchase of more efficient appliances or smart technologies. These recommendations should include predictions of energy savings. Additionally, students could make recommendations for energy saving in the home that do not have to do with appliances. They could also suggest insulation, or new doors.</td>
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<td>Each of the three parts above would count evenly for assessment. Each part could be graded as they are completed to give the chance to provide real time feedback to the students as the project is progressing.</td>
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## Resources and Costs

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<th>Costs</th>
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<td>List all the resources needed (equipment, facilities, materials or any other resources).</td>
<td>Computers and other hardware for reports and analyzing data are already in place.</td>
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<td></td>
<td>Electricity Monitors are $20 to $30 each depending on the functions they have.</td>
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<td>Flur Thermal Imaging Cameras are $400 each, but if you are lucky, you can check one out from the library.</td>
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### Resources Needed

- Computer with internet
- Camera phone to take pictures of appliances.
- Access to household online account
- Spreadsheet to track data and make predictions
- If student cannot gain access their household account, I will provide supervised access to mine. Or students might work in groups where
- Electricity Monitor
- Thermal Imaging Camera

### 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.

## 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.

- I would like to give this project about a 1 to 1.5 months. Students will need to look at data, make changes on thermostat settings or habits and then look at data again.
- I would plan on spending 4 to 6 in class hours with the introduction, collaboration, and presentation of findings.
- I would like to have the students present their plan to their parents and parents provide feedback to their students. It would be interesting to know if the parents are interested in making the adjustments.
Below is a sampling of data that I did personally over a couple of weeks. We kept track of household usage for things we felt would show on the data. I pulled the graphs from those dates so the correlation between the time certain appliances were on and the electric reading can be seen. It is very obvious when we wake up, go to work and come home. There also is a stark difference in the weekend. My goal would to have students collect data in a similar manner if possible.

Frantzs’ Electric and Gas Usage

Gas appliances include:

1) Water Heater
2) Clothes Dryer
3) Oven/Stove
4) Furnace

Electric Appliances include:

1) Clothes Washer
2) Clothes Dryer (Not the Heating Element)
3) Water Heater (Fan only, not the burner)
4) Furnace (Fan only, not the burners)
5) Refrigerator
6) Standup Freezer
7) Welder
8) Coffee Maker
9) Televisions
10) Lights
Saturday January 20th 2018
Laundry all Day 11 Loads
Dishwasher 6:30pm
Electric Heater 9:30-10pm

Sunday January 21st
Welded Aluminum 12-1pm
Dishwasher started 6pm
Monday January 22

Dishwasher started 6:10pm
May have left electric heater on from 7pm into the next day.

Tuesday January 23

Dishwasher started 6:10pm
May have left electric heater on from 7pm into the next day.
Wednesday January 24th

Thursday January 25th
Dishwasher 5:30
**Friday January 26th**
Dishwasher at 9:00pm

**Saturday January 27th**
Crock pot Started 7:30am
Laundry Started 8:00am 9 loads
Dishwasher 11am
Company over at 5pm
Dishwasher 9:45pm
Sunday January 28th

Monday January 29th (Snow Day)
Dishwasher 9:30
Tuesday January 30th
Laundry 4pm 3 loads

Chart shows use by hour for Jan 30, 2018 - Jan