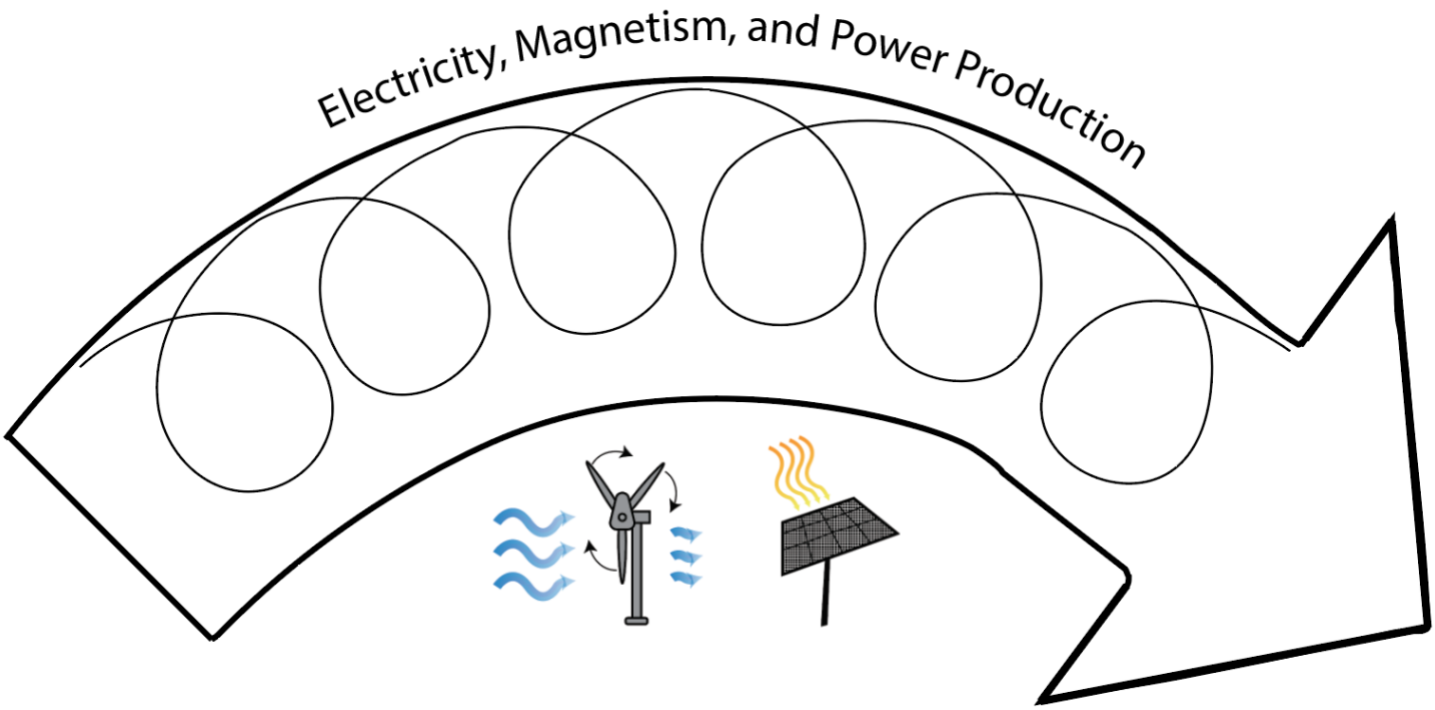
Unit 6 - Electricity, Magnetism, & Power Production

Name: _____ Period: _____ Date: _____



Self Assessment				Big Ideas
				I understand the basic physics of electric motors.
				I understand the basic physics of electric generators.
				I understand the basic physics of large scale power production.
				I understand the basic physics of Earth's climate.
				I understand the basics of long range energy planning.

Vocabulary Wall

Calendar of Learning Sequence

Day	What did we do?	How does it connect?
1		
2		
3		
4		
5		
6		
7		
8		

9		
10		
11		
12		
13		
14		
15		
16		

Voices of the World (inspired by Bill Bigelow with Rethinking Schools)

Who did you meet?	Where are they from?	What is most important to them?	Why? What else? (other important details?)
You: _____			
Find someone who lives on a different continent than you do. Name: _____			
Find someone who believes that he or she might personally benefit from climate change. Name: _____			
Find someone who believes that they are harmed by climate change. Name: _____			
Find someone who is affected by climate change in a way that is similar to how you're affected. Name: _____			
Find someone whose story involves a connection between water and climate change. Name: _____			
Find someone who has an idea about what should be done to deal with global warming. Name: _____			
Find someone who is from Oregon. Name: _____			

Find an Oregon politician. Name: _____			

Background Research on Power Production

Each of the energy strategies below is proven to be able to help meet our energy needs on a large scale. When thinking about our energy needs, there is no perfect solution and each of the energy strategy comes with trade-offs. Go to **studentenergy.org/map** and with your group, fill out the chart below detailing the energy strategies and their respective trade-offs. For this activity you will need access to the internet.

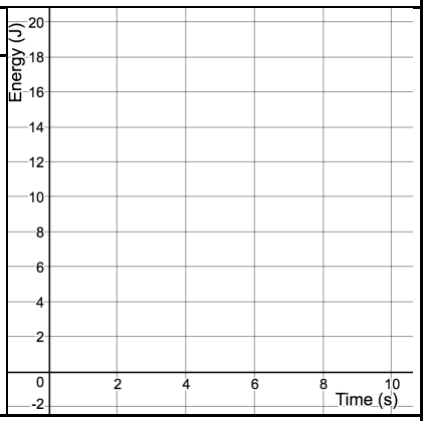
Energy Source	**Description**	Criterion #1:	Criterion #2:	Criterion #3:
Hydro Power				
Coal				
Natural Gas				

Nuclear				
Biomass				
Energy Source	**Description**	Criterion #1:	Criterion #2:	Criterion #3:
Wind				
Geothermal				
Solar Cells also called **Photovoltaics (PV) + Solar Thermal**				

Wave / Tidal Power				
Smart Grid Technology				
Energy Storage				

The Basic Physics of Electric Power

Graph (Diagrammatic)

Diagram of Analogy	Diagram of Circuit	
		

Experience (Phenomenon)

Water Bucket Analogy	Real Circuit

Mathematical

Equation 1	Equation 2

Word	Definition

Equation 3
Analogy
Mathematical

Questions

1: What happens to the power if the current is doubled? Use the analogy to support your answer.	2: What happens to the power if the voltage is doubled? Use the analogy to support your answer.
3: What happens to the power if batteries are placed in series (back to back)?	4: What happens to the power if batteries are placed in parallel (side to side)?

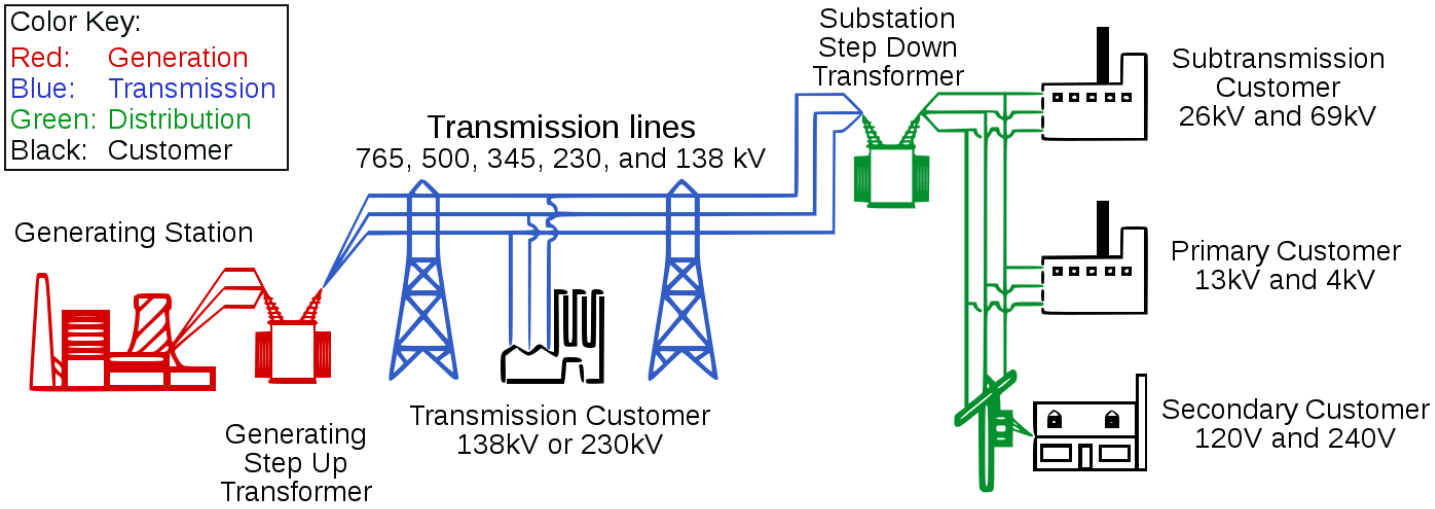
Placeholder for Building, Exploring, and Discovering how Speakers Work

See Packet 6P - Part 2 of Packet - Pages

Placeholder for Building, Exploring, and Discovering how Electric Generators Work

See Packet 6P - Part 2 of Packet - Pages

Getting Big: Large Scale Power Production



Notes about this Process:

Challenges we face:

Engineering a Wind Turbine

Request for Proposal: Criteria, Constraints, and Costs

Beaverton Public Works:
Cooper Mountain Nature Park Wind Turbine Project

Request for Proposal:

Beaverton Public Works is accepting bids, until _____, to refine the blade design of a wind turbine that increases power production for the Cooper Mountain Nature House within Cooper Mountain Nature Park. The wind turbine currently produces only _____ Watts (W) but to reach their energy goal of net neutral the wind turbine must generate at least _____ W. Additional production is desirable as a future cost saving measure. Beaverton Public Works Engineers did an initial investigation of the site before the original installation, in which they measured a nearly constant wind speed of 8 (± 2) m/s from the west at the site of the wind turbine during operation times. Additionally, Beaverton Public Works Engineers have measured maximum wind gusts at this location of 14 (± 2) m/s from the southwest. To justify the redesign and ensure its success the design recommendation report will need to display test data for the energy output for at least 4 different blade design parameters. The Beaverton City Council has approved $75,000 for the completed project and prefers that materials, as much as possible, be sourced locally to reduce the environmental impact of shipping materials long distances.

Request for Data:

Teachers' Data Co-op needs quality data on how various blade designs affect the max energy output of a wind turbine. Teachers' Data Co-op has defined max power output as the ability of the wind turbine to consistently produce the power for 5 continuous seconds. To simulate the constant wind speed found at the build site, data must be collected by placing the wind turbine 30 cm from the wind source which maintains a constant wind speed of 8 m/s. Teachers' Data Co-op has an open contract to pay out $40,000 for each quality data set and graph that helps to determine the effectiveness of different blade designs.

blem Statement:

Constraints: Circle 4 constraints in the Request for Proposal **Criteria:** Draw a rectangle around 1 criterion

Brainstorm blade-related parameters that could affect the power output of a wind turbine

1. 3. 5.

2. 4.

Wild Guess Design:

Figure 1: Material Costs

Tower (Base Station)	Total Cost of Tower ($)
1	30,000

Blade Angle (degrees)	Additional Cost to Blade for the Angle ($)
20	0
40	0
60	0
90	0

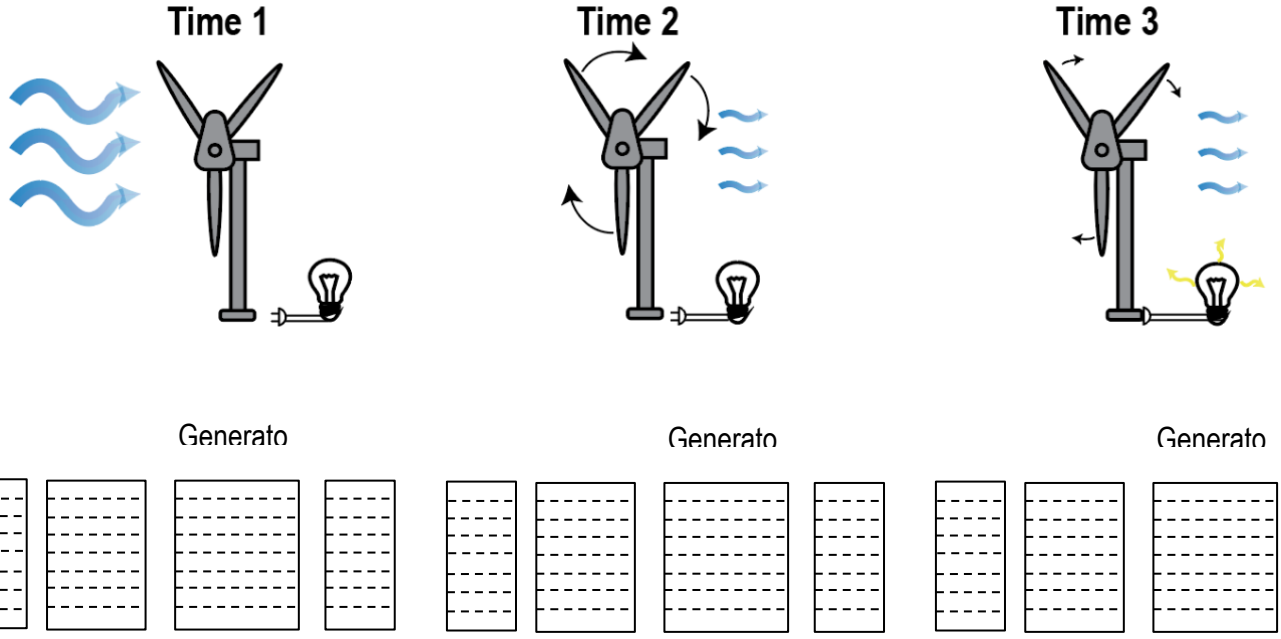
Number of Blade Holders (# of Pegs)	Total Cost of Blade Holders ($)
2	10,000
3	15,000
4	20,000
6	30,000

Total Area of Paper on all Blades (cm^2)	Total Cost of Paper on Blades ($)
40	20,000
60	30,000
80	40,000
100	50,000

Wind Turbine Report to Beaverton City Council

The Basic Energy Flow in a Wind Turbine:

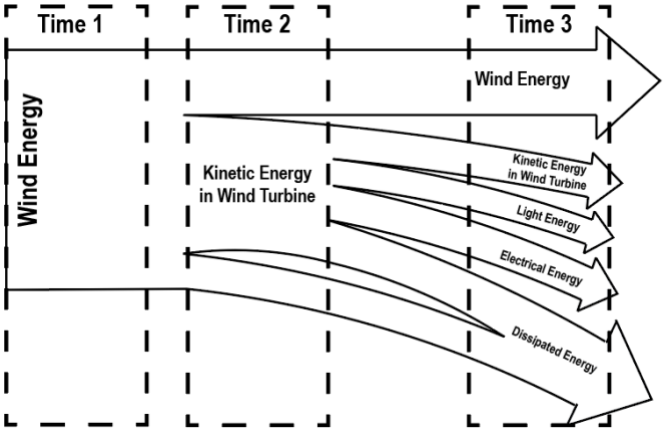
The image below shows a wind turbine in action. Fill in the energy bar charts below.



Advanced Energy Analysis of a Wind Turbine with Sankey Diagrams:

Modify the diagram to the right as follows:

1. Place a [square] around the energy initially captured by the wind turbine
2. Place a {bracket} around the useful energy coming out of the wind turbine.
3. Estimate both the overall efficiency and the internal efficiency of the wind turbine.
4. Modify the arrows (with a + or -) to show how each overall and internal efficiency could be increased.



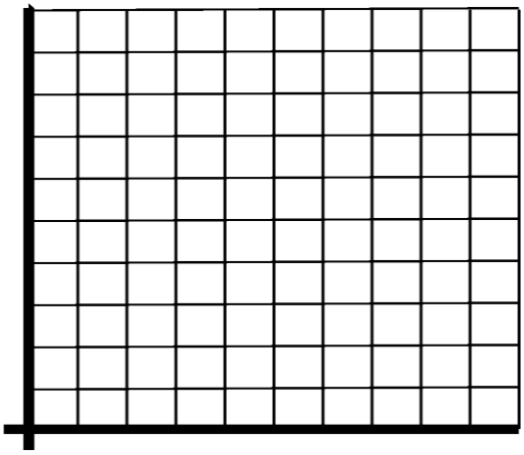
The Basic Physics of How a Wind Turbine Works:

Provide a written description of the basic physics of a wind turbine. Use key terminology: wind, wind turbine, energy, energy transfer, energy transformation, kinetic energy, electric energy, light energy, dissipated energy, and overall efficiency.

Research Results: Data Table & Graphs

Research Question:_____

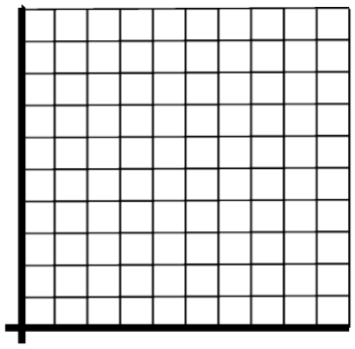
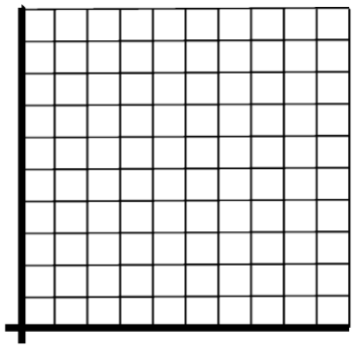
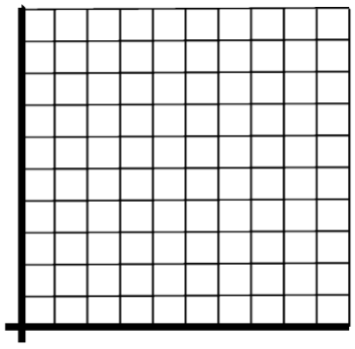
Title:	
Column heading:	Column heading:

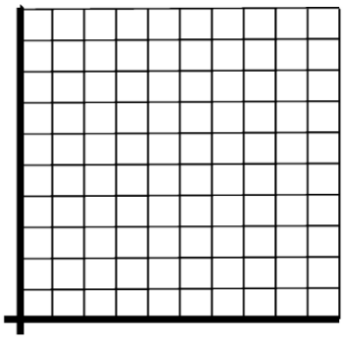


Expense Report for Final Blade Design:			Income ($)	Expense ($)
		Initial Funding		
		Income from Sale of Data		
		Cost of acquiring other Data		
Parts	Specification for Parts (Size/Number/Angle)	Price Per Piece		
Tower				
Axel to hold Paper Blade				
Paper for Blade				
Angle of Blades				
		Grand Total Cost for Wind Turbine		
		Remaining Funds		

Final Design and Performance Results

Claim: I claim the optimal design is …

Evidence		Reasoning about Design Decision
Graph	**Graph Explained in Words**	
	My first piece of evidence is … that shows …	Since …. my design recommendation is ….
	My second piece of evidence is … which demonstrates ...	Considering this and … , I recommend building a wind turbine with ….
	Graph 3 indicates that….	Therefore the optimal design should have …

		My final piece of evidence is … which reveals a ... pattern between ….	Considering this pattern and the budget I recommend …

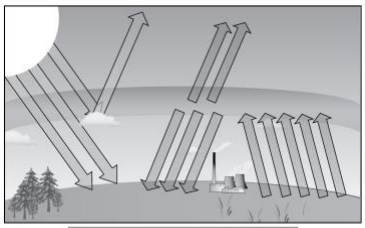
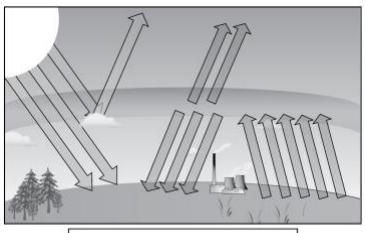
Placeholder for Climate Science Sankey Diagram

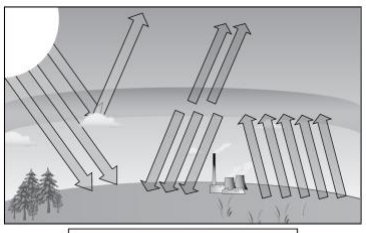
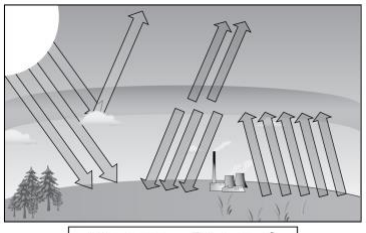
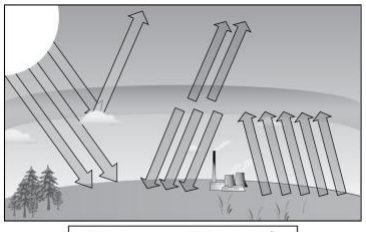
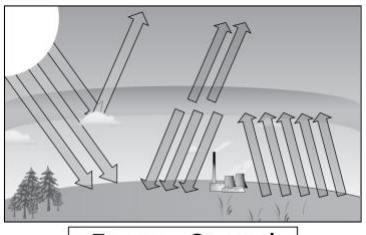
See Packet 6P - Part 2 of Packet - Pages

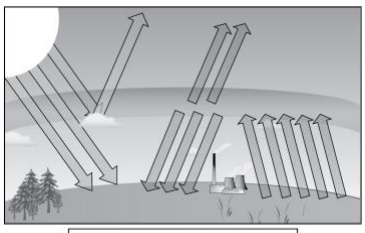
1. Complete the table below

- Warming Climate - Explain how the climate warms in words and by drawing energy transfers arrow.	$\frac{Energy_{in}}{Unit\ Time}$ $Energy_{Stored\ in\ Earth\ System}$ $\frac{Energy_{out}}{Unit\ Time}$ How does the Earth's climate warm?
- Cooling Climate - Explain how the climate cools in words and by drawing energy transfers arrow.	$\frac{Energy_{in}}{Unit\ Time}$ $Energy_{Stored\ in\ Earth\ System}$ $\frac{Energy_{out}}{Unit\ Time}$ How does the Earth's climate cool?
Energy Storage and Redistribution within the Earth System	

2. Complete the table below

Factor	Sankey Diagram	Energy Analysis	Notes
Atmospheric Composition		E_{Input} $E_{storage}$ E_{Output}	
Volcanic Activity		E_{Input} $E_{storage}$ E_{Output}	
Circulation of the Oceans	Sketch a Picture	E_{Input} $E_{storage}$ E_{Output}	
Factor	Sankey Diagram	Energy Analysis	Notes

Deforestation		E_{Input} $E_{storage}$ E_{Output}	
Earth's orbit and the axis		E_{Input} $E_{storage}$ E_{Output}	
Circulation of the Atmosphere	Sketch a Picture	E_{Input} $E_{storage}$ E_{Output}	
Glaciation		E_{Input} $E_{storage}$ E_{Output}	
Human activities		E_{Input} $E_{storage}$ E_{Output}	

Change in sun's energy	 Energy Stored	E_{Input} $E_{storage}$ E_{Output}	

Placeholder for 6CER

See Packet 6P - Part 2 of Packet - Pages