Alternative Power

High School Algebra I Performance Task

Co-Developed by:

Antelope Valley Algebra I Team,

Los Angeles County Office of Education,

and

Stanford Center for Assessment, Learning and Equity (SCALE)

Table of Contents

In the spring of 2015, instructional leaders from across Los Angeles County participated in a 2-day Building Educator Assessment Literacy (BEAL) project as a means to strengthen their understanding of the connection between the expectations of the state content standards and constructed response items on the state's annual assessments in English Language Arts/Literacy and Mathematics. Beyond a "scoring calibration" session, the BEAL project provided participants with tools to connect assessment to instructional practice. Subsequent training-of-trainer sessions were scheduled to equip instructional leaders to replicate the BEAL workshop in their respective districts.

These teacher-leaders requested a subsequent process be formulated to foster their understanding of what constitutes a valid and reliable performance task. Members of the Antelope Valley Curriculum Advisory Council consulted with the Stanford Center for Assessment, Learning and Equity (SCALE) to investigate the possibility of identifying classroom teachers and instructional coaches from their districts to work with SCALE experts to develop performance tasks to administer across participating districts. Facilitated by SCALE, 43 instructional leaders representing Antelope Valley Joint Union High School District, Eastside Union School District, Gorman School District, Keppel Union School District, Lancaster School District, Palmdale School District, Westside Union School District and Wilsona School District worked collaboratively over the course of four sessions spaced across the 2016-17 school year to create grade level performance tasks.

Antelope Valley Common Assessment Project Expected Outcomes:

1. The development, administration and scoring of a performance task specific to each grade level for students in grades one through grade 12.
2. Capacity building of teacher leaders in the development of new assessment items and the vetting of existing teacher-made and commercially developed assessment items.
3. The impact on student learning evidenced by the collaborative review of student work products with the intention of identifying and replicating best practices in teaching and learning.
4. Building a community of teacher-leaders across districts who can share best practices and work collaboratively to address issues of equity within and across school and district boundaries.

Theresa Morris and Susan Schultz from SCALE provided guidance for the development, administration, scoring and vetting of the performance tasks under contract to the Los Angeles County Office of Education. We are indebted to them for their tenacity in ensuring the Project's success.

Classroom Activity
Algebra I – Alternative Power

Time Needed: 10-20 minutes

Please read through the entire *Alternative Power* Classroom Activity and preview the PowerPoint and embedded Video before beginning the activity with students to ensure any classroom preparation can be completed in advance. The facilitator can decide to conduct the class discussion using the PowerPoint and embedded video or by using the questions below.

Materials Needed: Equipment to display the PowerPoint, video and/or pictures

Purpose:

The *Alternative Power* classroom activity and discussion provides students an opportunity to explore the idea of alternative power; consider what effect using alternative power has on a monthly electric bill; and understand the differences between a solar panel system and a wind turbine. The Classroom Activity is also intended to generate student interest in further exploration of the key ideas.

Key Terms:

During the Classroom Activity/Discussion, make sure to ask the students questions using the Key Terms.

- **Alternative Power:** Alternative power is a way to provide power using clean and renewable sources, not fossil fuel.
- **Community Center:** A place for the people in a neighborhood to use for various activities.
- **Wind Turbine:** A device that converts the motion created by the wind into electric power.
- **Solar Panel:** A device that converts sunlight into electric power.
- **Installation:** Putting a machine in place to be used.
- **Maintenance:** Making sure the machine works.

Classroom Activity/Discussion:

Facilitator says:

- We will start the Classroom Activity by watching a 50 second YouTube video that will introduce us to the use of solar power and wind turbines. https://youtu.be/z_gEC0u0MNE

Play video. (If video is not available, use Images provided.)

Classroom Activity
Algebra I – Alternative Power

Facilitator says:

- Who can name a type of alternative power?

(Student responses may include: solar, wind, hydroelectric, etc.)

- What types of alternative power is used in our community?

(Allow for student responses.)

Facilitator says:

- What are the benefits of using alternative power?

(Allow for student responses.)

- How does using an alternative power affect the monthly electric bill?

(Student responses may include: lowers the cost; shares the cost, etc.)

- Where do you see solar panels? Why are solar panels common in our community?

(Allow for student responses.)

- Where do you see wind turbines?
- Why do you think wind turbines are less common in our community?

(Allow for student responses.)

- Do you know how solar panel systems and the wind turbine are maintained?

(*Student responses may include:* ***Solar panel systems*** *require maintenance such as inspection, cleaning, checking the battery components.* ***Wind turbines*** *require maintenance such as inspection for damage, apply lubrication, painting, oil level in the gearbox, replacing other moving parts, etc.)*

Facilitator says:

- Today, we had a discussion about two alternative power sources, solar panels and the wind turbine. This discussion may help you when you complete the *Alternative Power* performance task.

- Do you have any questions about the concepts we discussed?

(Allow time for and respond to students' questions.)

Facilitator says:

- You are now ready to complete the *Alternative Power* performance task.

Classroom Activity developed by the Algebra I Antelope Valley Team to support student familiarity with science context within the associated performance task.

Classroom Activity
Algebra I – Alternative Power

Images:

Classroom Activity developed by the Algebra I Antelope Valley Team to support student familiarity with science context within the associated performance task.

Alternative Power

Name: _____ Date: _____

The Community Center is planning to install either a solar panel system or a wind turbine.

Your task is to recommend which is the better choice (solar panel system or wind turbine).

You are working with Isabella and Daniel.

Table 1 shows the information for a solar panel system and a wind turbine.

Table 1: Alternative Power

	Type of Alternative Power	
	Solar Panel System	**Wind Turbine**
Total Cost to Install	$25,000	$35,000
Yearly Maintenance Cost	$200	$110
Life Expectancy	35-40 years	20-25 years

Read the facts about the Community Center's current electric bill and the amount of electricity each type of alternative power can provide for the Community Center.

Electricity:

- Currently, the Community Center pays $4,800 each year for electricity.
- The Solar Panel system will provide 90% of the electricity the Community Center needs.
- The Wind Turbine will provide 100% of the electricity the Community Center needs.

1. What is the Community Center's cost for electricity for 1 month?

   $_____

2. Complete the table to show the Community Center's **yearly** cost for electricity and maintenance using each type of alternative power.

Alternative Power	**Total Yearly Cost for Electricity and Maintenance.**
Solar Panel System	
Wind Turbine	

3. Consider the costs of the Community Center using a wind turbine.

   Include the cost of:

   - installing a wind turbine
   - maintaining a wind turbine
   - electricity after installing the wind turbine.

   Write an equation to represent the total cost (y) for the Community Center to use a wind turbine for x number of years.

   Equation: _____

4. Consider the costs of the Community Center using a solar panel system. Isabella and Daniel are discussing how to write an equation to represent the total cost (y) for the Community Center to use a solar panel system for x number of years.
    - Isabella claims $y = 680x + 25000$ is the correct equation.
    - Daniel claims $y = 200x + 25000$ is the correct equation.

    Which student is correct? Justify your decision.

5. Consider the total costs for each type of alternative power. Determine when, in years, the total cost of using a solar panel system will equal the total cost of using a wind turbine. Justify your decision.

6. What is your recommendation?

   Should the Community Center install a solar panel system or a wind turbine?

   Justify your decision and provide the total yearly cost for your recommendation at x equals 20 years.

Alignment
Meta Data

Grade Level: Algebra I **Name of Task: Alternative Power**

Question	SBAC Claim	SBAC Targets (2)	DOK Level	CCSS (2 or more)	SMP (2 or more)	Point Value
1	2	D, A	2	7.RP.A.3	1, 2, 6	1
2	4	F, D	2	7.RP.A.3	1, 2, 6	2
3	2	D, A	2	7.EE.B.4, HSF.LE.B.5	1, 2, 4, 6	1
4	3	F, B	3	7.EE.B.4, HSF.LE.B.5	1, 2, 3, 4, 6	2
5	4	A, B	3	8.EE.C.8.B, HSF.LE.B.5	1, 2, 3, 4, 6	2
6	3	B, F	3	8.EE.C.7.B, HSF.LE.B.5	1, 2, 3, 4, 6	2

KEY

- SBAC - Smarter Balanced Assessment Consortia
- SBAC Math Claims: https://www.smarterbalanced.org/wp-content/uploads/2015/09/Smarter-Balanced-Mathematics-Claims.pdf
- DOK - Depth of Knowledge
- CCSS - Common Core State Standards, Geometry http://www.corestandards.org/Math/Content/HSG/introduction/
- SMP - Standards of Mathematical Practice

Smarter Balanced Claims and Assessment Targets for Mathematics

Claim #1: Concepts and Procedures

Students can explain and apply mathematical concepts and interpret and carry out mathematical procedures with precision and fluency.

Claim #2: Problem Solving

Students can solve a range of complex well-posed problems in pure and applied mathematics, making productive use of knowledge and problem solving strategies.

Target A: Apply mathematics to solve well-posed problems in pure mathematics and those arising in everyday life, society, and the workplace.

Target B: Select and use appropriate tools strategically.

Target C: Interpret results in the context of a situation.

Target D: Identify important quantities in a practical situation and map their relationships (e.g., using diagrams, two-way tables, graphs, flowcharts, or formulas).

Claim #3: Communicating Reasoning

Students can clearly and precisely construct viable arguments to support their own reasoning and to critique the reasoning of others.

Target A: Test propositions or conjectures with specific examples.

Target B: Construct, autonomously, chains of reasoning that will justify or refute propositions or conjectures.

Target C: State logical assumptions.

Target D: Use the technique of breaking an argument into cases.

Target E: Distinguish correct logic or reasoning from that which is flawed, and – if there is a flaw in the argument – explain what it is.

Target F: Base arguments on concrete referents such as objects, drawings, diagrams, and actions.

Target G: At later grades, determine conditions under which an argument does and does not apply.

Smarter Balanced Claims and Assessment Targets for Mathematics

Claim #4: Modeling and Data Analysis

Students can analyze complex, real-world scenarios and can construct and use mathematical models to interpret and solve problems.

Target A: Apply mathematics to solve problems arising in everyday life, society, and the workplace.

Target B: Construct, autonomously, chains of reasoning to justify mathematical models used, interpretations made, and solutions proposed for a complex problem.

Target C: State logical assumptions being used.

Target D: Interpret results in the context of a situation.

Target E: Analyze the adequacy of and make improvements to an existing model or develop a mathematical model of a real phenomenon.

Target F: Identify important quantities in a practical situation and map their relationships.

Target G: Identify, analyze and synthesize relevant external resources to pose or solve problems.

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning.

Rubric Alternative Power

1. Full credit: 1 point
   - Student writes the number 400 or $400.00 or equivalent

2. Full credit: 2 points
   - Student enters correct total yearly cost for electricity and maintenance for each alternative power
     - Solar Panel System: $680 or equivalent
     - Wind Turbine: $110 or equivalent

   Partial credit: 1 point
   - Student enters correct total yearly cost for electricity and maintenance for **one** alternative power

3. Full credit: 1 point
   - Student provides an acceptable equation such as: $y = 110x + 35000$

4. Full credit: 1 point
   - Student provides justification for selecting which student's equation is correct based on response to Q2.
   - Note: it is possible that the student may say neither is correct based on follow-through error from Q2: if this occurs the student can only earn full credit by also providing the correct equation or stating how the equations would need to be altered.

5. Full credit: 2 points
   - Student provides time at which the cost for both types of alternative power would be equal AND provides justification showing appropriate calculations, or provide an explanation.
   - Correct time is to set equation provided in Q3 equal to equation selected in Q4
     - If student correctly responds to both Q3 and Q4 the cost is equal at $x = 17.54$ years.
     - If student chooses "Daniel" in Q4 and has the correct equation in Q3, then the correct time is $x = 111.11$ years.
     - All other combinations will need to be manually tested to see if correct.

   Partial credit: 1 point
   - Student provides correct time at which the cost for both types of alternative power would be equal BUT does not provide justification
     OR
   - Student provides an incorrect time BUT uses a correct process/approach which includes a calculation error.

6. Full credit: 2 points
   - Student provides justification for the suggested type of alternative power AND provides cost at x = 20 years.

   - Notes:
     - ✓ Student can choose either alternative power – not necessarily the least expensive the justification needs to include a mathematical reason as to why the alternative power was chosen (cost the least, will last longer, cost less to install etc.)
     - ✓ Cost at 20 years:
       1. Wind Turbine: Substitute 20 in for x within equation provided in Q3
          a. If correct equation, then total = $37,200
       2. Solar Panel System: Substitute 20 in for x within equation selected in Q4.
          a. If correct choice (Mia), then total is $38,600
          b. If Daniel, then total is $29,000
          c. Substitute if alternative equation was provided by student.

   Partial credit: 1 point

   - Student provides an appropriate justification for the alternative power BUT does not provide correct cost at 20 years.
     OR
   - Student does not provide an appropriate justification for the alternative power BUT does provide correct cost at 20 years.

Question 4 is dependent upon student response from Question 2 (early cost of electricity and maintenance of the solar panel system)

Sample A:

2. Complete the table to show the Community Center's **yearly** cost for electricity and maintenance using each type of alternative power.

Alternative Power	Total Yearly Cost for Electricity and Maintenance.
Solar Panel System	$680
Wind Turbine	$110

4. Consider the costs of the Community Center using a solar panel system. Isabella and Daniel are discussing how to write an equation to represent the total cost (y) for the Community Center to use a solar panel system for x number of years.

- Isabella claims $y = 680x + 25000$ is the correct equation.
- Daniel claims $y = 200x + 25000$ is the correct equation.

Which student is correct? Justify your decision.

Isabella is correct because she added the cost of electricity Daniel only added the yearly maintenance cost.

Score: _____

Sample B:

2. Complete the table to show the Community Center's **yearly** cost for electricity and maintenance using each type of alternative power.

Alternative Power	Total Yearly Cost for Electricity and Maintenance.
Solar Panel System	$200
Wind Turbine	$110

4. Consider the costs of the Community Center using a solar panel system. Isabella and Daniel are discussing how to write an equation to represent the total cost (y) for the Community Center to use a solar panel system for x number of years.

- Isabella claims $y = 680x + 25000$ is the correct equation.
- Daniel claims $y = 200x + 25000$ is the correct equation.

Which student is correct? Justify your decision.

Daniel is correct, because it makes sense "y" is the total cost, 200 is how much it costs for Maintanence and lastly the 25000 represents how much it is for the solar panels. In Isabella's equation she put y = 680x + 25000 which was close to being correct until she put 680 for yearly maintanence which isn't true because the yearly cost for maintanence is 200.

Score: _____

Sample C:

2. Complete the table to show the Community Center's **yearly** cost for electricity and maintenance using each type of alternative power.

Alternative Power	Total Yearly Cost for Maintenance and Electricity.
Solar Panel System	$4520
Wind Turbine	$4910

4. Isabella and Daniel are discussing how to write an equation to represent the total cost (y) for electricity, installing and maintaining a solar panel system for x number of years.

   - Isabella claims $y = 680x + 25000$ is the correct equation.
   - Daniel claims $y = 200x + 25000$ is the correct equation.

   Which student is correct? Justify your decision.

   Daniel is Correct because 200 is the yearly maintence cost and 25,000 is the initial cost.

Score: _____

Scores and Rationale for Question 3 Samples

Question 3		
Max Points: 1		
Sample	**Score**	**Description and Rationale**
A	1	Response provides justification of equation and is consistent with student response in question 2.
B	1	Response provides justification of equation and is consistent with student response in question 2.
C	0	Response provides justification of equation BUT it is inconsistent with student response in question 2 and does not include yearly cost of electricity.

Question 5 is dependent upon questions 3 and 4:

- Question 3 provides student equation for wind turbine
- Question 4 provides student equation for solar panel system

Sample D

Question 3	Equation: $y = 110x + 35{,}000$
Question 4	Student selected Isabella's equation: $y = 680x + 25000$

Question 5:

Solar Panels: $y = 680x + 25000$
Wind turbine: $y = 110x + 35000$

$$680x + 25000 = 110x + 35000$$
$$-110x \quad -25000 \quad -110x \quad -25000$$
$$570x = 10{,}000$$
$$x = 17.5 \text{ years}$$

The total cost of solar panels is equal to wind turbine is at $x = 17.5$ years.

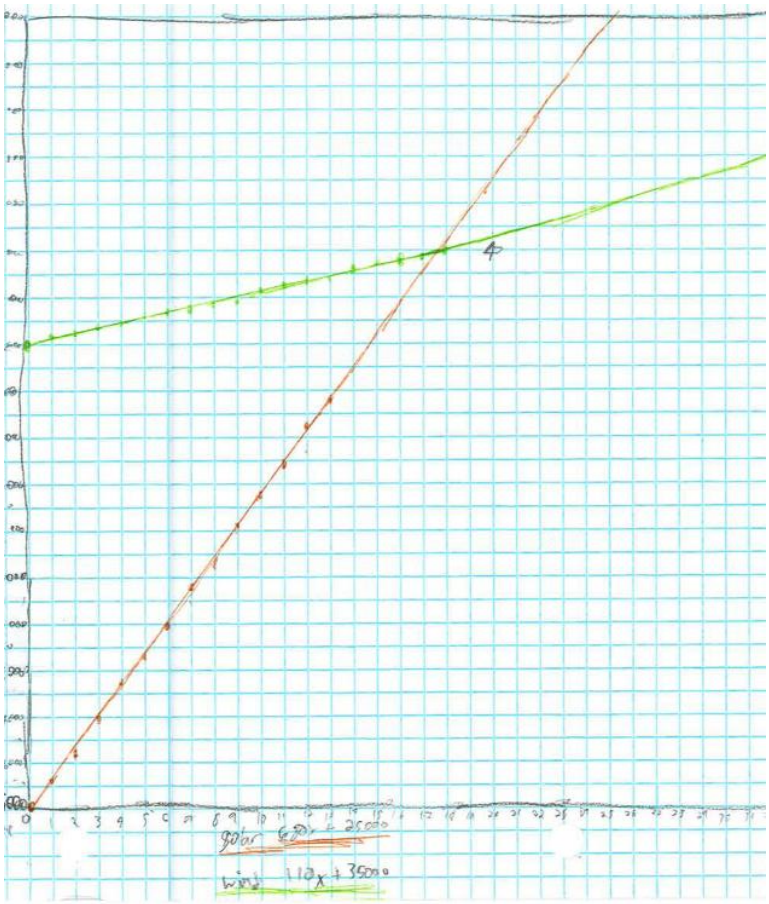
Score: _____

Sample E:

Question 3	Equation: $y = 110x + 35000$
Question 4	Student selected Isabella's equation: $y = 680x + 25000$

Question 5 Response

On year 18, they tie, and from that point onwards, wind > solar.



Score: _____

Sample F:

20

Question 3	Equation: $y = 110x + 35000$
Question 4	Student selected Daniel's equation: $y = 200x + 25000$

Question 5:

Solar panel $200x + 25000$

wind $110x + 35000$

$90x = 10000$

$x = 111.11$ years

The solar panel will always be cheeper

Score: _____

Sample G:

Question 3	Equation: 110x + 35000
Question 4	Student selected Isabella's equation: $y = 680x + 25000$

Question 5:

680x + 25000
110x + 35000
770x = 10000

x = 12.987 years

The cost is equal at 12.987 years

Score: _____

Sample H:

Question 3	Equation: y=110(x)+35,000
Question 4	Student selected Daniel's equation: $y = 200x + 25000$

Question 5:

In 50 years the cost of solar panel will equal the cost of wind turbines in 1 year.

Score: _____

Sample I:

Question 3	**Equation:** y= 110x + 35000
Question 4	Student selected Daniel's equation: $y = 200x + 25000$

Question 5:

The total cost of a solar panel is $25,200. While this is the wind turbine would cost $35,110. In years the solar panel would last 35-40 years and the wind turbine would last at least 20-25 years. The total cost is $25,200 for installation and yearly maintance. The total cost for wind turbine is $35,110 for installation and yearly maintance.

Score: _____

Scores and Rationale for Question 5 Samples

Question 5		
Max Points: 2		
Sample	**Score**	**Description and Rationale**
D	2	Response provides time at which the cost for both types of alternative power would be equal AND provides justification by solving a system of equations.
E	2	Response provides time at which the cost for both types of alternative power would be equal AND provides justification by graphing both equations.
F	2	Response provides time at which the cost for both types of alternative power would be equal (based on follow-through error from Question 4 AND provides justification by solving a system of equations.
G	1	Response provides an incorrect time at which the cost for both types of alternative power would be equal BUT provides justification by solving a system of equations that includes an error (added the x coefficient rather than subtracting).
H	0	Response provides neither a correct time at which the cost for both types of alternative power would be equal OR provides justification.
I	0	Response provides neither a correct time at which the cost for both types of alternative power would be equal OR provides justification.

Question 6 is dependent upon equations provided in questions 3 and 4. The equations are provided if response does not include them within the answer or calculations.

Sample J:

I would recomend the wind turbine

- It cost less after 17.5
- It last 2.5 to 7.5 years after the cost are equal
- They look cool

$y = 110x + 35000$

$y = 110(20) + 35000$

$y = 37,200$

$y = 680x + 25000$

$y = 680(20) + 25000$

$y = 38,600$

The wind turbine cost \$37,200 at x = 20 years. This is \$1,400 less than the solar panel system.

Score: _____

Sample K:

My recommendation is that the community center should use solar panels instead of wind turbines because it helps more & cost way less. The equation for wind turbines & x equals 20 years would be y = 110 (20) + 35000 and if you were to solve it your answer / total cost for everything would be $37,200 but if you solve the solar panels equation which is y = 200 (20) + 25,000 you would figure out the answer is $29,000 and $8,200 cheaper than wind turbines. Another reason why I chose solar panels over wind turbine is because solar panels can last 35-40 yrs & wind turbines last about 20-25 years so its a win win situation lower cost & more life.

Score: _____

Sample L:

Student equations provided in questions 3 and 4:

- Wind turbine: $y = 110x + 35000$
- Solar panel system: $y = 680x + 25000$

The wind turbine

- It cost less after 12.98 years
- It last 20-25 years
- Each year after 13 years saves $570 every year

at x = 20 years

wind = 37200

solar = 38600

1400

~~x = 13 yrs~~

~~wind 36430~~

~~solar 33840~~

~~2590~~

The wind turbine cost $37,200 at x = 20 years which is $1400 less than solar panels

Score: _____

Sample M:

Student equations provided in questions 3 and 4:

- Wind turbine: $y = 110x + 35000$
- Solar panel system: $y = 680x + 25000$

I suggest installing the solar panel system because it has a longer life expectancy. The cost for the solar panel systems is less than the wind turbine from 0→17.5 years. So a wind turbine would cost less after 17.5 years but it is only expected to last 20-25 years that leaves only 2.5 to 7.5 years then the Community Center would need to install a brand new wind turbine. The solar panel system has a life expectancy of 35-40 years which is 15-20 years more than the wind turbine. In the 40 years total the wind turbine would cost less for 2.5 to 14 years leaving more years for the solar panel system.

Score: _____

Sample N:

Question 4: Student selected Daniel's equation: $y = 200x + 25000$

Solar panels

at x = 20 years cost is $29,000

Score: _____

Sample O:

Student equations provided in questions 3 and 4:

- Wind turbine: $y = 110x + 35000$
- Solar panel system: $y = 200x + 25000$

I personally thinks they should invest in a solar panel because for one it's way cheaper than a wind turbine. Also it last way longer. For example if they did invest in a wind turbine where would they put it, has to be on ground it can't be on the roof. If they invest in a solar panell it's more convenient you can put it on the roof ; you'll pay less for a long warranty.

Score: _____

Scores and Rationale for Question 6 Samples

Question 6		
Max Points: 2		
Sample	**Score**	**Description and Rationale**
J	2	Student provides justification for the wind turbine (cost less after x=17.5 years) AND provides cost at x = 20 years.
K	2	Student provides justification for the suggested type of alternative power AND provides cost at x = 20 years. Student previously selected Daniel's equation: $y = 200x + 25000$ which will make Solar Panel's the least expensive regardless of number of years.
L	2	Student provides justification for the wind turbine (that is cost less after 13 years – which is a carry through error from Question 5) AND provides cost at x = 20 years.
M	1	Student provides justification for the wind turbine (cost less after x=17.5 years and excellent additional mathematical reasoning) BUT does not provide cost at x = 20 years.
N	1	Student does not provide justification for the solar panel BUT does provide cost at x = 20 years based on student previous answer to question 4 (selected Daniel's equation $y = 200x + 25000$)
O	0	Student does not provide mathematical justification for the solar panel ("way cheaper" is insufficient evidence as a standalone statement without including calculations or other evidence) AND student does not provide cost at x = 20 years.

What do students need to know?	What math skills do students need?
- Reading Informational Text *- Interpreting Charts/Graphs*	*- Computational skills* *- Solving an equation*
What are implications for my instruction?	**What are the Learning Goals and Success Criteria needed to show mastery for these skills?**
- Increase expectation for students to justify their response	**LEARNING GOAL(S):** *Specific, realistic target(s) for this lesson that are clear to both the teacher and the student* **SUCCESS CRITERIA:** *Clear criteria by which the student and the teacher can gauge progress toward meeting the Goal(s)*