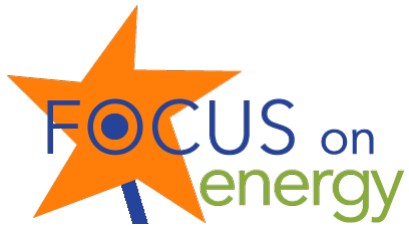


# Reframing Energy Learning in Elementary School

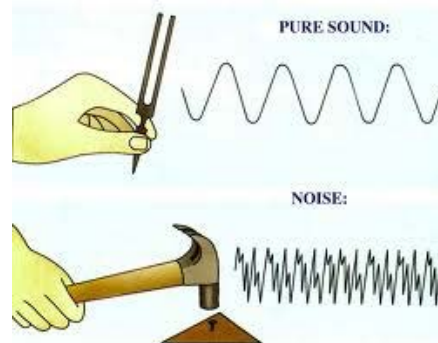
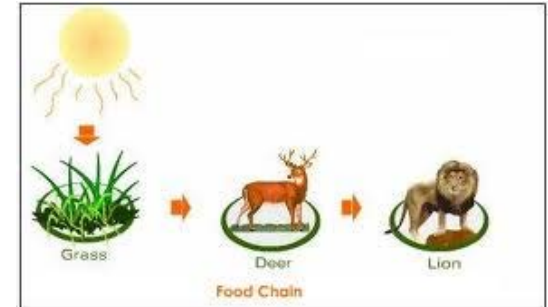
Sara Lacy  
Sally Crissman  
*TERC, Cambridge MA*

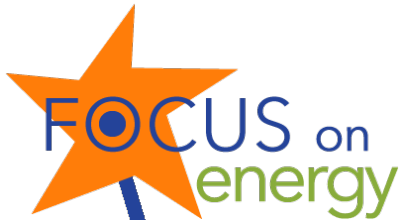
MSELA, November 2016





# Energy in elementary school: What is the challenge?





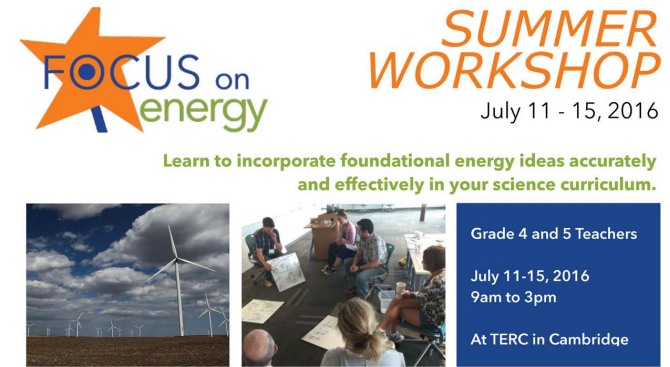
# Preparing Elementary Teachers to Meet the New Standards



Classroom Activities



Web-based Resources



Teacher Workshop

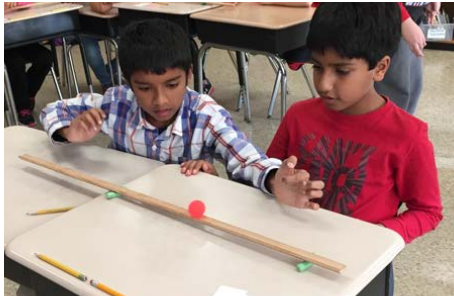
*A system of resources and support for teaching and learning about energy in elementary school.*

A 4-year NSF DRK-12 development project

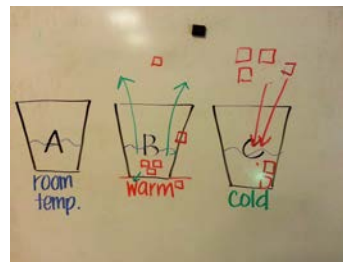


# Classroom Activities

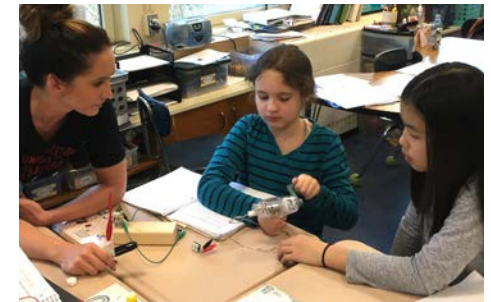
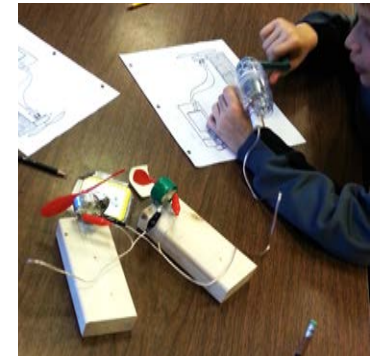
## Motion and Elastic



## Thermal



## Electrical





# SUMMER WORKSHOP

July 11 - 15, 2016

Learn to incorporate foundational energy ideas accurately  
and effectively in your science curriculum.



Grade 4 and 5 Teachers

July 11-15, 2016

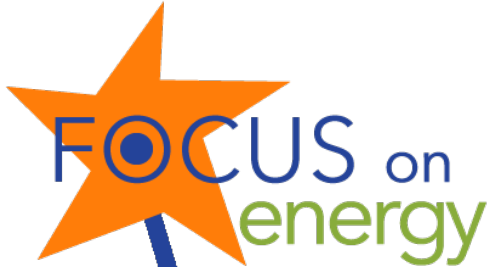
9am to 3pm

At TERC in Cambridge

## 3 Strands:

- ◆ Learning about Energy
- ◆ Listening to Children's Ideas
- ◆ Planning to integrate energy into your curriculum





# Web Based Resources

 Focus on Energy

[Workshop](#) [Curriculum Units](#) [Resources](#) [About](#)



**Workshop**

[Learn more »](#)



**Curriculum Units**

[Learn more »](#)



**Resources**

[Learn more »](#)

**Focus on Energy: Preparing Elementary Teachers to Meet New Science Standards.**

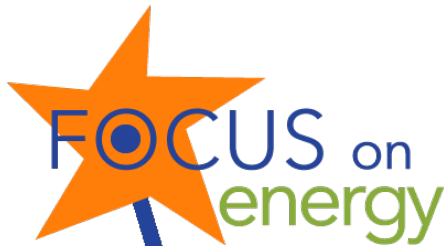
A joint partnership of



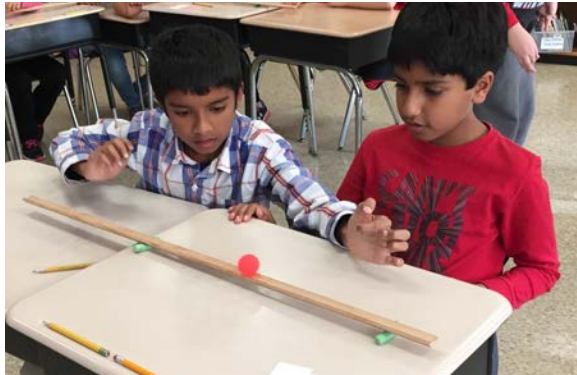
Copyright 2015, TERC



This material is based upon work supported by the National Science Foundation under Grant No. #1418052 (TERC) and #1418211 (Seattle Pacific University). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.



# Classroom activities reflect the vision of the Massachusetts standards



- Lessons focus on core energy ideas
- Students learn core ideas through through science practices
- Lessons are carefully sequenced

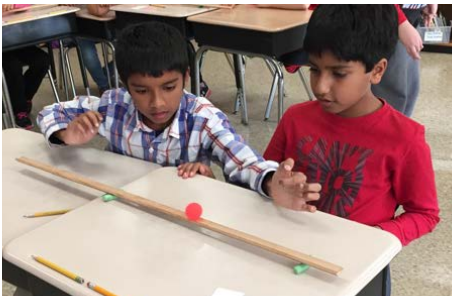
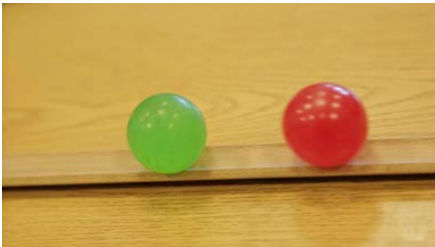
In each investigation, students

- Ask a question
- Explore and collect data
- Make meaning

# Learning about motion energy

## Collisions:

Can a ball cause another ball to move  
AND not lose any  
of its own energy?

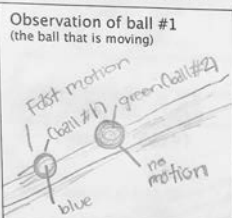


**Zoom in on Collisions: Trial 1**


Use pictures and words to describe your observations before you fill in the energy bars

**Just before collision**

Observation of ball #1  
(the ball that is moving)

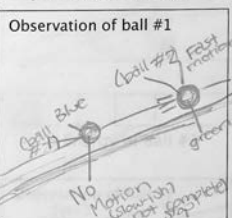


Collision




**Just after collision**

Observation of ball #1




Remember, you can't see energy - you have to make sense of indicators or clues!  
**What do your observations tell you about the energy of ball #1?**


Energy of ball #1



Collision



Energy of ball #1



**Energy Change**

Gain

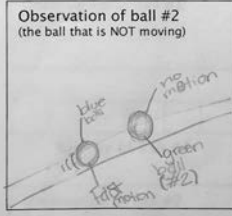
Loss

No change


  

**Just before collision**

Observation of ball #2  
(the ball that is NOT moving)

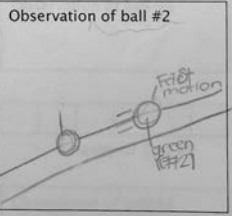


Collision



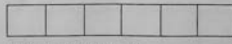
**Just after collision**

Observation of ball #2




What do your observations tell you about the energy of ball #2?


Energy of ball #2



Collision



Energy of ball #2



**Energy Change**

Gain

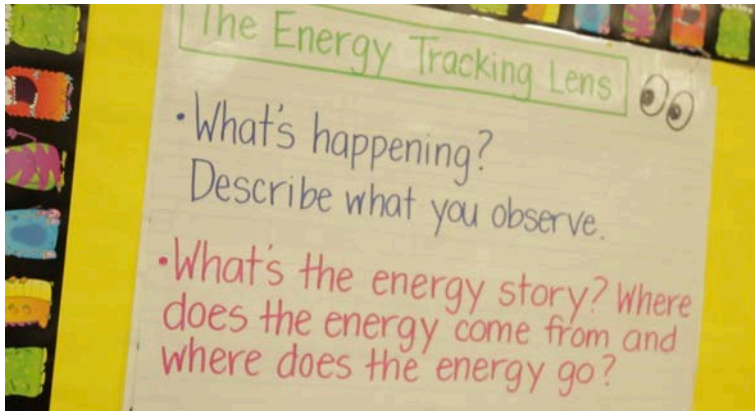
Loss

No change

Motion Energy - Investigation 2



# Building a Framework for Looking at Phenomena in Terms of Energy



Type of Energy	Indicator
motion	speed
elastic	deformation (bent, twisted, stretched)
thermal	temperature

Part 1. Describe what you observe.

Part 2. Tell the energy story.

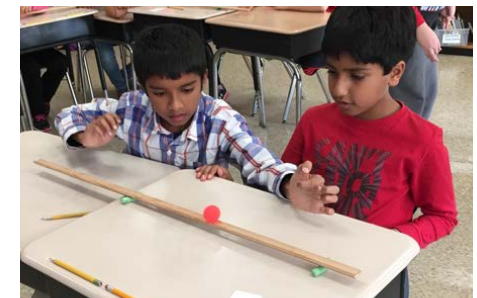
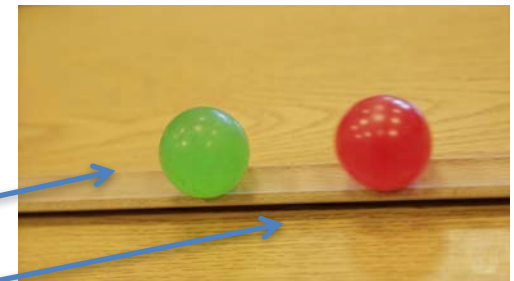
What are the system components?

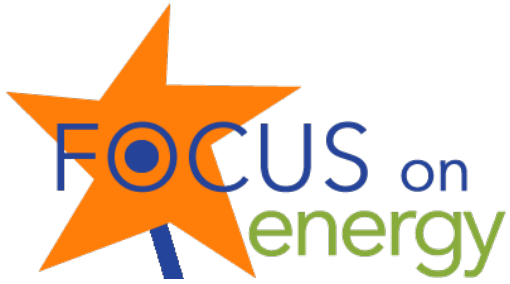
Form (s) of energy?

Energy gain?

Energy loss?

-- If the green ball's energy increased,  
**Where did the energy come from?**





# Adding to the framework: adding another form of energy and energy transformation

Part 1. Describe changes you observe.

Part 2. Tell the energy story.

Components of the system?

Form(s) of energy?

Energy gain?

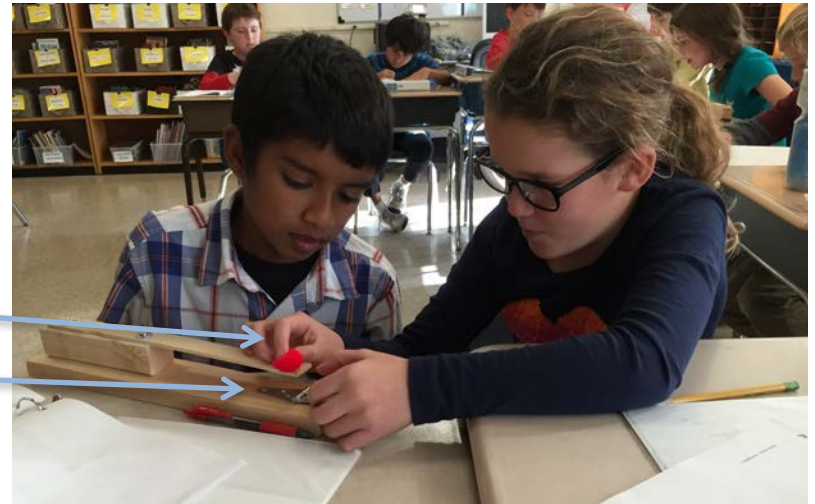
Energy loss?

Energy transfer?

Energy transformation?

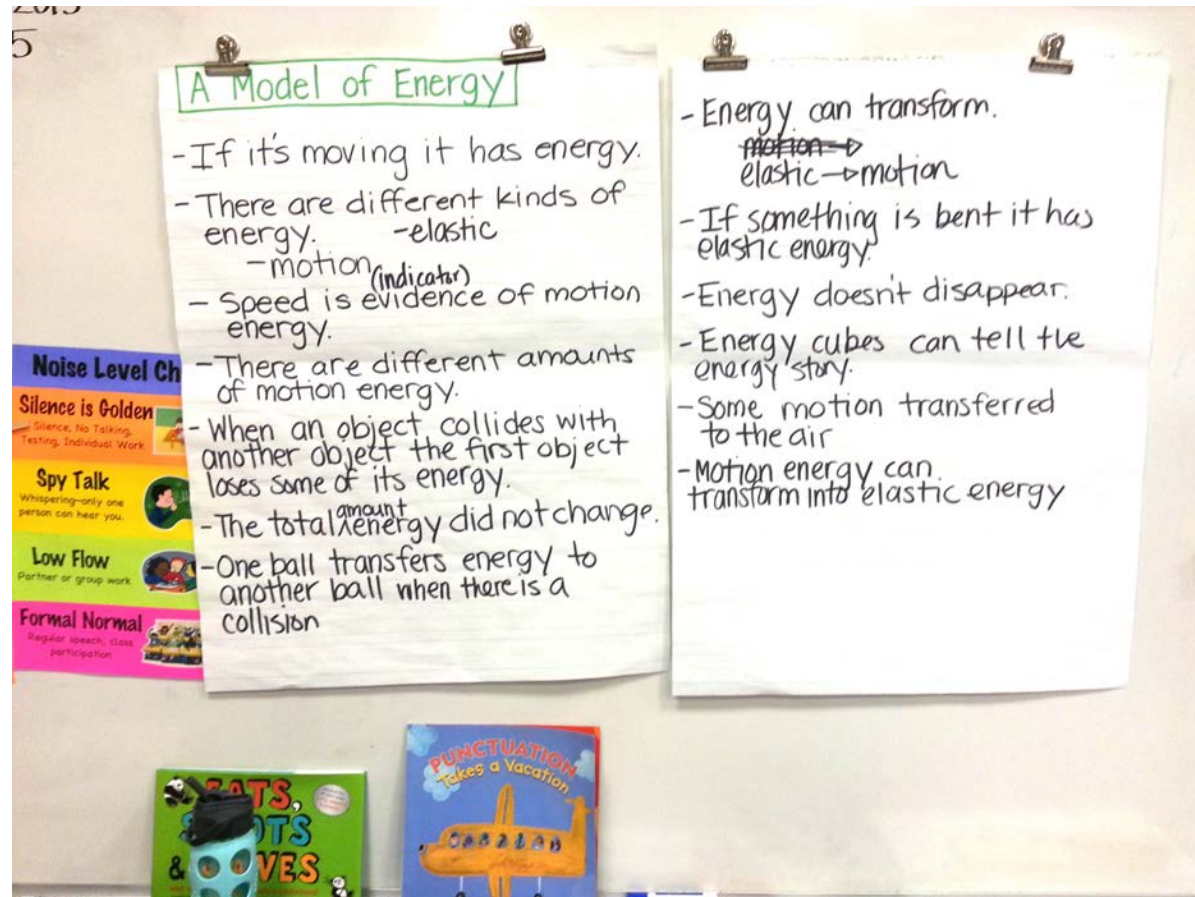
Where does the energy come from?

Where does the energy go?



If the pom-pom gained energy,  
what lost energy?

# Generating and using a conceptual model of energy



5

**A Model of Energy**

- If it's moving it has energy.
- There are different kinds of energy.
  - elastic
  - motion (indicator)
- Speed is evidence of motion energy.
- There are different amounts of motion energy.
- When an object collides with another object the first object loses some of its energy.
- The total <sup>amount</sup> energy did not change.
- One ball transfers energy to another ball when there is a collision.

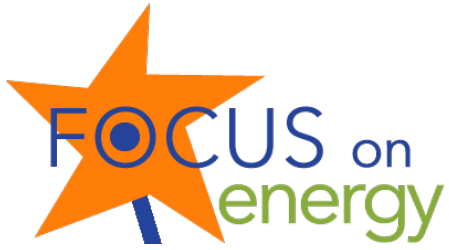
**Energy can transform.**

~~motion~~ → motion  
elastic → motion

- If something is bent it has elastic energy.
- Energy doesn't disappear.
- Energy cubes can tell the energy story.
- Some motion transferred to the air.
- Motion energy can transform into elastic energy.

**Noise Level Chart**  
**Silence is Golden** (Silence, No Talking, Testing, Individual Work)  
**Spy Talk** (Whispering—only one person can hear you.)  
**Low Flow** (Partner or group work)  
**Formal Normal** (Regular speech, class participation)

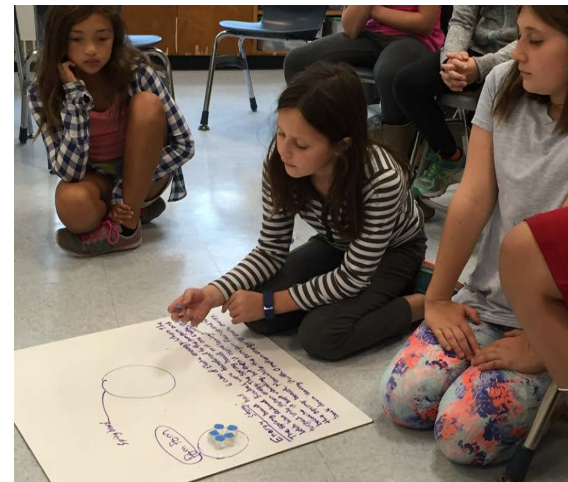
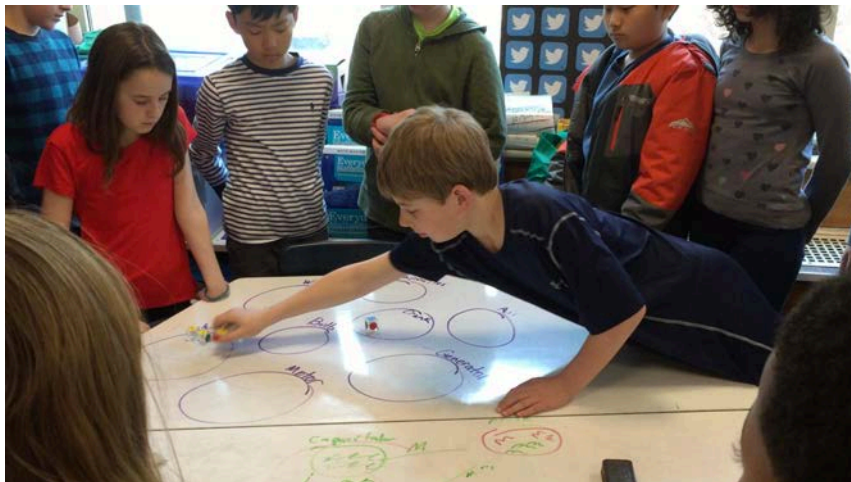
**CATS, DOGS & BATS**  
**PUNCTUATION Takes a Vacation**

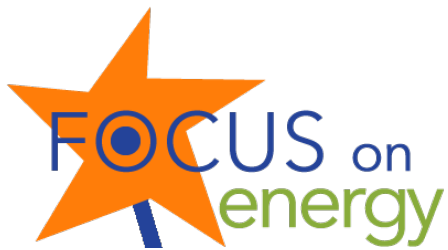


# Representing Energy Flow

Energy is abstract!!!

Students use representations to communicate and reason about energy flow.



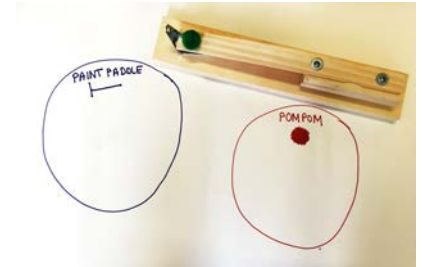


# Energy Cube Rules

Each cube is a unit of energy.

Regions on a paper represent objects involved in the scenario.

Each cube indicates its form of energy with a symbol (such as “M” for motion energy) on the side facing up.



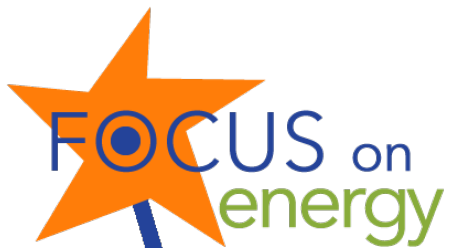
To represent energy transformation, cubes flip so that a different symbol (such as “Elas” for elastic energy) faces up .



The number of cubes showing a particular symbol on the upward side corresponds to the quantity of a particular form.

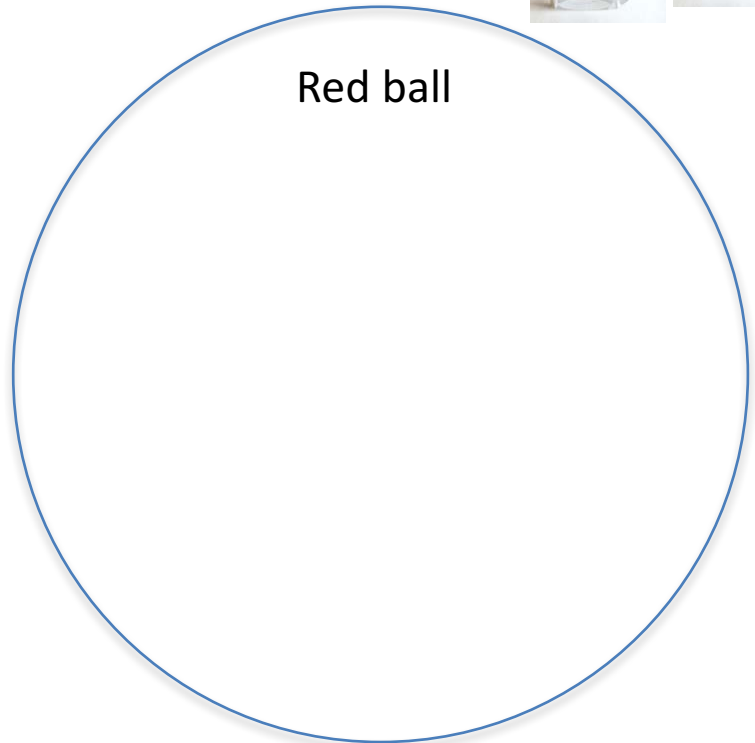
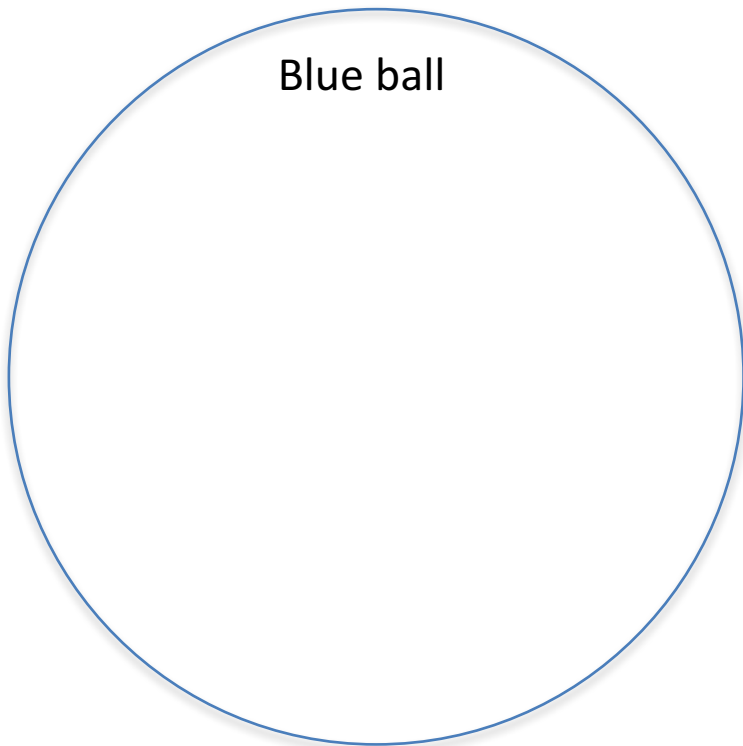
The number of cubes in a region corresponds to the quantity of energy in an object.

To show energy transfer, cubes move from one region to another.



# Energy Cube Representation

Slide the cubes to represent energy changes during the collision.



# Energy Cube Representation

Blue ball

Red ball moving along the track  
Blue ball stationary

Red ball



# Energy Cube Representation

Slide the cubes to represent energy changes during the collision.

Blue ball



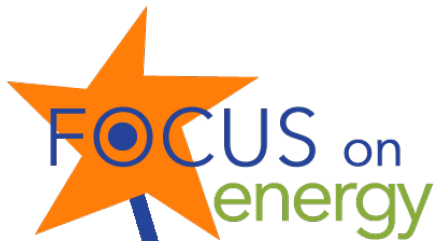
Red ball moving slowly

Red ball

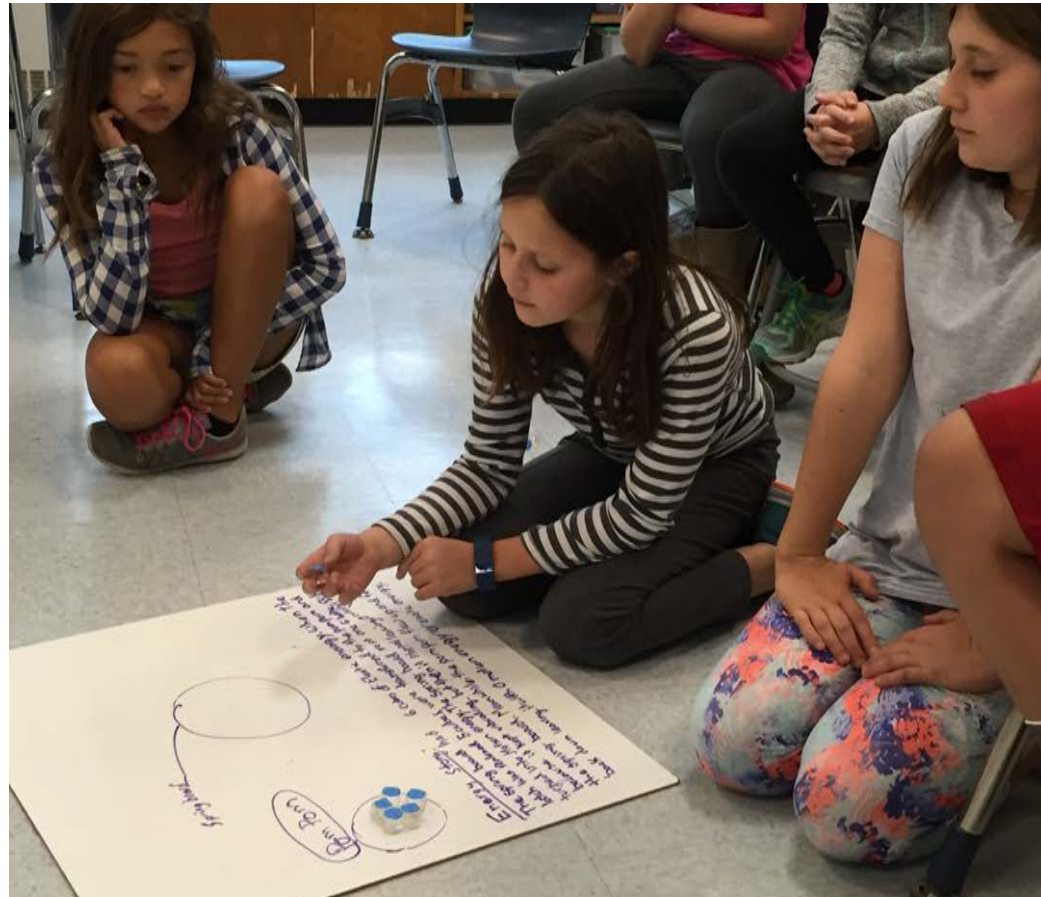


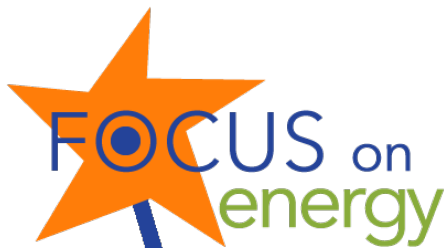
Blue ball moving fast





# What's the Energy Story of the Paint Paddle and the Pompom?





# The propeller and elastic band

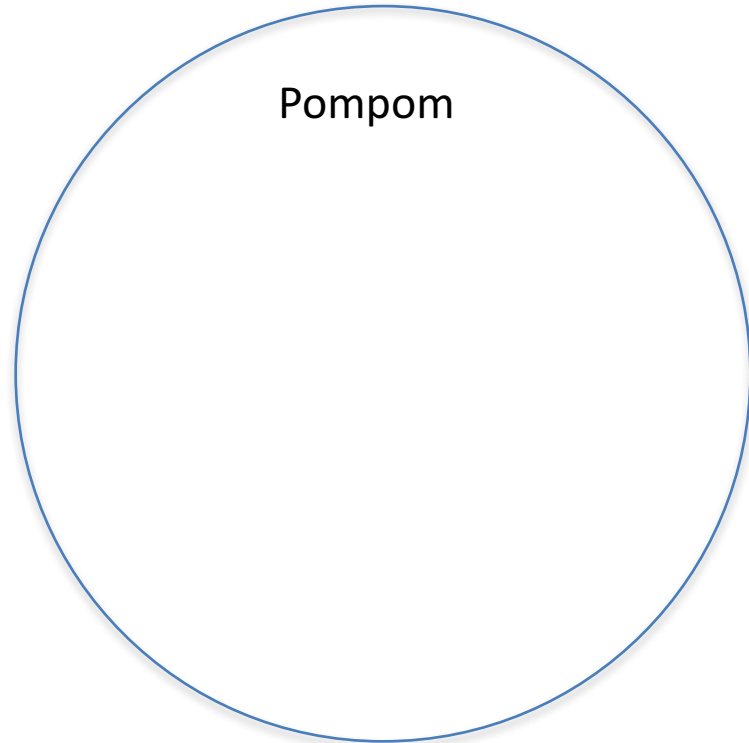
Use energy cubes and Energy Tracking Lens questions.

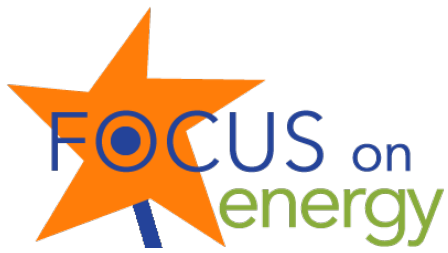
- System Components?
- Form(s) of energy?
- Energy gains and losses?
- Energy transfers
- Energy transformations?
- Where does the energy come from and where does the energy go?

Paint Paddle



Pompom

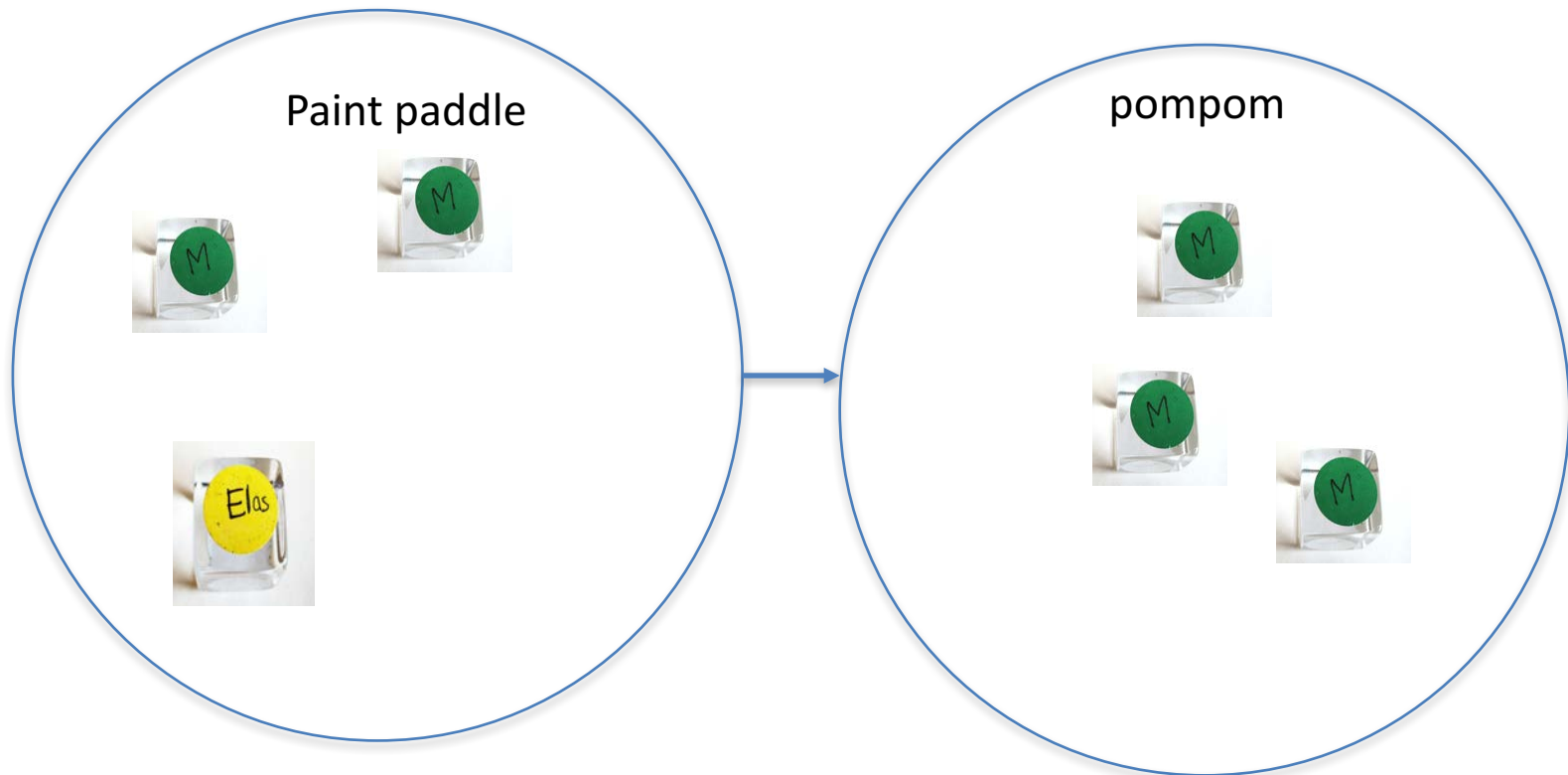


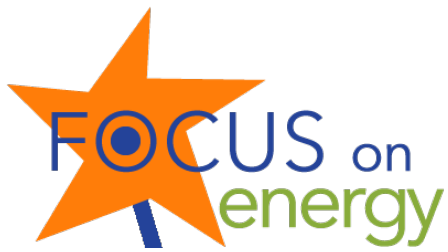


# The paint paddle and pompom

Use energy cubes and Energy Tracking Lens questions.

- System Components?
- Form(s) of energy?
- Energy gains and losses?
- Energy transfers
- Energy transformations?
- Where does the energy come from and where does the energy go?





# The paint paddle and pompom

Use energy cubes and Energy Tracking Lens questions.

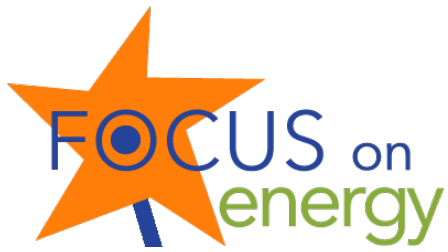
- System Components?
- Form(s) of energy?
- Energy gains and losses?
- Energy transfers
- Energy transformations?
- Where does the energy come from and where does the energy go?

Paint Paddle



Pompom

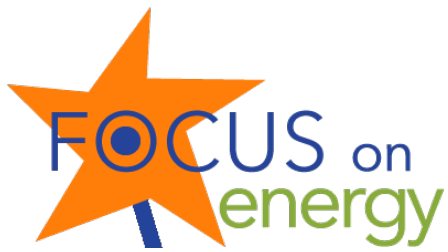




## The propeller and elastic band

- Turn the propeller 10-20 times and hold.
- Release the propeller.
- Observe changes in the propeller and the rubber band.
- Use energy cubes to describe the energy flow.





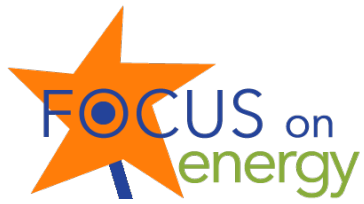
# The propeller and elastic band

Use energy cubes and Energy Tracking Lens questions.

- System Components?
- Form(s) of energy?
- Energy gains and losses?
- Energy transfers
- Energy transformations?
- Where does the energy come from and where does the energy go?

propeller

elastic band



# Looking Through The Energy Tracking Lens



What is the Evidence?

Part 1. What do you observe?

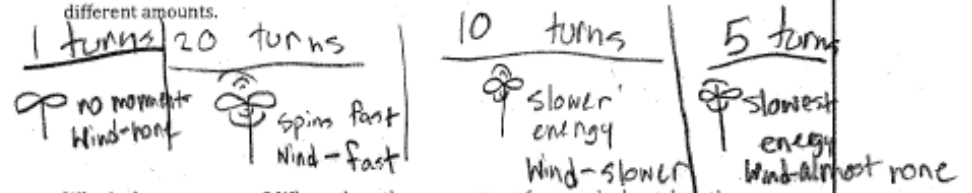
Part 2. Tell the energy story

- What are the system components?
- What form(s) of energy?
- Increase in motion energy?
- Decrease in elastic energy?
- Transformation from elastic to motion energy?
- Where does the energy come from and where does the energy go?

### The Energy Tracking Lens

- What's happening?

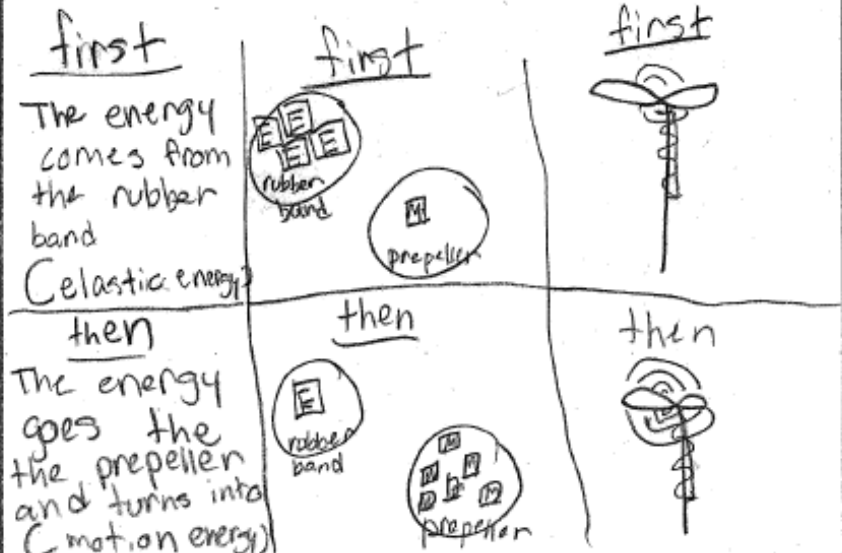
Describe what you observe when you turn the propeller or twist the elastic band different amounts.



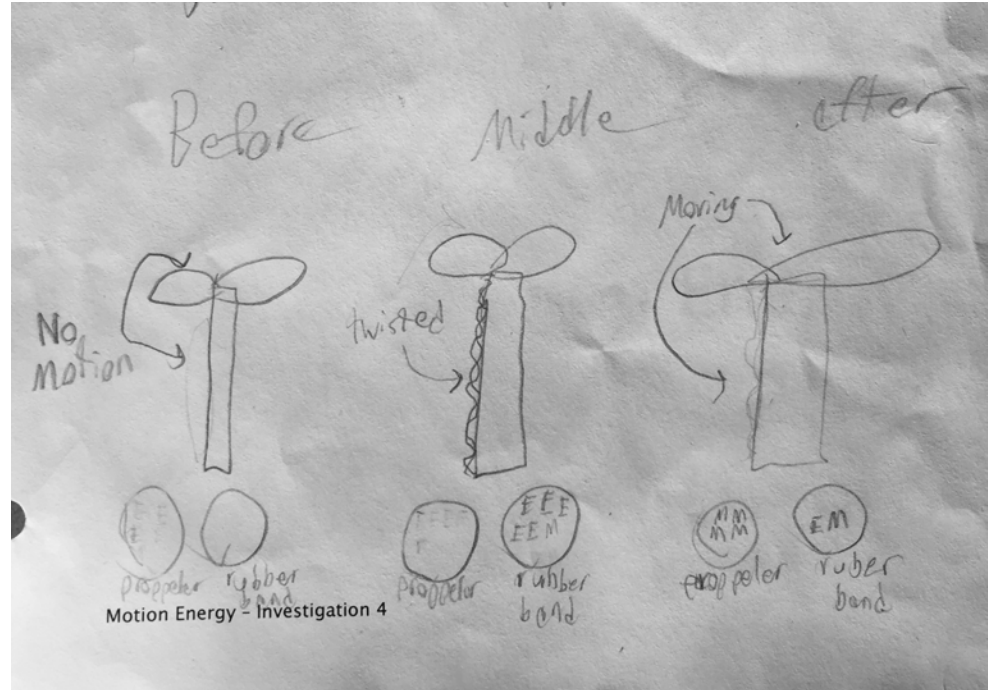
- What's the energy story? Where does the energy come from and where does the energy go?

Track the energy flow. You can use drawings, words, labels, and arrows. Show:

- Components of the system
- Form(s) of energy
- Energy transfers and transformations
- Energy gains and losses





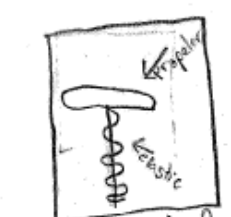


# Representing forms and flow of energy



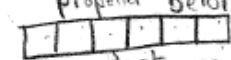
### The Energy Tracking Lens


- What's happening?  
Describe what you observe when you turn the propeller or twist the elastic band different amounts.  
*When you spin the propeller it twists the elastic band so then when you let go the propeller spins.*
- What's the energy story? Where does the energy come from and where does the energy go?  
Track the energy flow. You can use drawings, words, labels, and arrows. Show:
  - Components of the system
  - Form(s) of energy
  - Energy transfers and transformations
  - Energy gains and losses



Propeller before let go

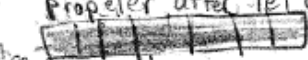
no elastic energy or motion

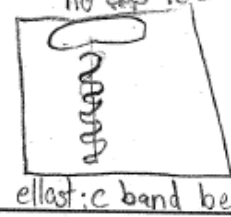




Propeller after let go


gain loss same






elastic band before let go


elastic

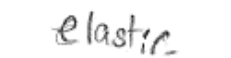


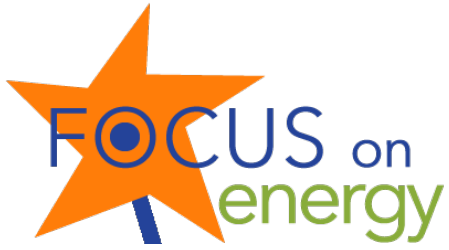


elastic band after let go

gain loss same



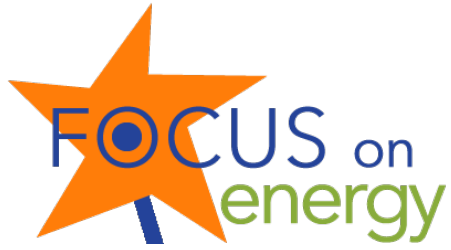
Motion En  motion



## Classroom Activities

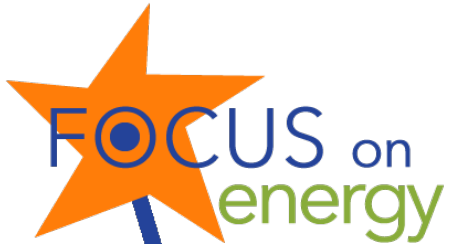
‘This was just so well thought out and pieced together carefully. And it builds up so nicely the ideas on top of each other and the investigations are so engaging and the students really get into them. But they’re not so complex that you can’t set them up in a prep period.’





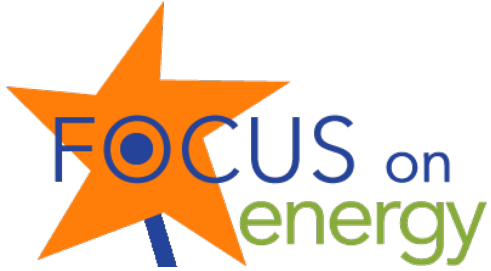
## Teacher Workshop

"Got me excited to teach the unit and I feel equipped to facilitate the lessons in the classroom. It was a phenomenal learning experience on a topic that I was unfamiliar /nervous to teach. THANK YOU!"



## Teacher Workshop

- . "I felt challenged and taken seriously as an adult learner and respected as a professional. I've added to, clarified and honed my own understanding and am ready to use my stronger skills and these excellent materials to help students use the Energy Tracking Lens!"



## Pilot Study

- 9 Teachers
- Summer Workshop: July 11-17, 2017
- Teach Focus on Energy 2017-2018

Contact: [Sara\\_Lacy@TERC.edu](mailto:Sara_Lacy@TERC.edu)

[Sally\\_Crissman@TERC.edu](mailto:Sally_Crissman@TERC.edu)

## Curriculum

- Available to everyone September, 2018
- [Focusonenergy.TERC.edu](http://Focusonenergy.TERC.edu)