



Climate Engineering Teaching Module

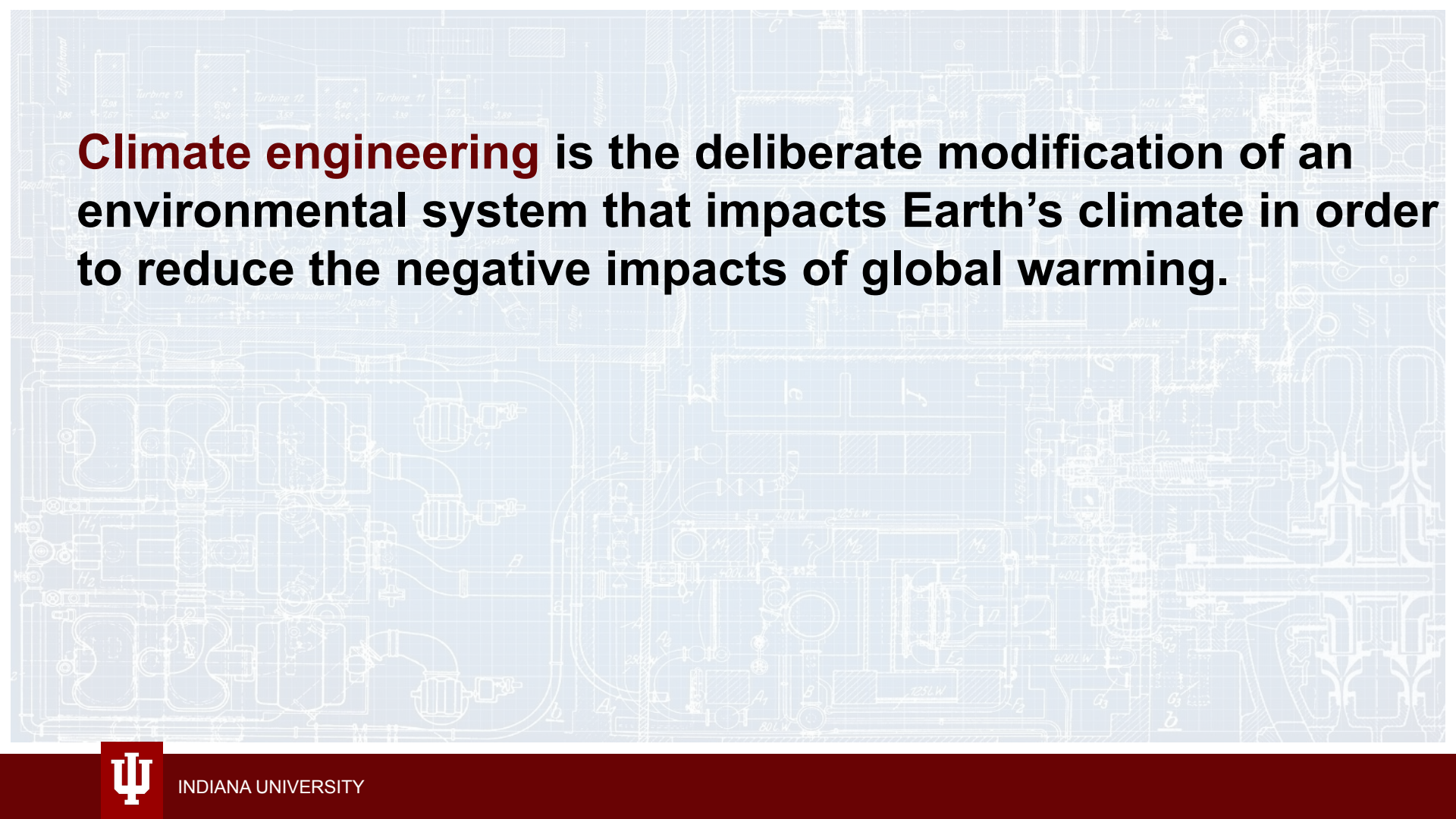
Lesson 1 – Collaborative Design Thinking

Ben Kravitz¹, Paul Goddard¹, and Adam Scribner²

1. Department of Earth and Atmospheric Sciences 2. The School of Education

Objective

Design a Technology to Slow Global Warming

The background of the slide is a detailed technical drawing or blueprint, rendered in a light blue color. It features various mechanical components, pipes, and structural elements, typical of an engineering schematic. The drawing is dense with lines and includes some text labels such as 'Turbine 13', 'Turbine 12', and 'Turbine 11' at the top. The overall aesthetic is that of a professional engineering document.

Climate engineering is the deliberate modification of an environmental system that impacts Earth's climate in order to reduce the negative impacts of global warming.



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But...

What is global warming and climate change?

How do we know it is occurring?

What are these environmental systems you speak of?

You want me to fix global warming?!?!



Climate change in ten words

It's real

It's us

It's bad

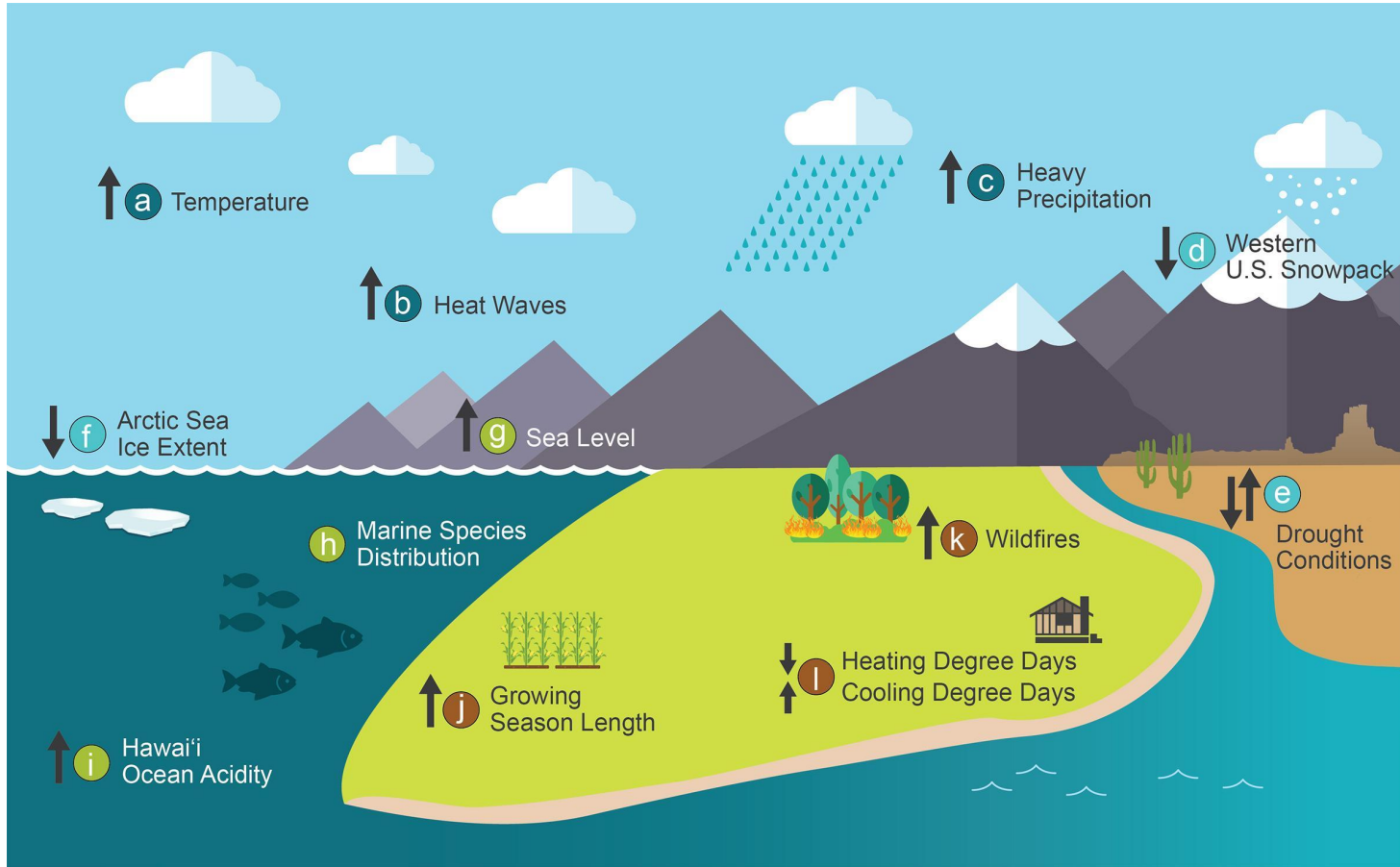
Scientists agree

There's hope

Tony Leiserowitz



Evidence of Climate Change

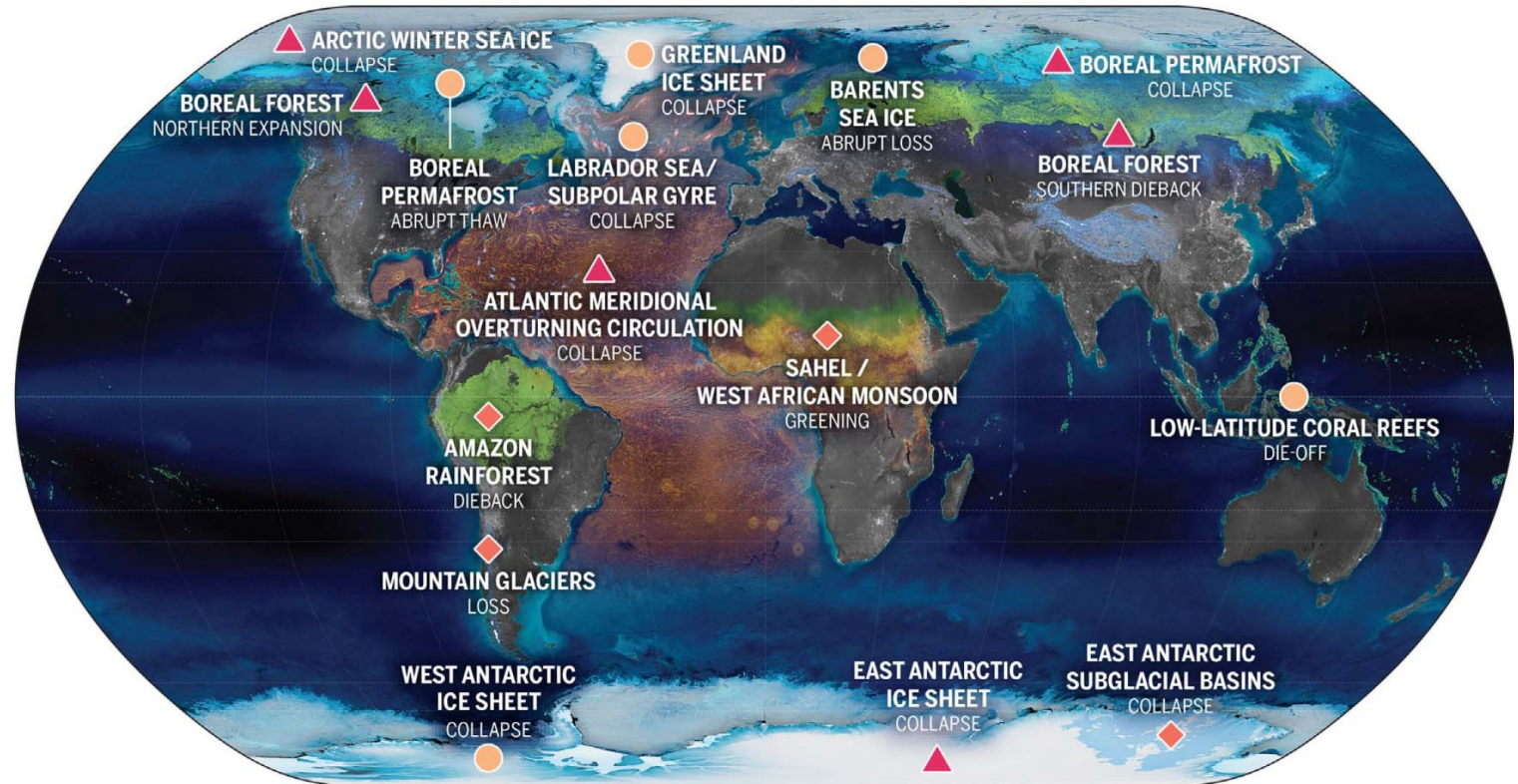


4th National
Climate
Assessment

(5th NCA just
released!)



Nearing Tipping Points



GLOBAL WARMING THRESHOLDS

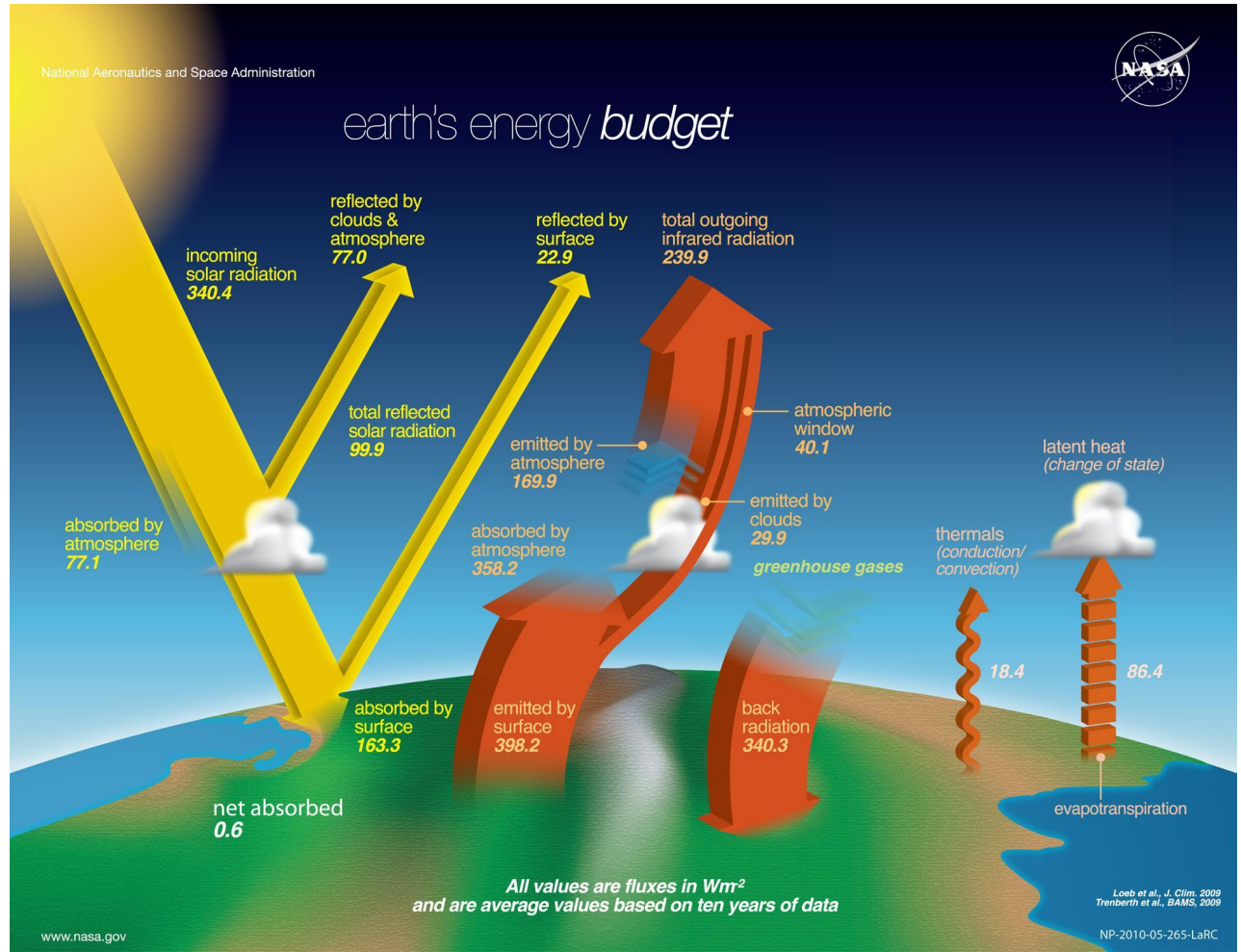
● $< 2^{\circ}\text{C}$ ◆ $2\text{--}4^{\circ}\text{C}$ ▲ $\geq 4^{\circ}\text{C}$

McKay et al. (2022)



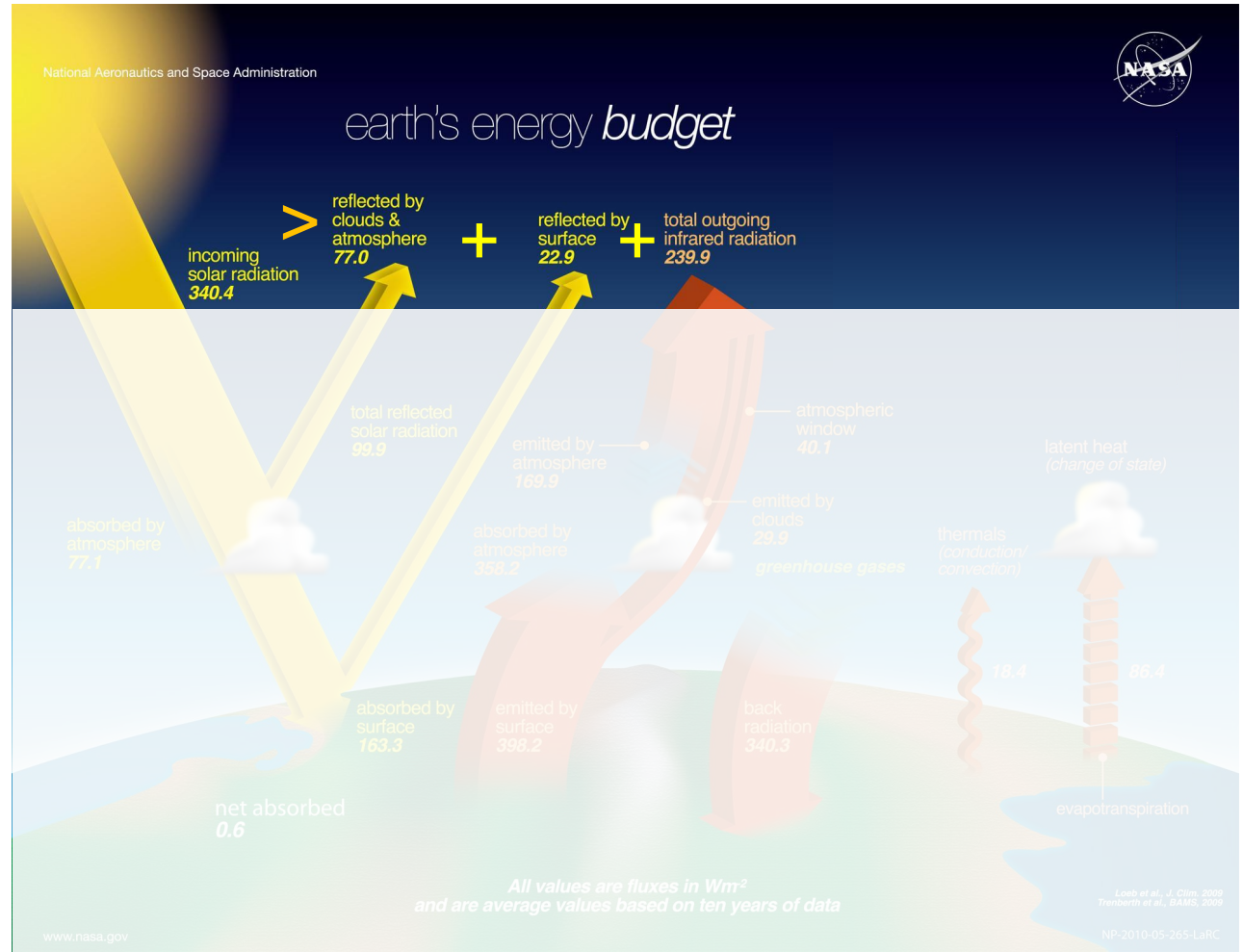
Global Warming Simplified:

Energy going in is greater than the energy going out



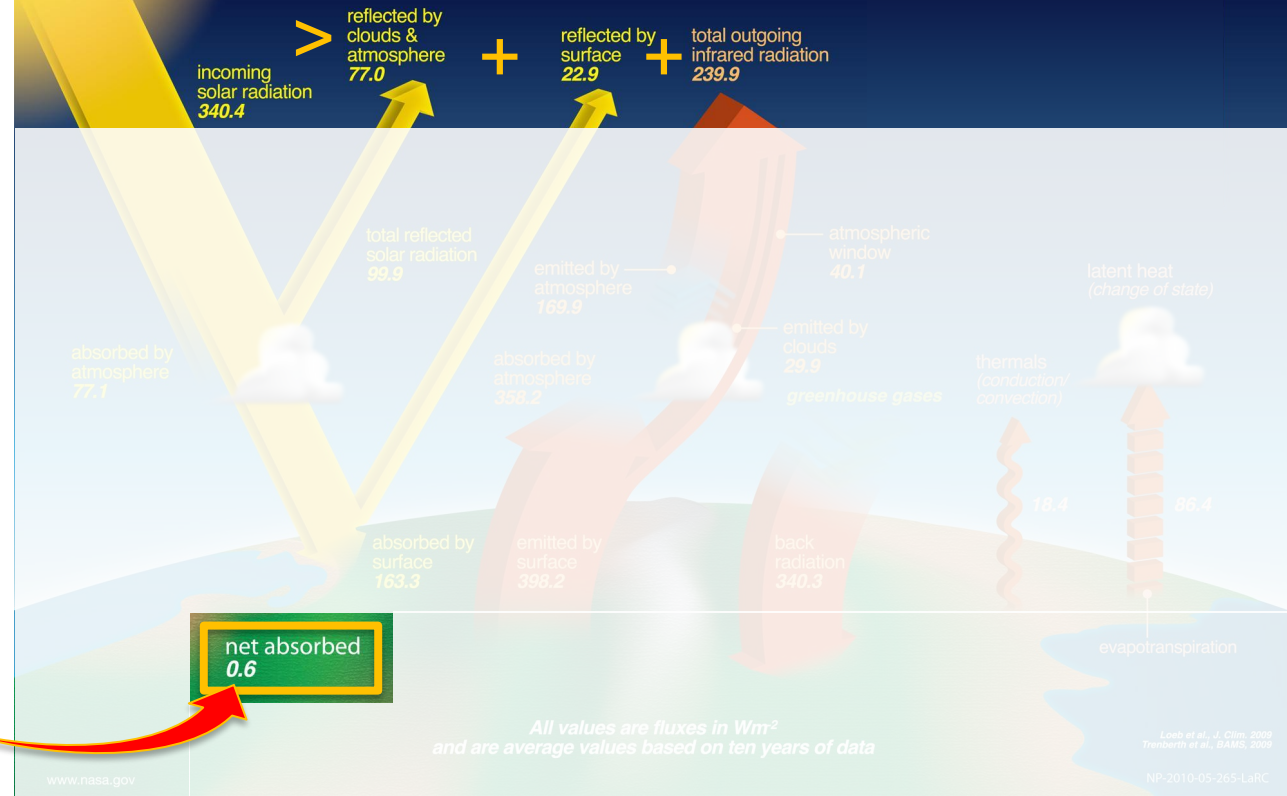
Global Warming Simplified:

Energy going in is greater than the energy going out

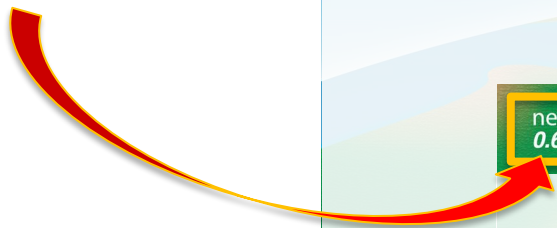




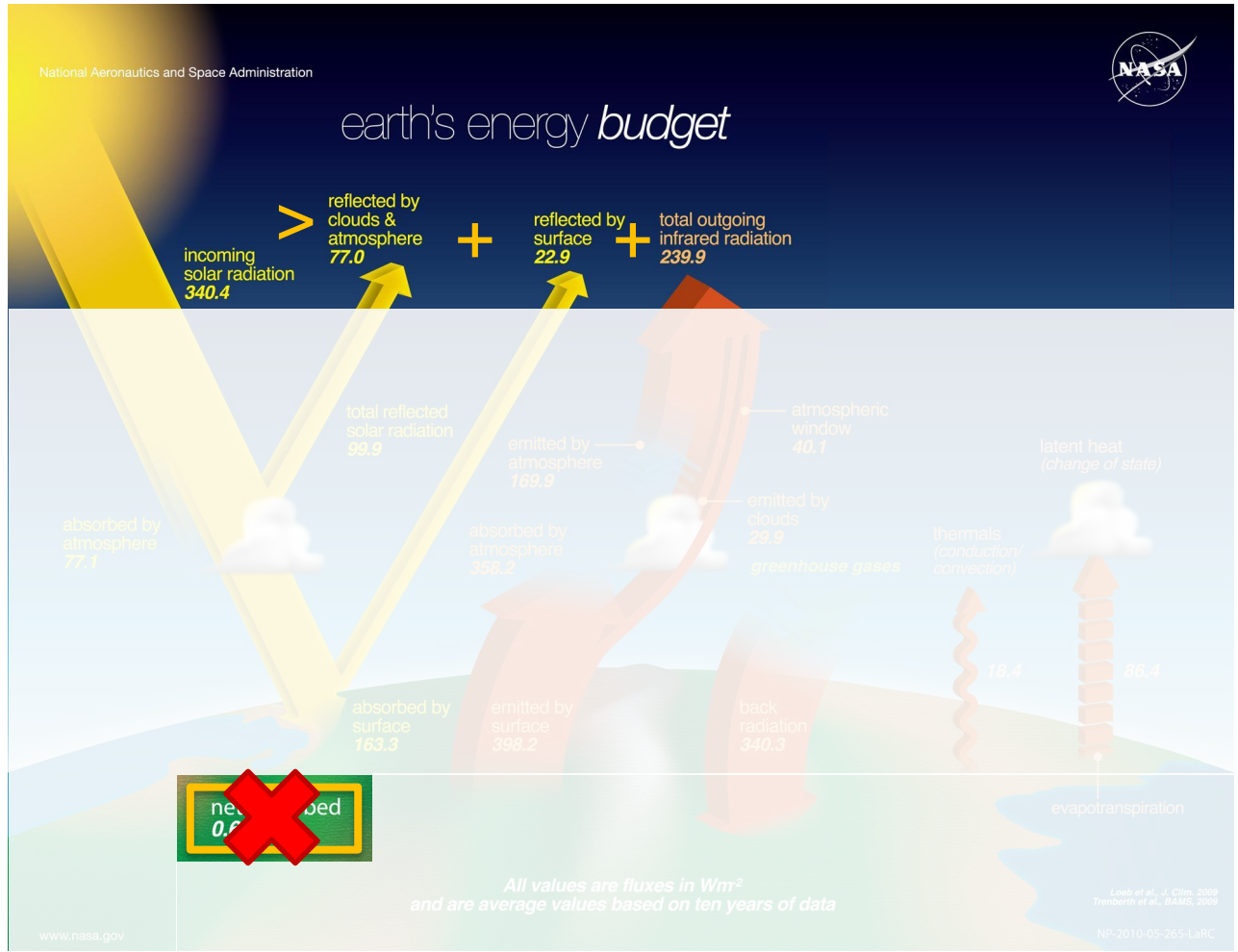
earth's energy *budget*



Global Warming Simplified:
Energy going in is greater than the energy going out

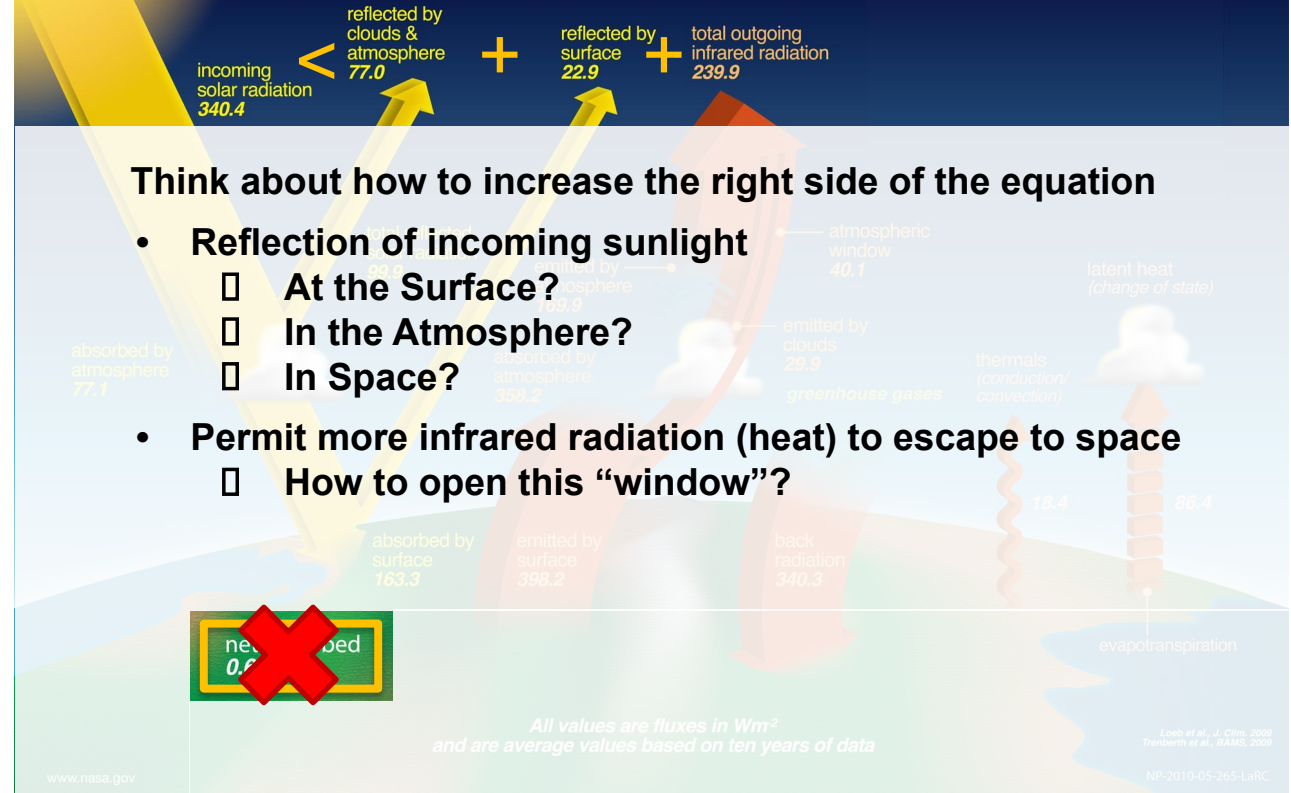


Climate Engineering is about developing technologies to reverse this inequality





earth's energy *budget*



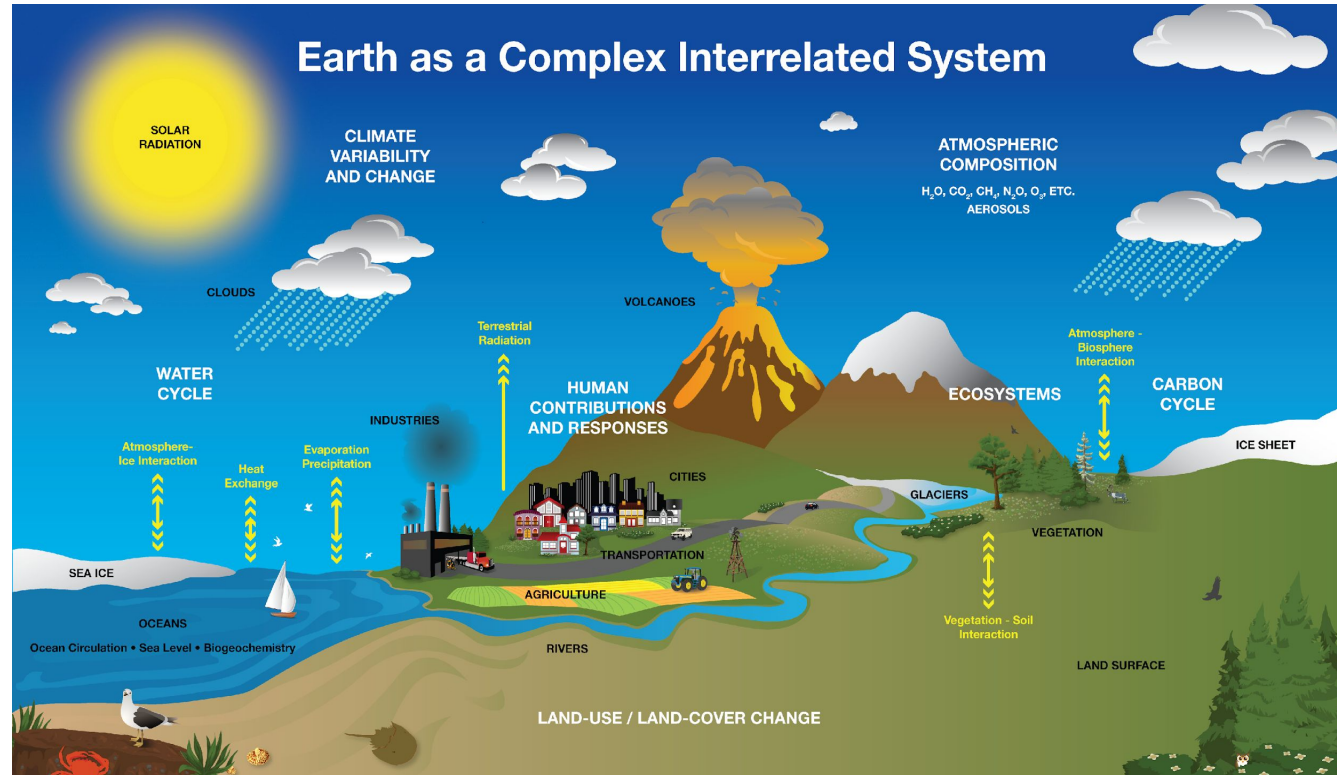
Think about how to increase the right side of the equation

- Reflection of incoming sunlight
 - At the Surface?
 - In the Atmosphere?
 - In Space?
- Permit more infrared radiation (heat) to escape to space
 - How to open this “window”?

Climate Engineering is about developing technologies to reverse this inequality



Climate Engineering is about developing technologies to reverse this inequality by modifying a part of the climate system



NASA



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Can you think of ways to modify these systems to slow global warming (increase the RHS of the equation??

Write as many (wild!) ideas as possible in 3 minutes.

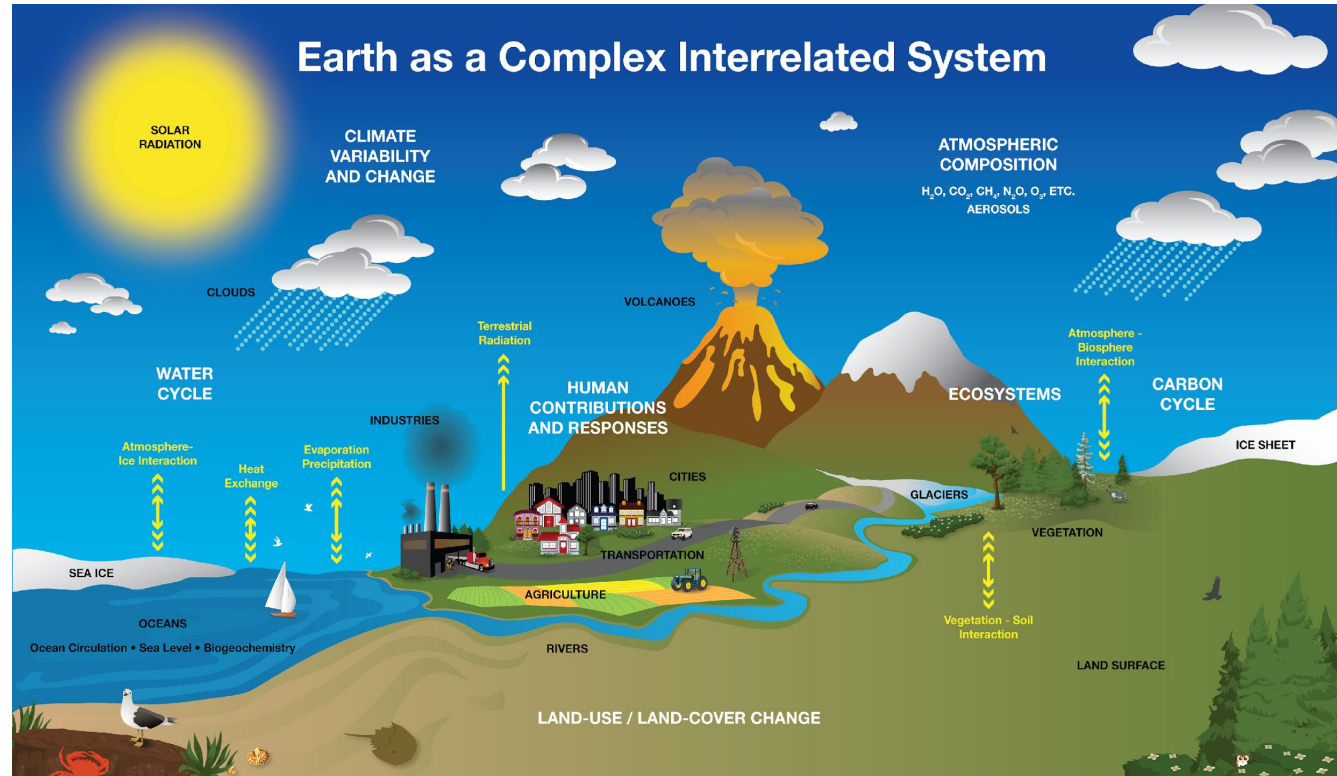
Incoming solar radiation

>

Total reflected incoming radiation

+

Total outgoing infrared radiation



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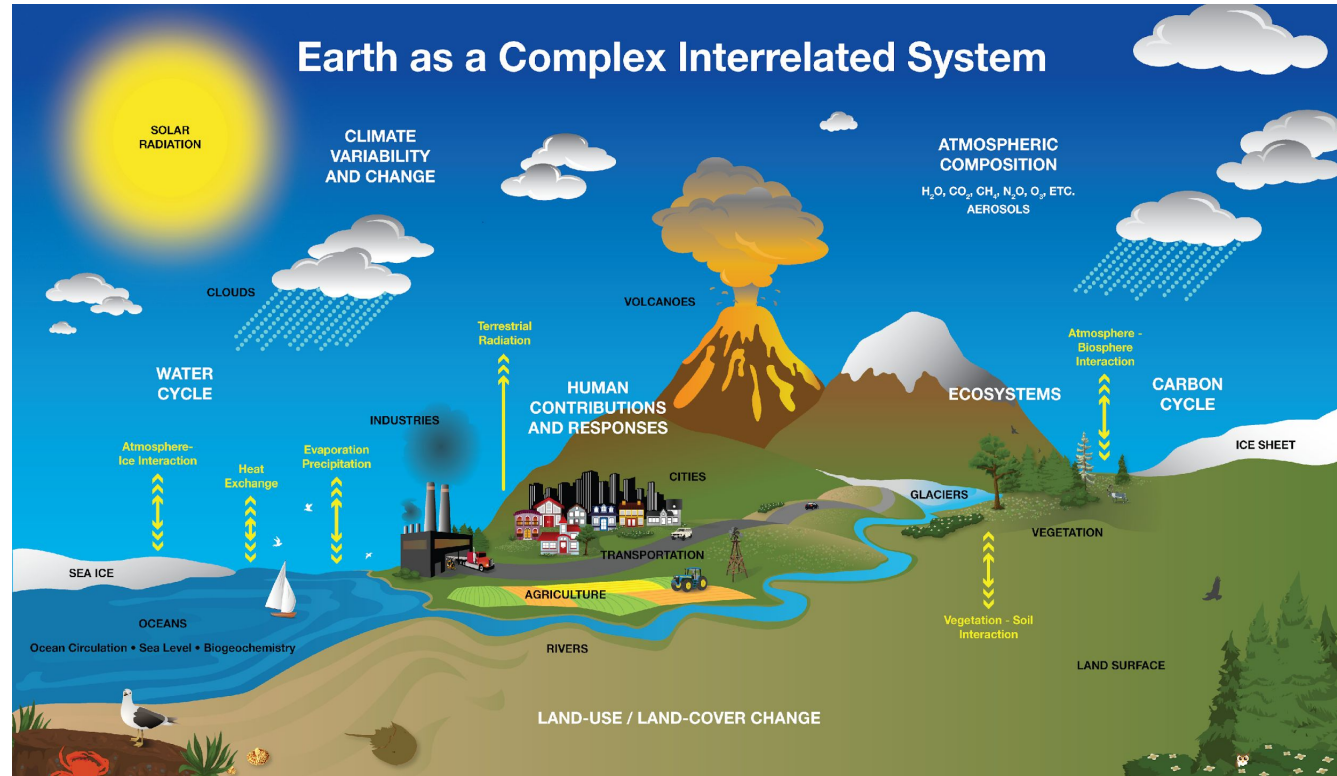
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*Catherine

Can you think of ways to modify these systems to slow global warming (increase the RHS of the equation??)

Now, as a small group write (wild!) ideas for 3 minutes

$$\text{Incoming solar radiation} < \text{Total reflected incoming radiation} + \text{Total outgoing infrared radiation}$$



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Incoming solar radiation <

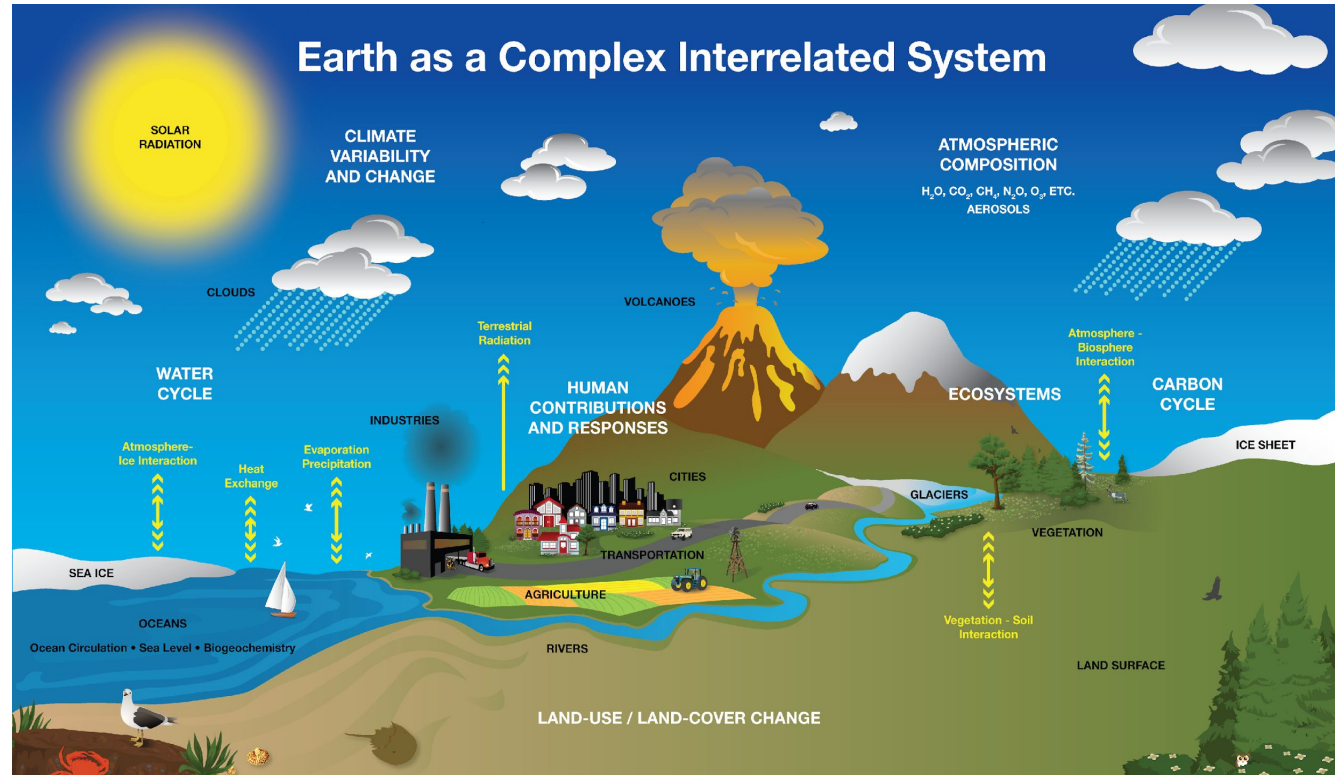
Total reflected incoming radiation +

Total outgoing infrared radiation

What ideas does AI have? - Ask ChatGPT:

“Create 10 wild ideas that fit the category of geoengineering to stop global warming”

Then ask ChatGBT: “But, more wild” to get some sensational ideas



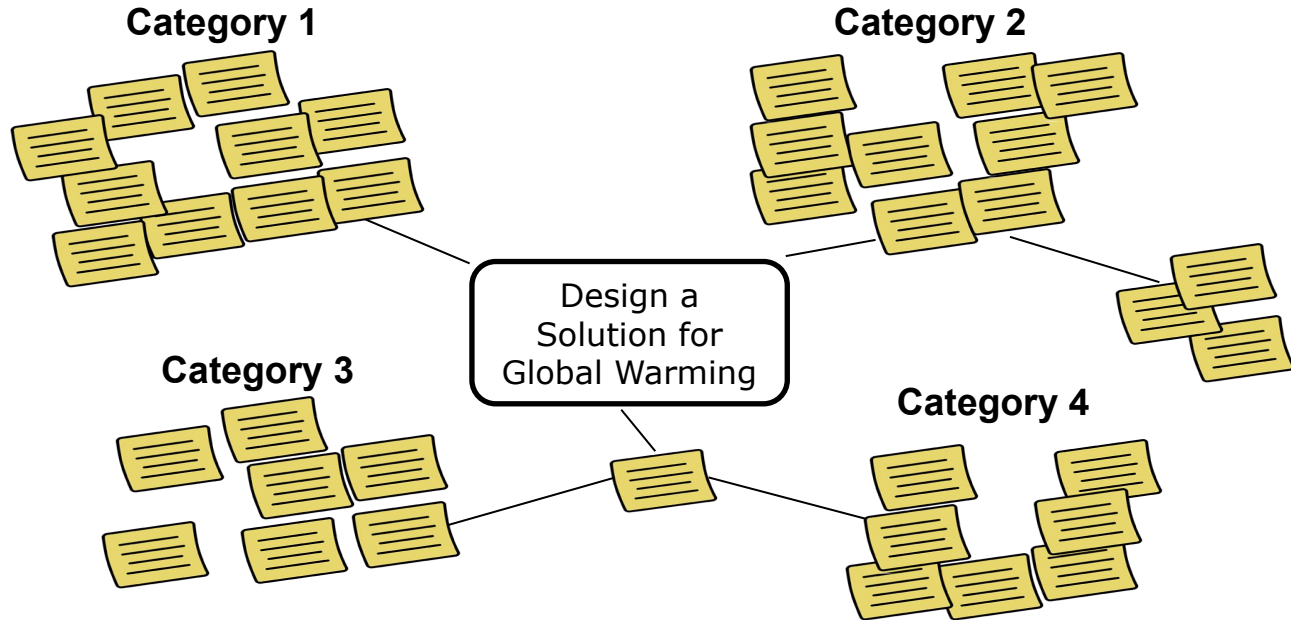
NASA



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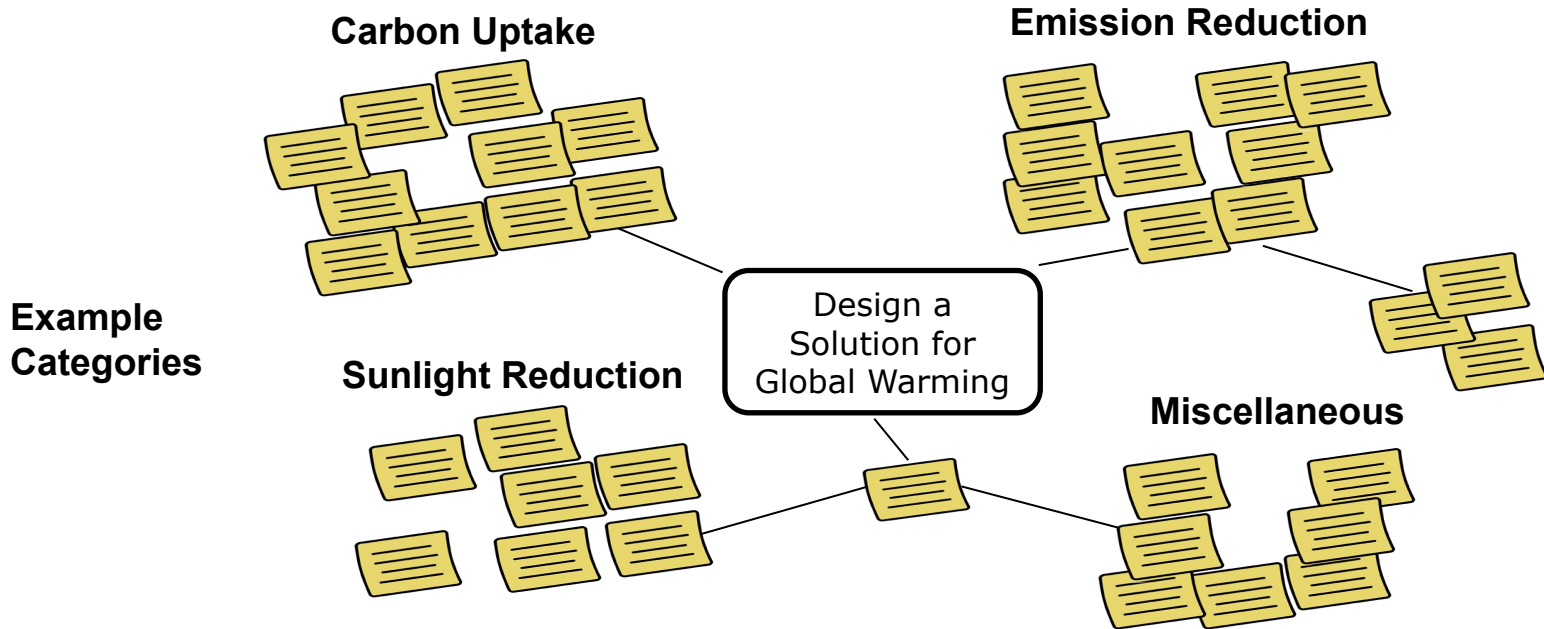
Mind Map

Organize group and individual sticky notes on large sheet of paper or wall.



Mind Map

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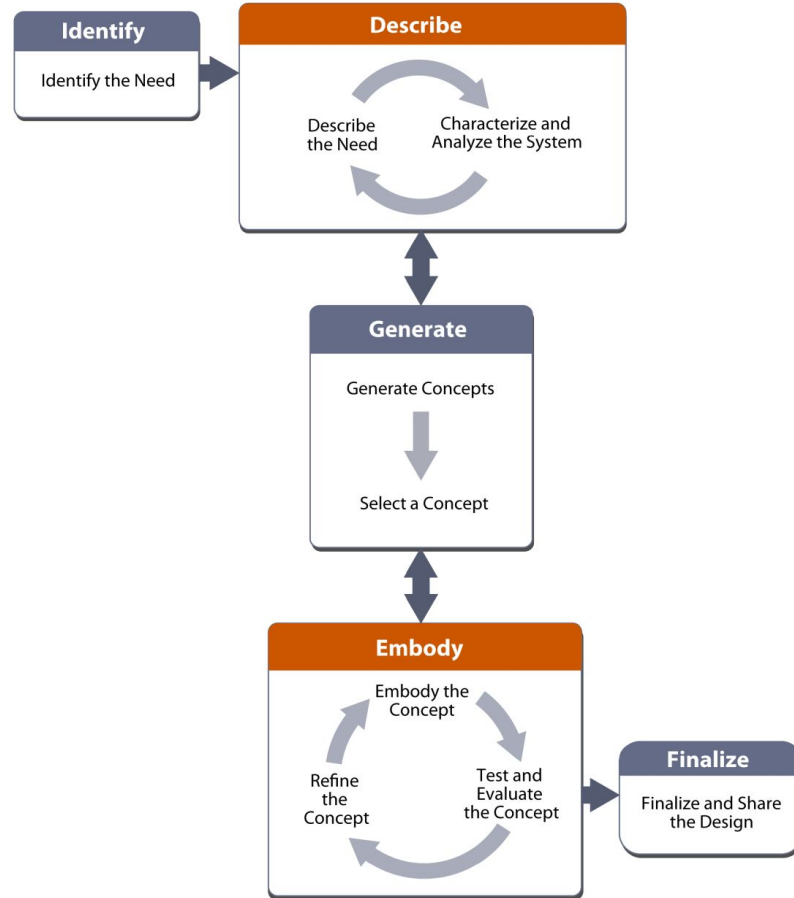


Collaborative Design

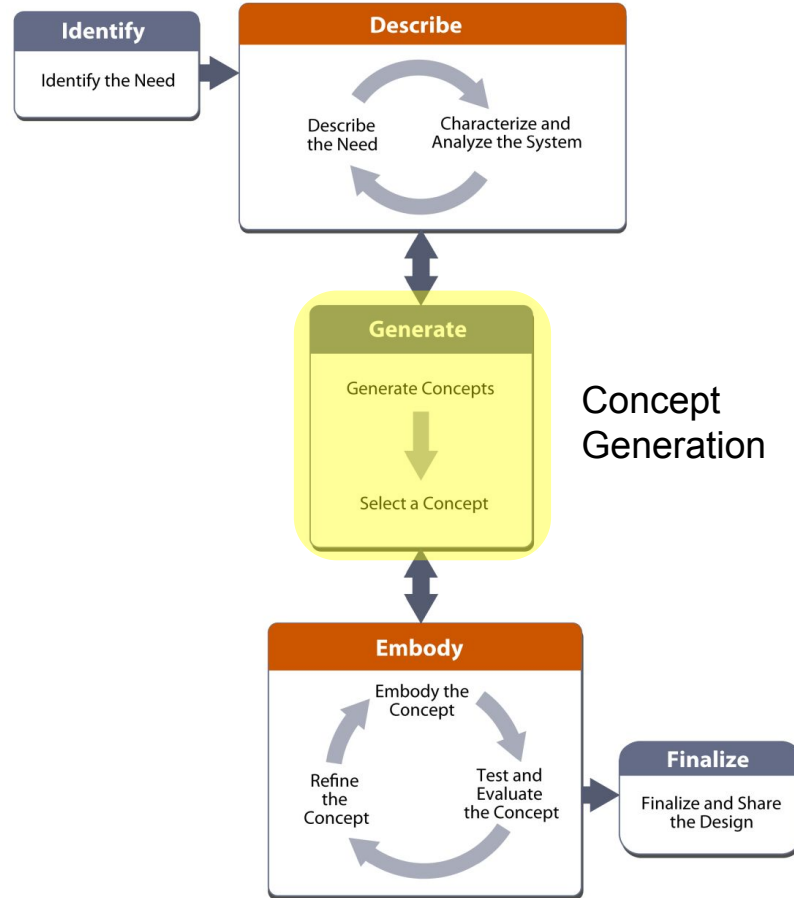
Collaborative design is when people think and brainstorm as team with a shared design goal.



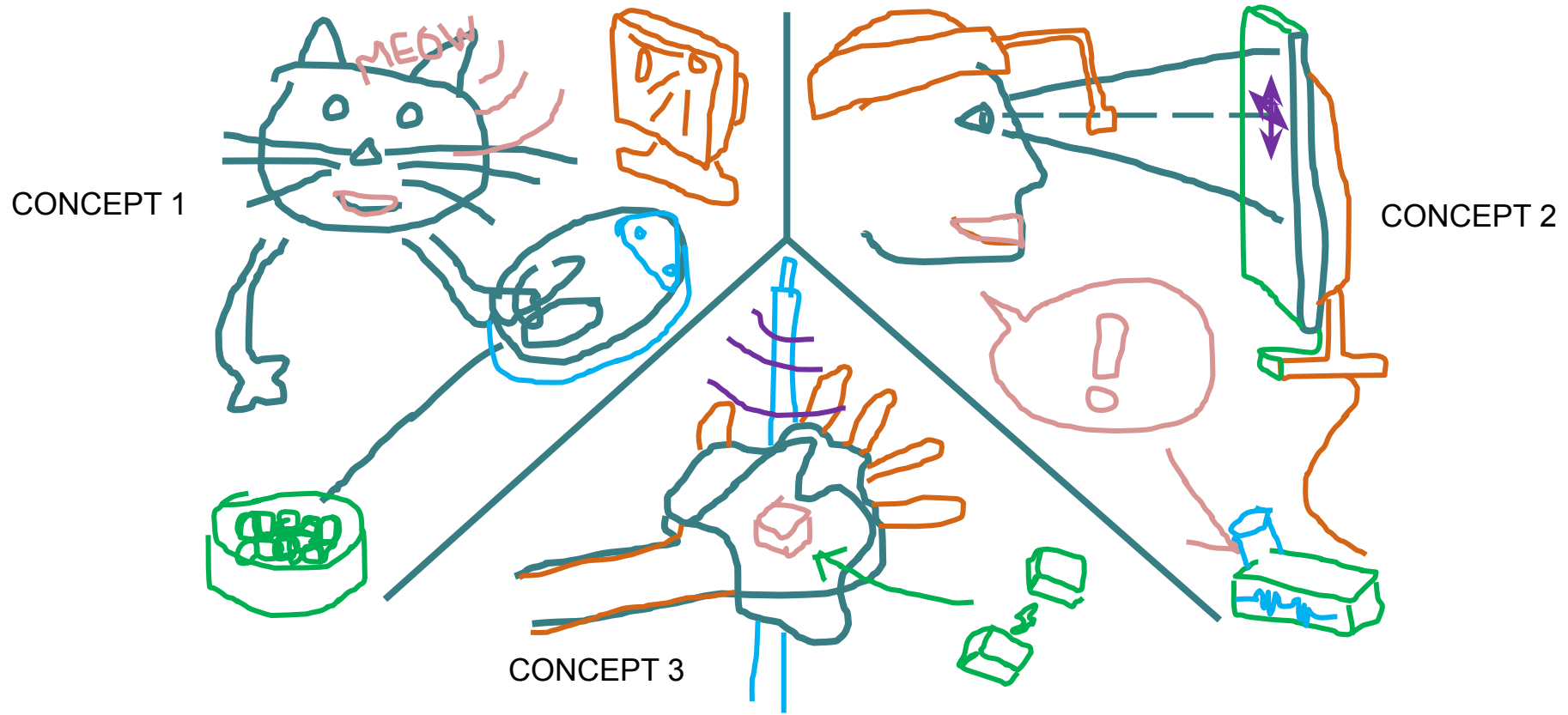
The Engineering Design Process can be Complex



The Engineering Design Process can be Complex



Concept Sketching



Concept Sketching

- Individually... Draw an upside-down “Y” on paper
- Sketch 3 ideas in the 3 spaces on your paper using one colored pencil (10 min)



Concept Sketching

- As a group... Pass your paper to the person to your right.
- Sketch more design details on their paper using your colored pencil (2-3 min for each rotation).
- Repeat until you have added to everyone else's papers.



Prepare for Lesson 2

This lesson introduced and developed ideas for engineering solutions to global warming and climate change.

In the next lesson we will learn about a specific climate engineering design that is currently being researched by scientists and engineers.

Questions/Comments/Thoughts/Ideas welcome!

Paul Goddard pgoddard@iu.edu
Ben Kravitz bkravitz@iu.edu
Adam Scribner

