ENERGY:
WHAT IS IT?

ENERGY

The ability to do work

Cannot be created or destroyed, can take different forms

Common Forms of Energy:

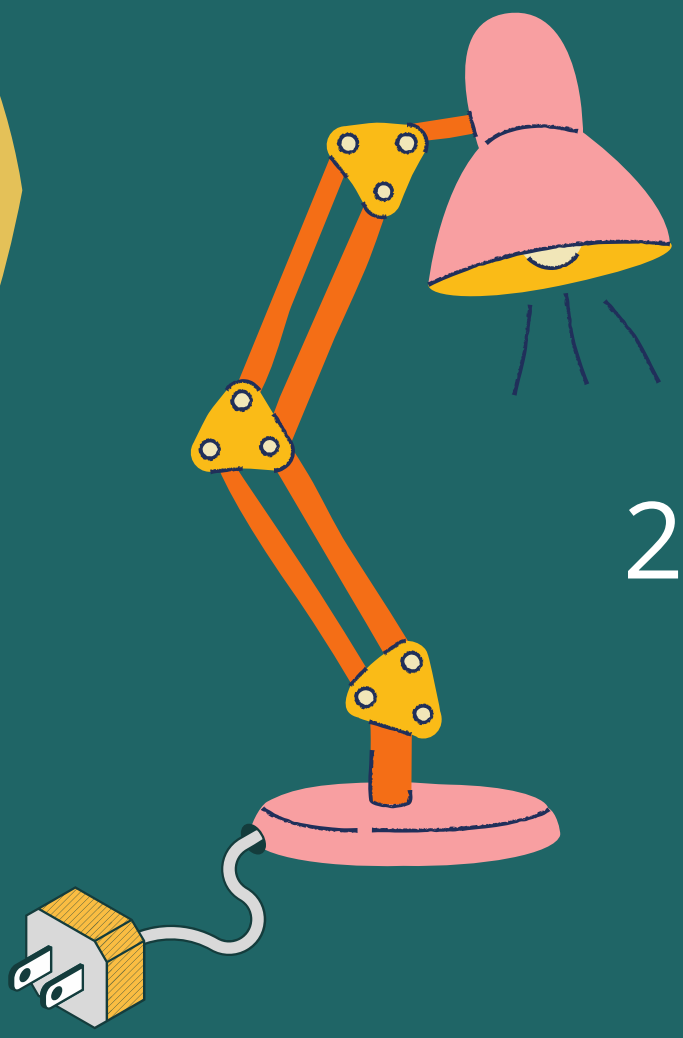
Electricity

Light

Heat

Sound

How does energy change form?



3) heat energy produced over time

2) light energy generated

1) electrical energy from outlet

All forms of energy need to be considered when we evaluate our *energy systems*

CLASSIFYING ENERGY:

1. POTENTIAL ENERGY

The **energy stored** within something

batteries (chemical)

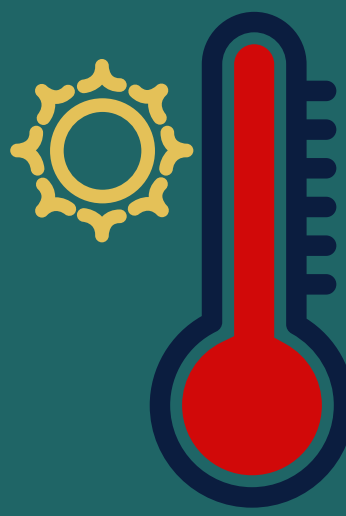
nuclear 

hydropower (gravitational)

CLASSIFYING ENERGY:

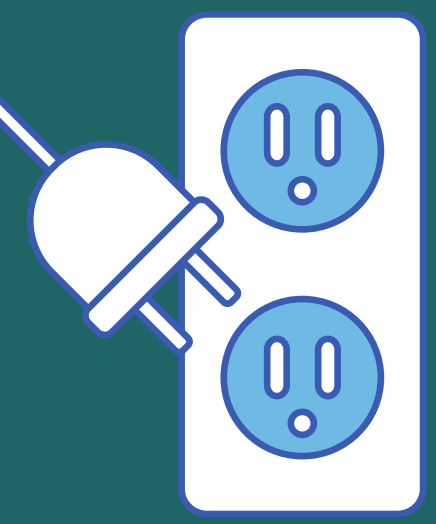
2. KINETIC ENERGY

The energy of something **in motion**



heat (movement of atoms)

light & xrays (radiant energy, moves in waves)



lightning & electricity (movement of electrons)

CLEAN ENERGY:

A QUICK GUIDE

CLEAN ENERGY

Renewable, zero-emission energy.

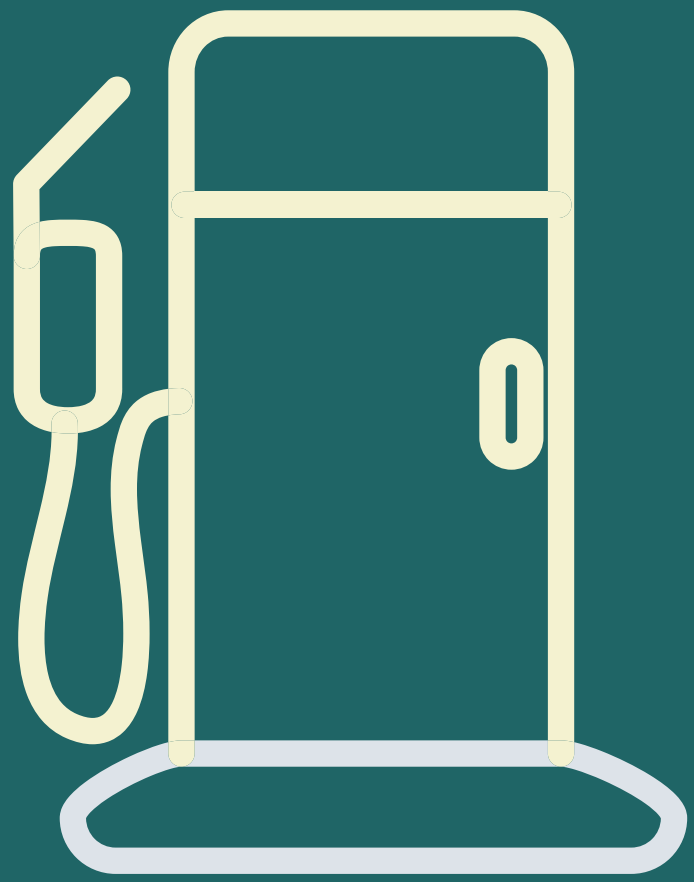
Common renewable, low-emission energy sources:

solar
wind
biomass
hydro
geothermal

"ZERO-EMISSION" VS. FOSSIL FUELS

Energy-related emission primarily from fossil fuels (oil, coal, gas)

carbon dioxide from fossil fuels accounted for 75% of UW human-caused greenhouse gas emission in 2018



U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018, April 2020.

CLEAN ENERGY

Energy saved through energy efficiency.

Energy efficiency allows smaller amounts of energy to complete the same processes.

- conservation efforts
- new technology
- new manufacturing processes

SOLAR ENERGY

OVERVIEW

WHAT IS SOLAR ENERGY?

1. electrical energy produced from sunlight
2. enabled by the photovoltaic effect

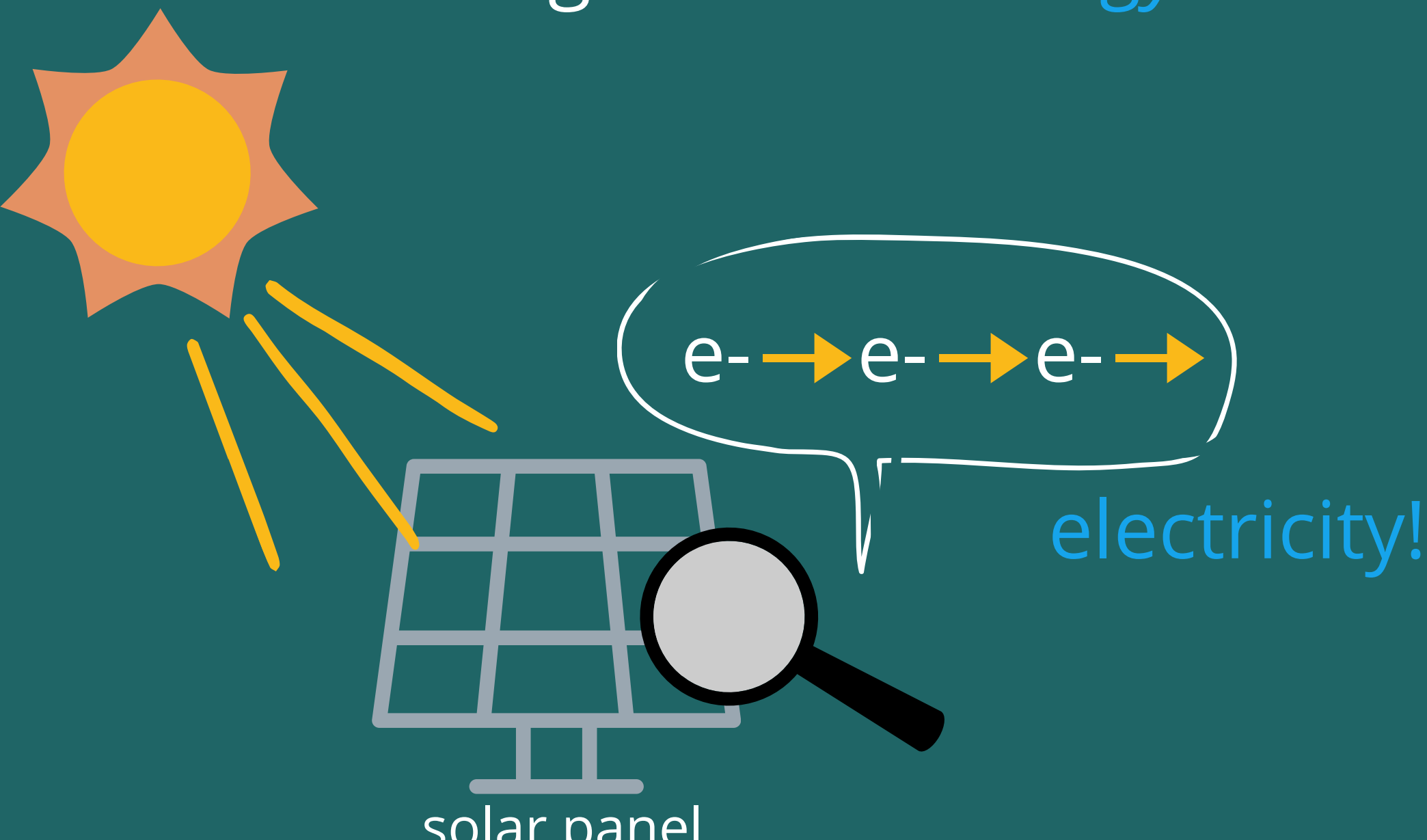
Sunlight

Electrical Energy

Electrical Energy: the flow of electrical charge (e.g. electron flow)

<u>The Photovoltaic Effect:</u>

1. material absorbs *light*, generating energized electrons (e-)
2. the energized electrons move, creating *electrical energy*



ADVANTAGES

- a form of renewable, carbon-free energy
- sunlight is abundant everywhere
- advancing technology enables broader use and more affordable prices

LIMITATIONS

- doesn't work when the sun isn't out
  - energy storage is expensive!
- producing solar panels takes a lot of energy
- lifespan: disposal and recycling necessary when panels get old
- won't work at every site depending on trees, buildings, angle, etc.

MORE INFO + SOURCES

(1) www.energy.gov/eere/solar/solar-energy-technologies-office
(2) cleanenergywiki.org
(3) www.nrel.gov/solar/index.html

ENERGY STORAGE OVERVIEW

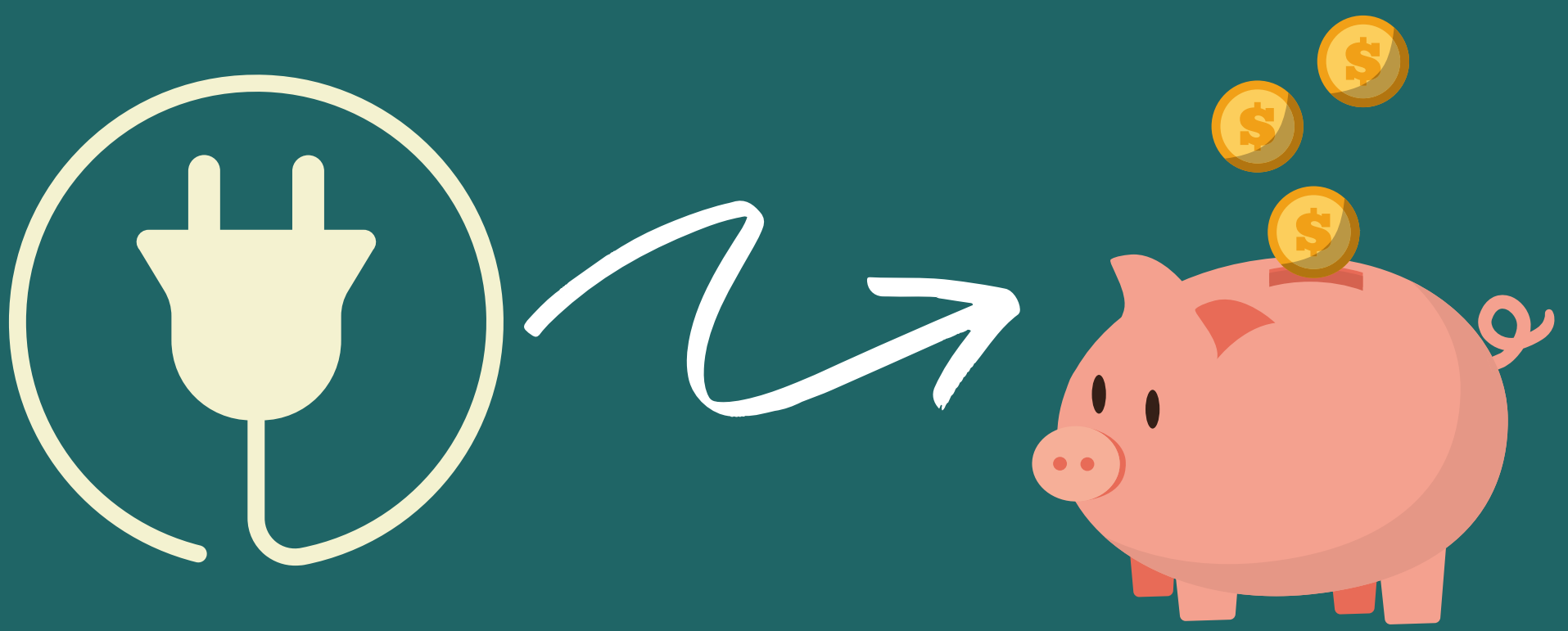
CLEAN ENERGY + ENERGY STORAGE

Renewable energy generation is *highly variable*:
e.g. solar energy can only be generated during the day

To rely on renewable energy sources, we need a way to store energy for future use (e.g. nighttime)

WHAT IS ENERGY STORAGE?

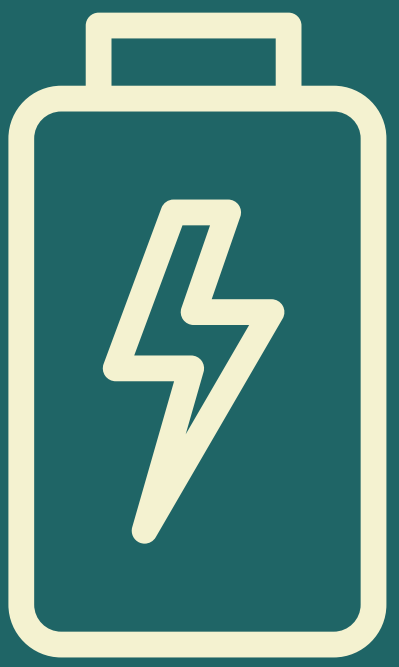
Energy set aside for use at some future point in time



Energy Storage: a stockpile of energy for future use

CURRENT METHODS:

- pumped hydro
  - 99% of global energy storage
- thermal storage
- battery storage
  - conventional household batteries, and advanced new technology
- & many others!



CONSIDERATIONS:

- different types of storage for different needs!

- size and scope of storage
- portability (e.g. for electric vehicles)
- energy density
- power & efficiency
- cost
- safety

MORE INFO + SOURCES

(1) www.eesi.org/papers/view/energy-storage-2019
(2) cleanenergywiki.org/index.php?title=Storage_Basics
(3) www.energy.gov/oe/energy-storage
(4) www.sandia.gov/ess-ssl/global-energy-storage-database-home/

ENERGY SYSTEMS

OVERVIEW

THE GRID

the system that delivers electric power to houses & businesses

(1) generation

power plants, solar and wind farms, etc.

(2) transmission

carries power from generation site

(3) distribution

power goes to consumers for use

THE TRADITIONAL GRID

stability:

electricity demand must meet electricty supply - if it doesn't blackouts can occur

generation:

power is generated at remote power plants and transmitted to users

THE GRID + SOLAR ENERGY: PROBLEMS

(1) supply/demand balance:
solar energy production is variable and unpredictable, causing unstablility in the grid

THE GRID + SOLAR ENERGY: PROBLEMS

(2) voltage control:
traditional generation and transmission goes from a power plant to consumers - allows control over ensuring voltage is in an acceptable range
with at-home solar cells, the power is produced at the consumer's site without the ability to control the voltage.

THE GRID + SOLAR ENERGY: PROBLEMS

(3) line overloads:

any given power line can only carry so much power

since solar farms can produce a lot of energy at once, they can overload the power lines

MORE INFO + SOURCES

(1) www.enbridge.com/energy-matters/energy-school/grid-101
(2) greeningthegrid.org/quick-reads
(3) cleanenergywiki.org/index.php?title=Grid_Integration_of_Renewables