

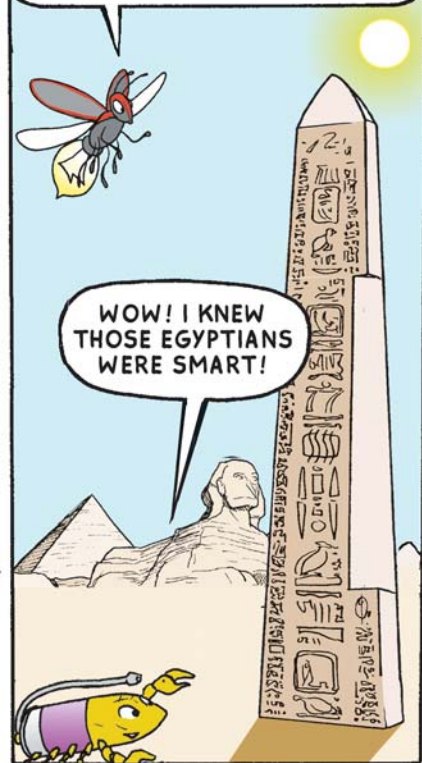


HURRY UP,
LIGHTNING!
I WANT TO
EXPLORE
MORE ENERGY!

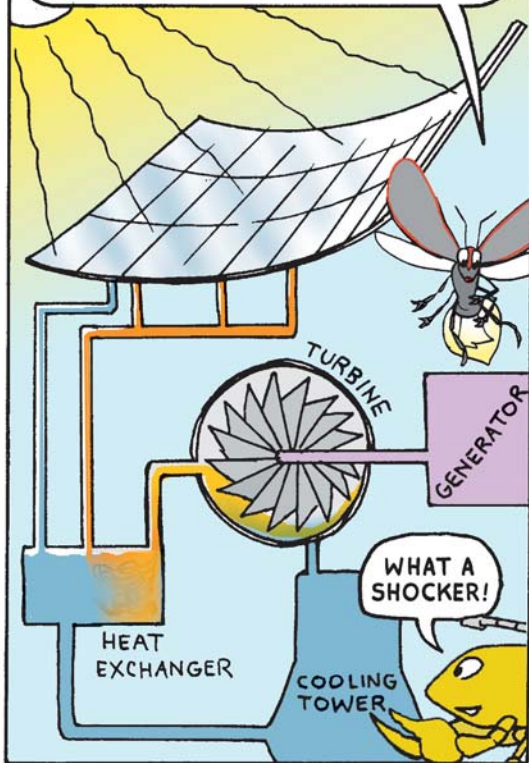
WE ARE EXPLORING ENERGY
RIGHT NOW, SCORPY, AS THE
SUN'S RENEWABLE **SOLAR**
ENERGY DRIES THIS LAUNDRY.

THE SUN SUSTAINS LIFE ON OUR
PLANET. IT KEEPS US WARM AND
ALSO ENABLES PLANTS TO GROW
SO THAT WE CAN EAT. EVEN THE
ANCIENT EGYPTIANS RECOGNIZED
THE IMPORTANCE OF THE SUN.

MODERN SOLAR PANELS ABSORB
SUNLIGHT AND CONVERT IT TO
ELECTRICITY THROUGH A
PHOTOVOLTAIC DEVICE. THE SUN'S
RAYS CAN ALSO BE USED TO
CREATE STEAM TO TURN A
TURBINE ATTACHED TO A
GENERATOR THAT CREATES
ELECTRICITY.



WOW! I KNEW
THOSE EGYPTIANS
WERE SMART!



WHAT A
SHOCKER!



SO THE SUN'S HEAT
DRIES OUR CLOTHES
AND HEATS OUR
WATER, TOO! WE
COULDN'T EXIST
WITHOUT IT.

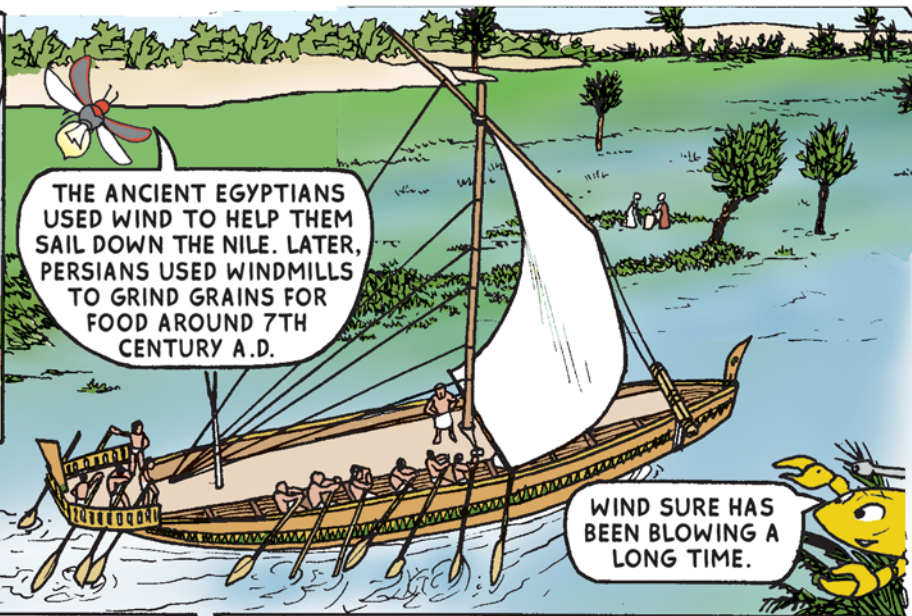


HMMM. WITHOUT THE
SUN'S RENEWABLE ENERGY,
WE ALL WOULD BE LEFT
OUT IN THE DARK!



WHAT A WINDY DAY, LIGHTNING!

HOW CONVENIENT - OUR NEXT RENEWABLE SOURCE OF ENERGY TO EXPLORE IS **WIND!**




THE ANCIENT EGYPTIANS USED WIND TO HELP THEM SAIL DOWN THE NILE. LATER, PERSIANS USED WINDMILLS TO GRIND GRAINS FOR FOOD AROUND 7TH CENTURY A.D.

WIND SURE HAS BEEN BLOWING A LONG TIME.



WINDMILLS PROVIDED POWER FOR MANY REMOTE WESTERN COMMUNITIES IN THE EARLY 1900s. BY THE 1930s, THESE WINDMILLS WERE REPLACED BY POWER LINES THAT TRANSPORTED ELECTRICITY TO REMOTE LOCATIONS.

I HAD NO IDEA THAT WIND COULD GENERATE ELECTRICITY. THANKS FOR **ENLIGHTENING** ME!



DURING THE OIL CRISIS OF THE 1970s, PEOPLE BEGAN TO ONCE AGAIN USE WIND TO CREATE ELECTRICITY. IN THIS CASE THE WIND TURNS THE TURBINE BLADES ATTACHED TO A GENERATOR TO PRODUCE ELECTRICITY. A FAMOUS WIND FARM IN TEXAS HAS 46 WIND TURBINES TO POWER OVER 7,000 HOMES.

WOW! I'M BECOMING A **BIG FAN** OF WIND POWER!

COWABUNGA!

I LOVE SMITH MOUNTAIN LAKE!

NO SWIMMING YET, SCORPY. WE'RE HERE TO EXPLORE THE HYDROELECTRIC DAM USING **WATER** FLOW TO CREATE ENERGY.

WATER IS ONE OF THE OLDEST AND MOST OFTEN USED SOURCES OF ENERGY. HISTORICALLY IT HAS BEEN USED TO TURN PADDLE WHEELS TO GRIND GRAIN.

IN MODERN TIMES WITH A DAM, WATER ACCUMULATES IN A RESERVOIR. IT'S THEN RELEASED TO FLOW THROUGH A PIPE WHERE IT TURNS BLADES IN A TURBINE TO SPIN A GENERATOR THAT PRODUCES ELECTRICITY.

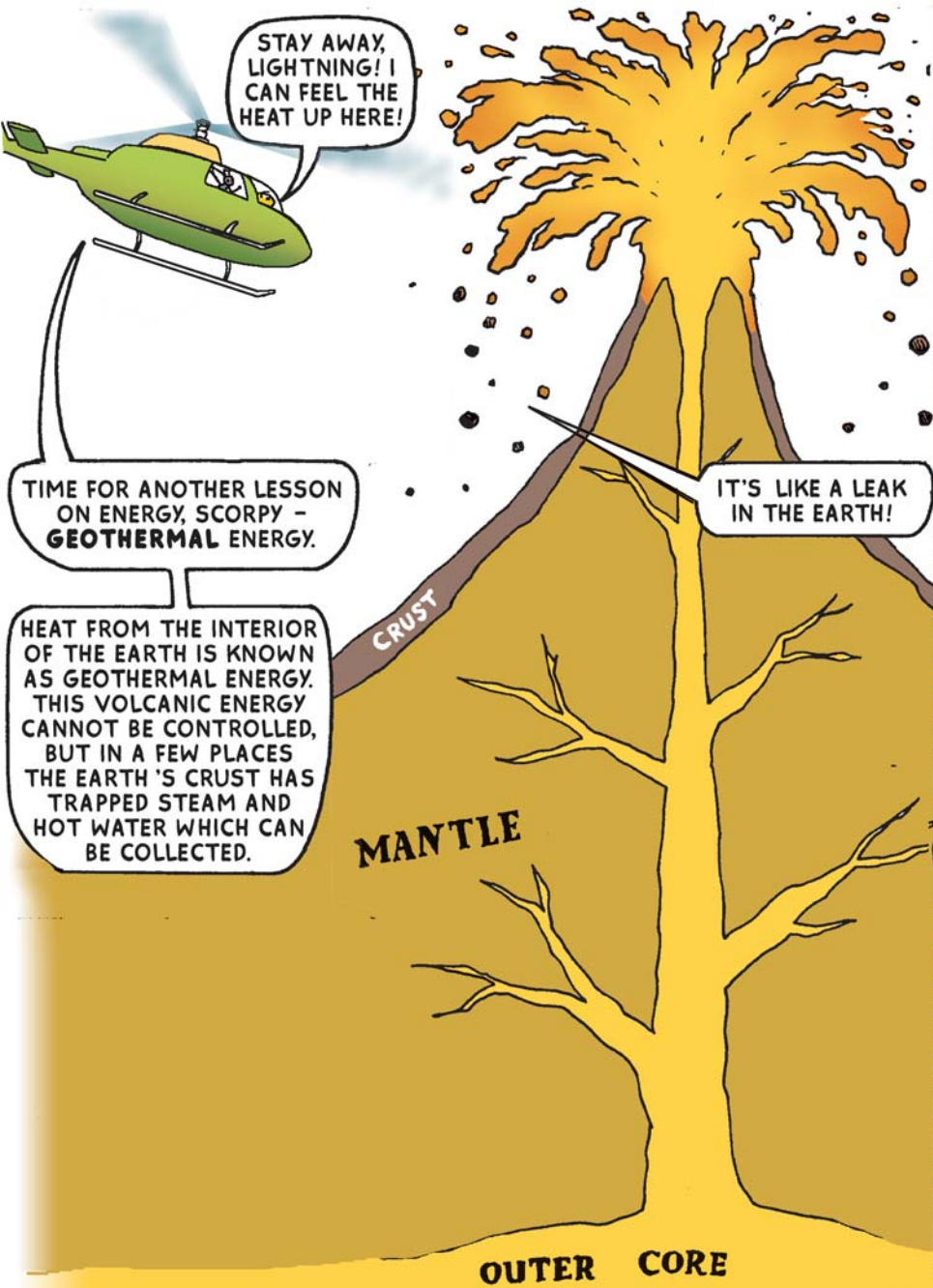
MAN, THAT TURBINE AND GENERATOR COMBO IS EVERYWHERE WE GO!

GENERATOR

TURBINE

THESE RESERVOIRS AND LAKES CREATED BY DAMS CAN BE USED FOR BOATING, FISHING, AND SWIMMING.

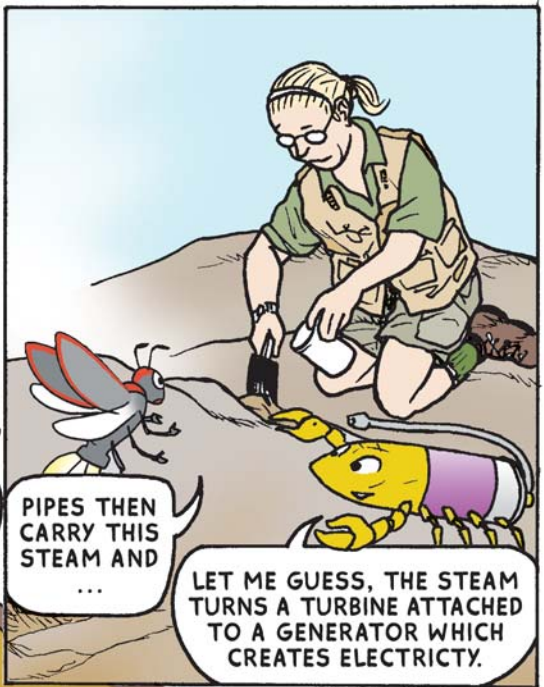
I'M DEFINITELY HOOKED ON WATER!



TIME FOR ANOTHER LESSON ON ENERGY, SCORPY - **GEOTHERMAL ENERGY.**

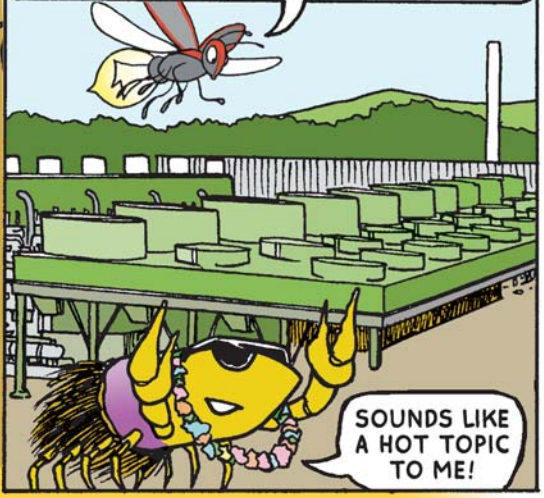
HEAT FROM THE INTERIOR OF THE EARTH IS KNOWN AS GEOTHERMAL ENERGY. THIS VOLCANIC ENERGY CANNOT BE CONTROLLED, BUT IN A FEW PLACES THE EARTH'S CRUST HAS TRAPPED STEAM AND HOT WATER WHICH CAN BE COLLECTED.

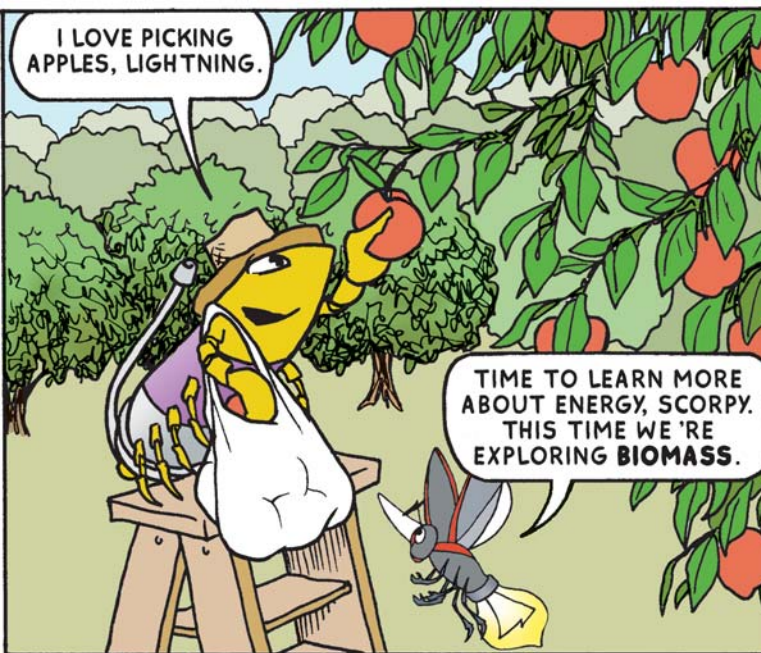
IT'S LIKE A LEAK IN THE EARTH!



LET ME GUESS, THE STEAM TURNS A TURBINE ATTACHED TO A GENERATOR WHICH CREATES ELECTRICITY.

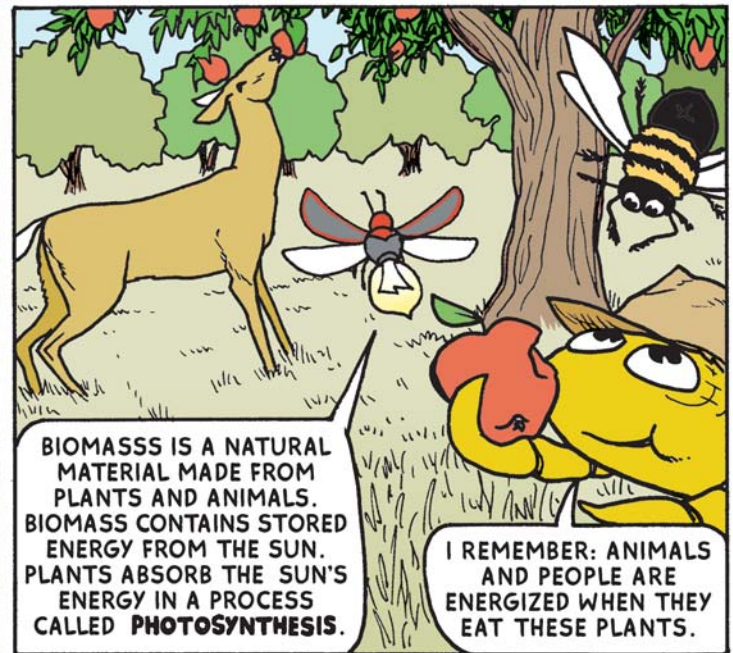
RIGHT! THERE ARE OVER 43 GEOTHERMAL POWER PLANTS IN THE UNITED STATES. MOST ARE LOCATED IN CALIFORNIA AND NEVADA, BUT THIS ONE IS IN HAWAII.





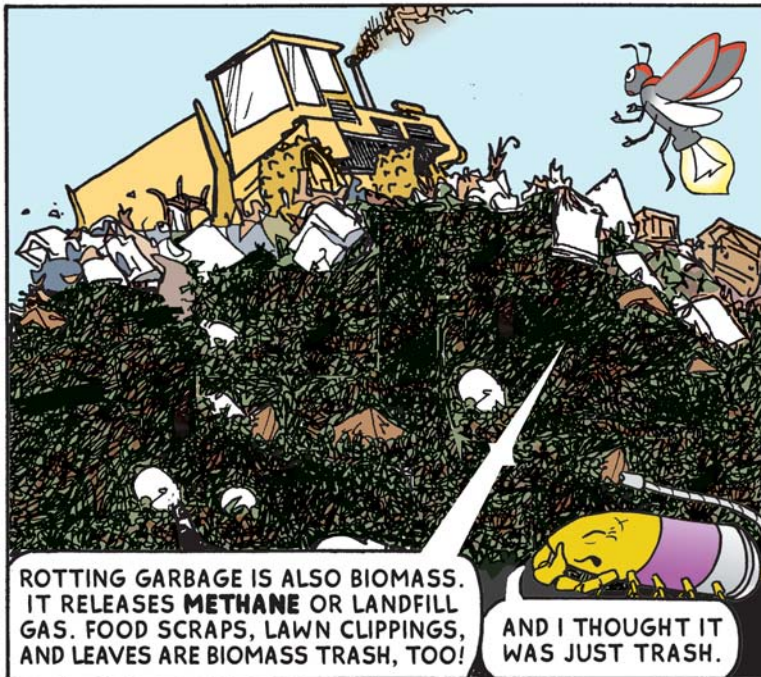
I LOVE PICKING APPLES, LIGHTNING.

TIME TO LEARN MORE ABOUT ENERGY, SCORPY. THIS TIME WE'RE EXPLORING **BIOMASS**.



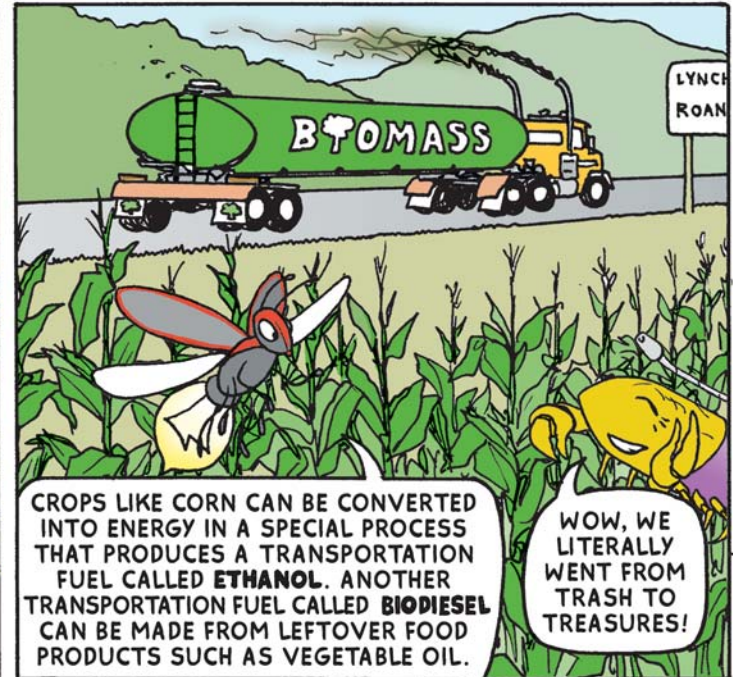
BIOMASS IS A NATURAL MATERIAL MADE FROM PLANTS AND ANIMALS. **BIOMASS** CONTAINS STORED ENERGY FROM THE SUN. PLANTS ABSORB THE SUN'S ENERGY IN A PROCESS CALLED **PHOTOSYNTHESIS**.

I REMEMBER: ANIMALS AND PEOPLE ARE ENERGIZED WHEN THEY EAT THESE PLANTS.



ROTTING GARBAGE IS ALSO **BIOMASS**. IT RELEASES **METHANE** OR LANDFILL GAS. FOOD SCRAPS, LAWN CLIPPINGS, AND LEAVES ARE **BIOMASS TRASH**, TOO!

AND I THOUGHT IT WAS JUST TRASH.



CROPS LIKE CORN CAN BE CONVERTED INTO ENERGY IN A SPECIAL PROCESS THAT PRODUCES A TRANSPORTATION FUEL CALLED **ETHANOL**. ANOTHER TRANSPORTATION FUEL CALLED **BIODIESEL** CAN BE MADE FROM LEFTOVER FOOD PRODUCTS SUCH AS VEGETABLE OIL.

WOW, WE LITERALLY WENT FROM TRASH TO TREASURES!

WHAT DO FOSSILS
HAVE TO DO WITH
NONRENEWABLE
SOURCES OF ENERGY?!

WE WOULD
NOT HAVE
OIL, NATURAL
GAS, OR COAL
IF IT WEREN'T
FOR FOSSILS.

300-400 MILLION YEARS AGO

50-100 MILLION YEARS AGO

TODAY

MILLIONS OF YEARS AGO SEA PLANTS
AND ANIMALS DIED AND WERE BURIED ON
THE OCEAN FLOOR, COVERED WITH MANY
LAYERS OF MUD. OVER TIME, HEAT AND
PRESSURE FROM THESE LAYERS TURNED
THE REMAINS INTO OIL AND NATURAL GAS.

SAND
SILT
ANIMAL
AND
PLANT
REMAINS

SAND
SILT
OIL
AND GAS

I GET IT! IT'S
CALLED **FOSSIL
FUEL** BECAUSE
YOU HAVE TO
HAVE FOSSILS
TO MAKE IT!!

TODAY WE DRILL DOWN INTO THE GROUND TO LOCATE
THE OIL AND GAS DEPOSITS. THE OIL IS THEN REMOVED
FROM THE GROUND AND TRAVELS BY PIPELINE OR SHIP
TO A REFINERY WHERE IT WILL BE SEPARATED INTO
DIFFERENT PETROLEUM PRODUCTS.

SO ALL FUEL IS
NOT THE SAME.

GASOLINE

DIESEL FUEL AND
HEATING OIL

JET FUEL

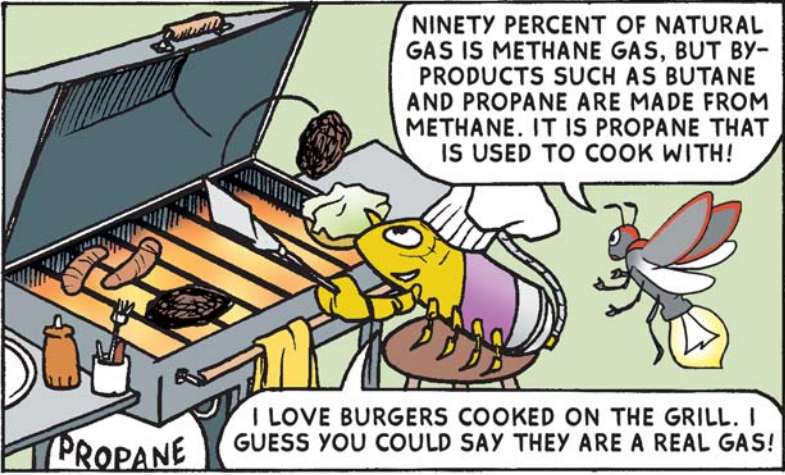
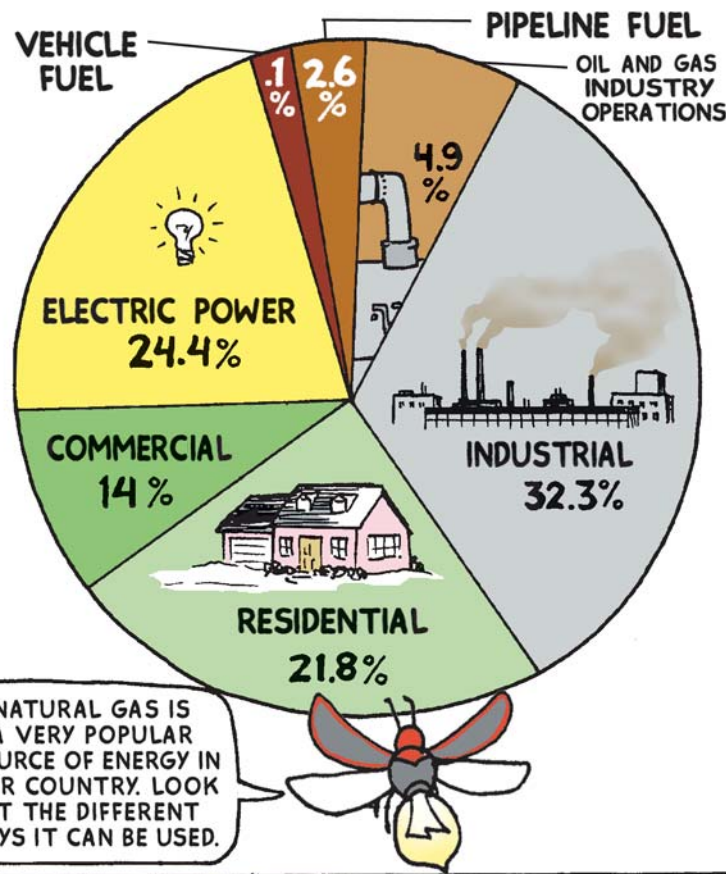
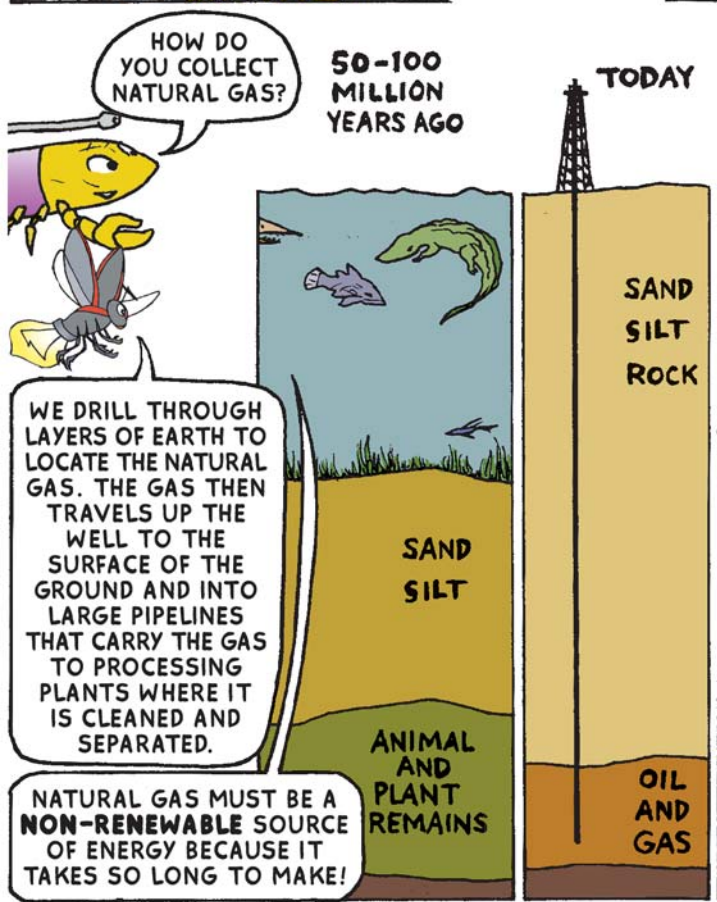
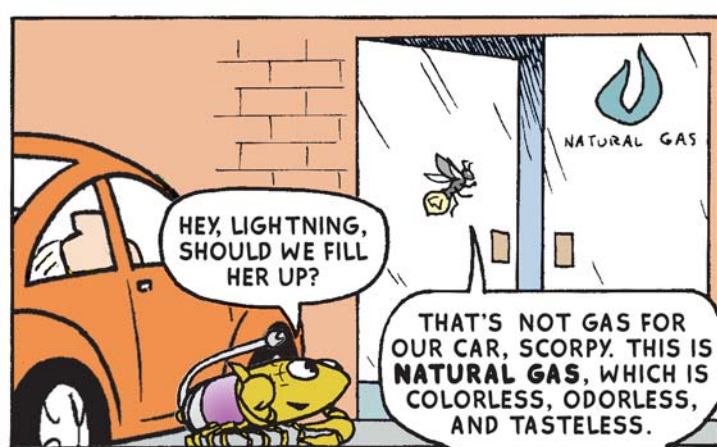
HEAVY FUEL OIL

LIQUEFIED PETROLEUM GAS

OTHER PRODUCTS

YOU CAN ALSO USE
PETROLEUM TO MAKE
THINGS LIKE INK,
CRAYONS,
TIRES AND EVEN BUBBLE GUM.

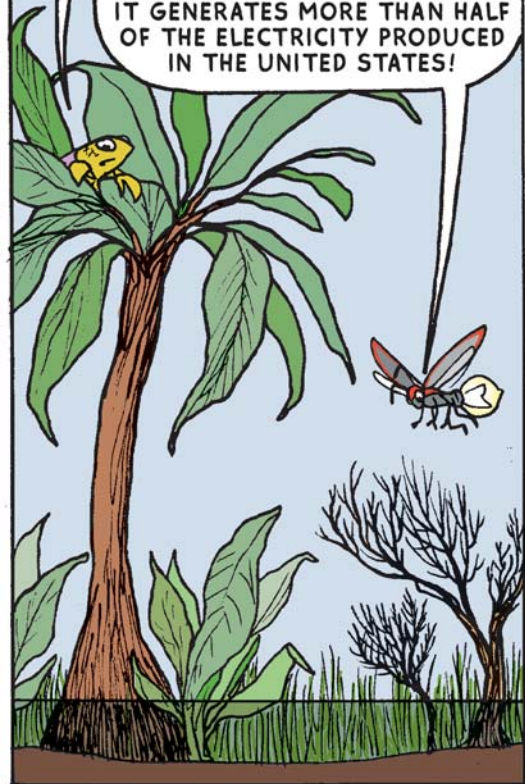
IMAGINE
THAT!



300 MILLION YEARS AGO

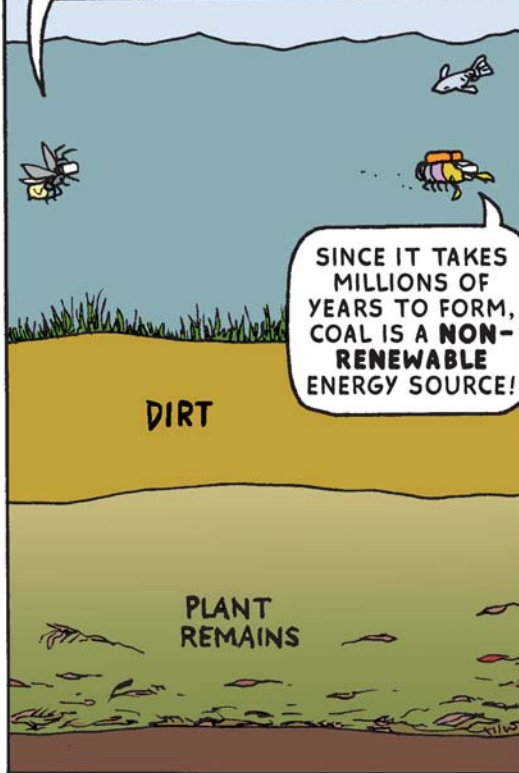
WHAT ARE WE DOING IN THIS SWAMP, LIGHTNING?

WE ARE GOING TO EXPLORE **COAL**, ANOTHER FOSSIL FUEL. IT GENERATES MORE THAN HALF OF THE ELECTRICITY PRODUCED IN THE UNITED STATES!



100 MILLION YEARS AGO

FOR MILLIONS OF YEARS, A LAYER OF DEAD PLANTS AT THE BOTTOM OF THE SWAMPS WAS COVERED BY LAYERS OF WATER AND DIRT TRAPPING THE ENERGY OF THE DEAD PLANTS. THE HEAT AND PRESSURE FROM THE TOP LAYERS TURNED THE PLANT REMAINS INTO COAL.



SINCE IT TAKES MILLIONS OF YEARS TO FORM, COAL IS A **NON-RENEWABLE** ENERGY SOURCE!

TODAY

AFTER THE COAL IS MINED, IT GOES TO A PREPARATION PLANT THAT CLEANS THE COAL TO REMOVE DIRT, ROCK, AND OTHER UNWANTED MATERIALS. AFTER THE COAL IS PROCESSED, IT IS READY TO BE TRANSPORTED. MOST COAL IS SHIPPED BY TRAIN, BUT IT CAN ALSO GO BY TRUCK AND BARGE!



BOY, THIS MINING STUFF IS HARD WORK!



POWER PLANTS CAN BURN COAL TO MAKE STEAM. THE STEAM TURNS TURBINES WHICH GENERATE ELECTRICITY. BUT THERE ARE OTHER USES FOR COAL.



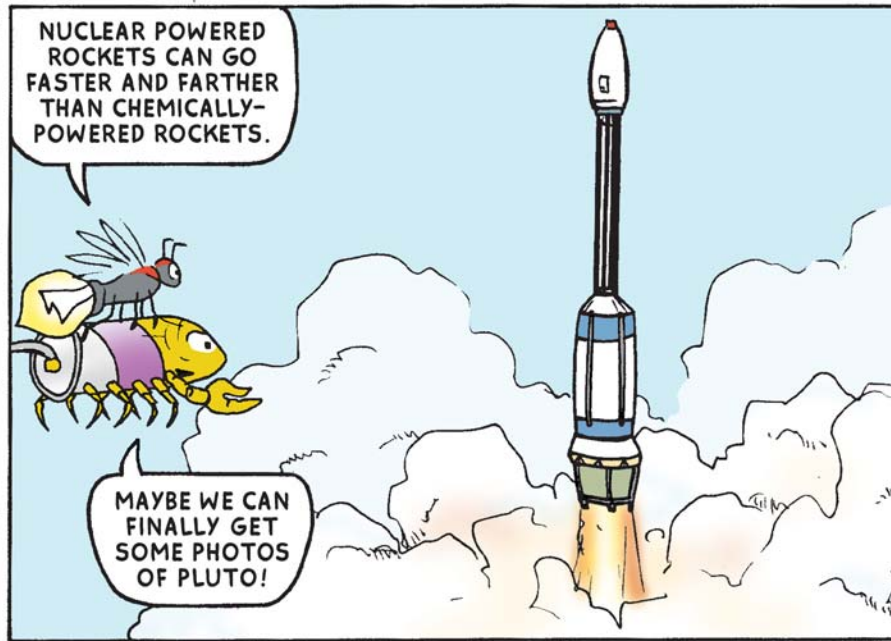
WOW! CHARCOAL SURE MAKES A SUPER TASTY BURGER!



WHAT ARE WE DOING AT THE HOSPITAL, LIGHTNING?


WE ARE GOING TO LEARN MORE ABOUT NUCLEAR ENERGY. NUCLEAR MEDICINE USES RADIOACTIVE MATERIALS TO PREVENT, DIAGNOSE, AND TREAT DISEASES SUCH AS CANCER AND HEART DISEASE.

BOY, THAT SOUNDS LIKE A REAL LIFESAVER.



NUCLEAR POWERED ROCKETS CAN GO FASTER AND FARTHER THAN CHEMICALLY-POWERED ROCKETS.

MAYBE WE CAN FINALLY GET SOME PHOTOS OF PLUTO!



NUCLEAR POWER CAN ALSO BE USED TO POWER SUBMARINES AND SHIPS. THE NUCLEAR POWERED AIRCRAFT CARRIER USS RONALD REAGAN CAN SAIL FOR **20 YEARS** BEFORE REFUELING.

TWENTY YEARS?! THAT'S AMAZING!!

OUR FRIENDS AT BWXT MUST STAY VERY BUSY!

THE SKY IS THE LIMIT WITH ENERGY!!!!

I'M ... I'M TIRED, LIGHTNING. I NEED TO CREATE MORE ENERGY.

THE LAW OF CONSERVATION OF ENERGY SAYS ENERGY IS NEITHER CREATED NOR DESTROYED. IT IS CHANGED FROM ONE FORM TO ANOTHER.

FOR EXAMPLE, A CAR'S ENGINE BURNS GASOLINE, WHICH GIVES IT ENERGY TO MOVE.

SOUNDS LIKE A TRANSFORMATION TO ME!!

THAT'S RIGHT. **POTENTIAL ENERGY** IS ENERGY NOT IN USE THAT IS AVAILABLE TO DO WORK.

KINETIC ENERGY IS ENERGY THAT IS IN USE.

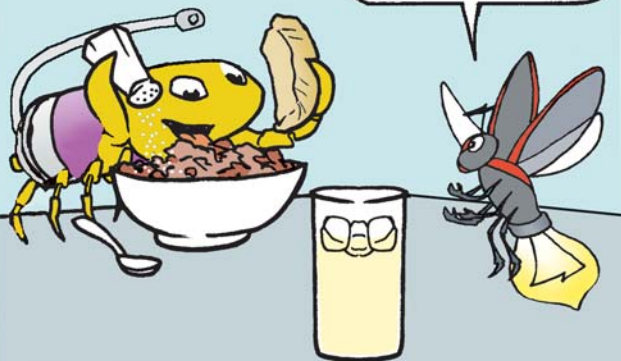
SO THE GASOLINE SITTING IN THE TANK HAS **POTENTIAL ENERGY**. ONCE BURNED BY THE CAR'S ENGINE, IT IS CHEMICALLY CHANGED, GIVING THE CAR ENERGY TO MOVE. THE MOVEMENT OF THE CAR IS **KINETIC ENERGY**!

WE'LL SPEND MORE TIME EXPLORING **POTENTIAL AND KINETIC ENERGY** THIS WEEK.

I'D BETTER HAVE A SNACK TO MAINTAIN MY **POTENTIAL** TO STAY **KINETIC**!

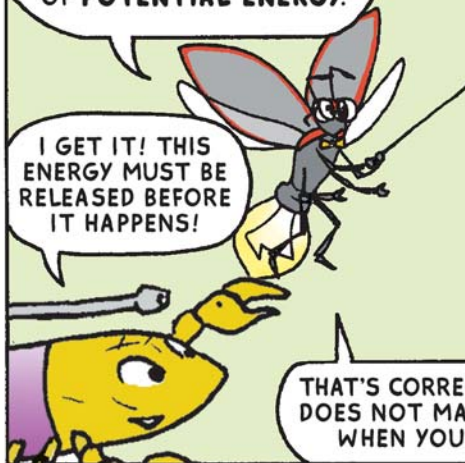
MY TEACHER TELLS ME I HAVE A LOT OF STORED ENERGY.

I HOPE YOU USE IT AT RECESS AND NOT IN THE CLASSROOM!

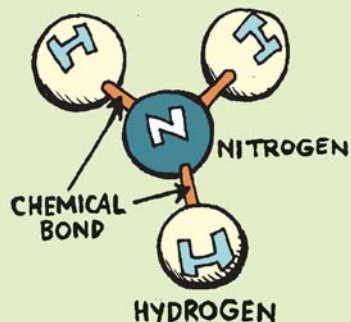


CHEMICAL ENERGY IS STORED IN THE BONDS OF THE ATOMS AND MOLECULES OF BIOMASS, PETROLEUM, NATURAL GAS, AND PROPANE - ALL SOURCES OF **POTENTIAL ENERGY**.

I GET IT! THIS ENERGY MUST BE RELEASED BEFORE IT HAPPENS!



AMMONIA MOLECULE NH_3
(MADE OF 4 ATOMS)

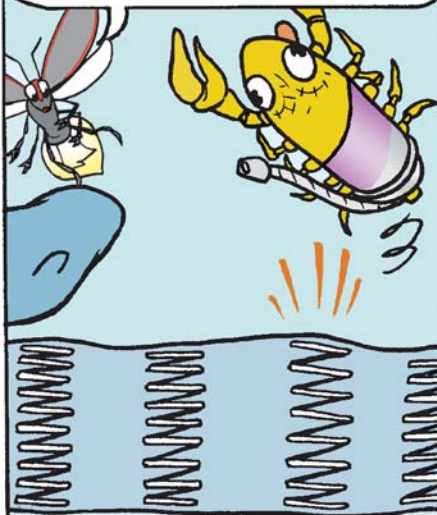


THAT'S CORRECT, SCORPY. THE GAS ITSELF DOES NOT MAKE THE CAR RUN. IT RUNS WHEN YOU TURN THE ENGINE ON.

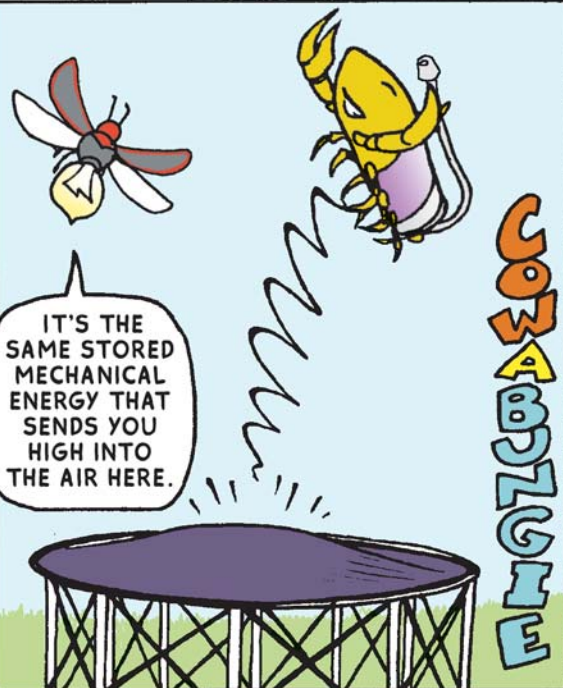
IN THIS CASE, YOU ARE APPLYING FORCE TO THE SPRINGS SO THEY BECOME COMPRESSED - THIS IS **STORED MECHANICAL ENERGY**.



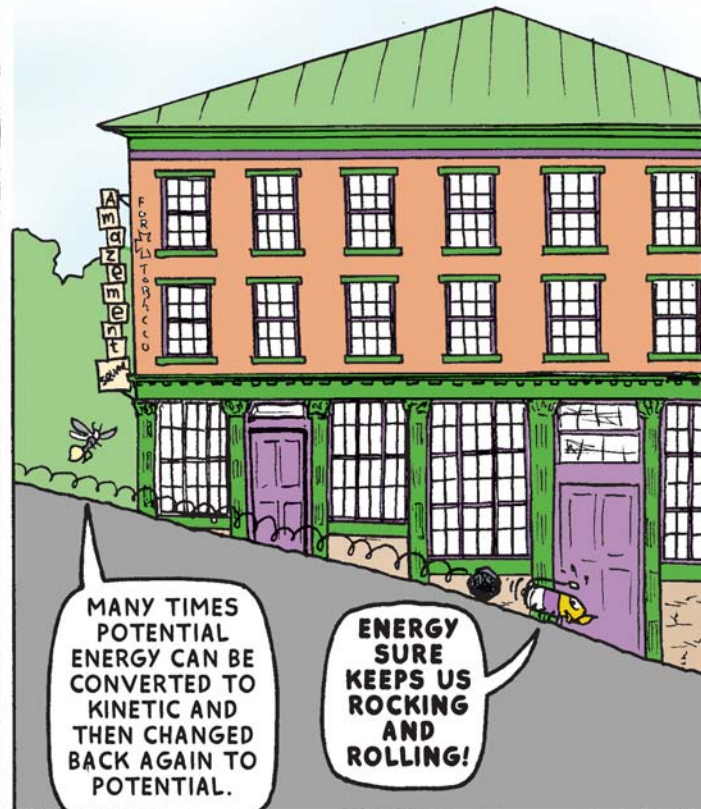
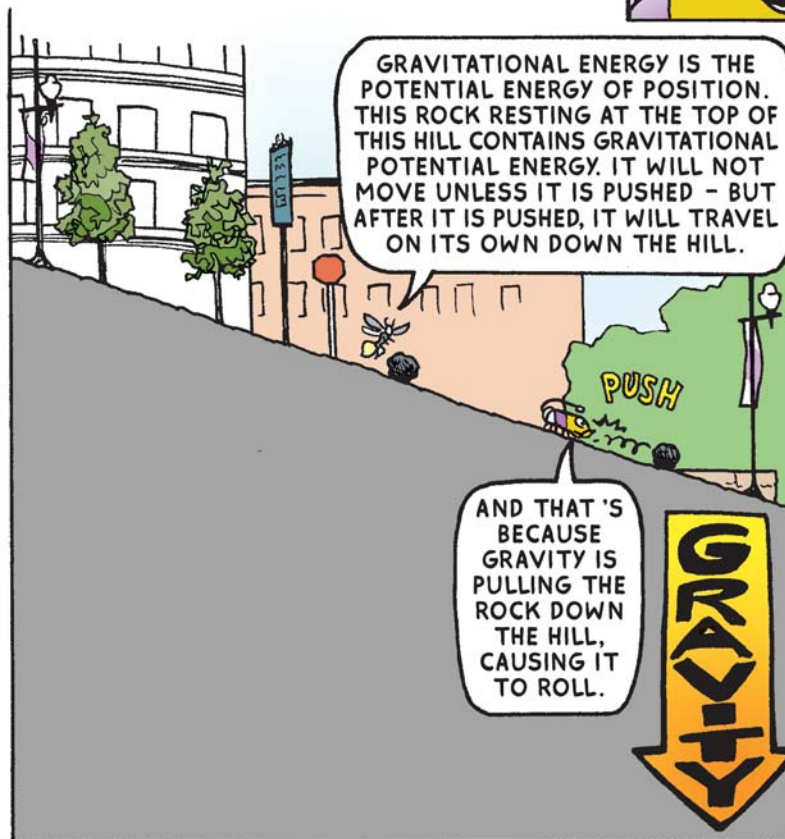
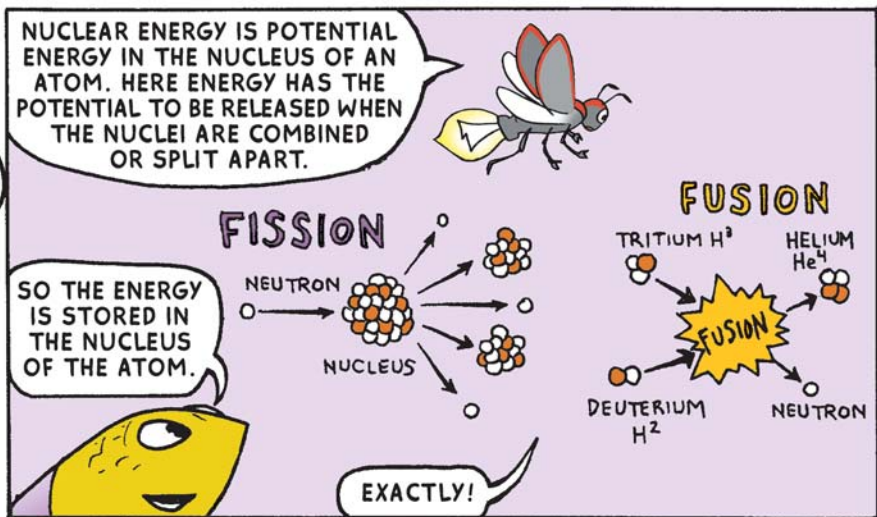
WHEN YOU TAKE AWAY YOUR HAND THE SPRINGS WILL GO UPWARDS. THE SPRINGS CAN'T SPRING UP WITHOUT A FORCE BEING APPLIED.

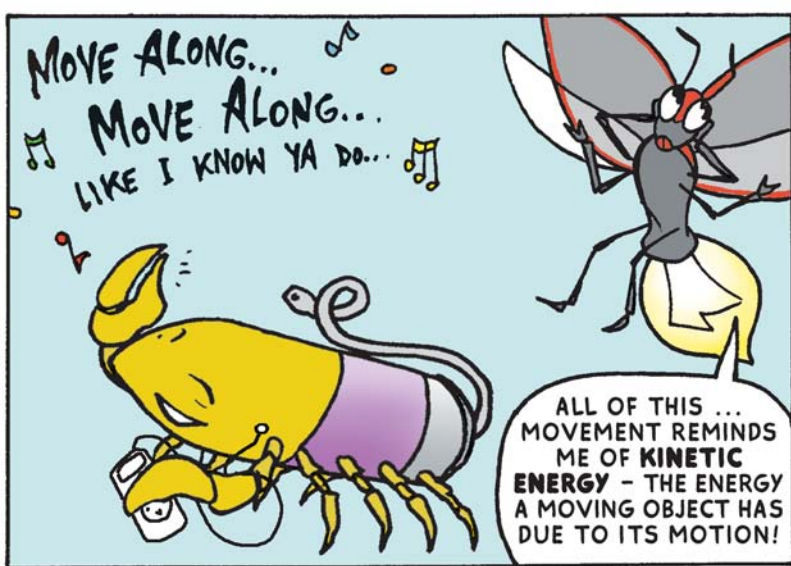


IT'S THE SAME STORED MECHANICAL ENERGY THAT SENDS YOU HIGH INTO THE AIR HERE.



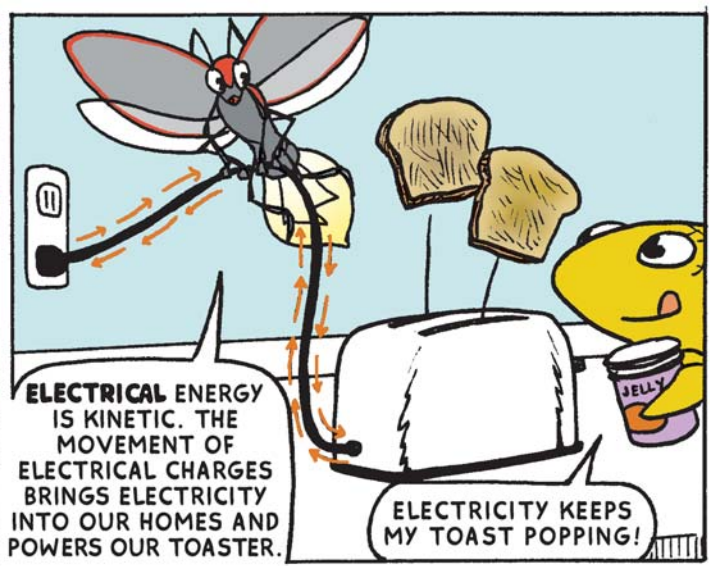
PHOTON





MOVE ALONG...
MOVE ALONG...
LIKE I KNOW YA DO...

ALL OF THIS ...
MOVEMENT REMINDS
ME OF **KINETIC
ENERGY** - THE ENERGY
A MOVING OBJECT HAS
DUE TO ITS MOTION!



ELECTRICAL ENERGY
IS KINETIC. THE
MOVEMENT OF
ELECTRICAL CHARGES
BRINGS ELECTRICITY
INTO OUR HOMES AND
POWERS OUR TOASTER.

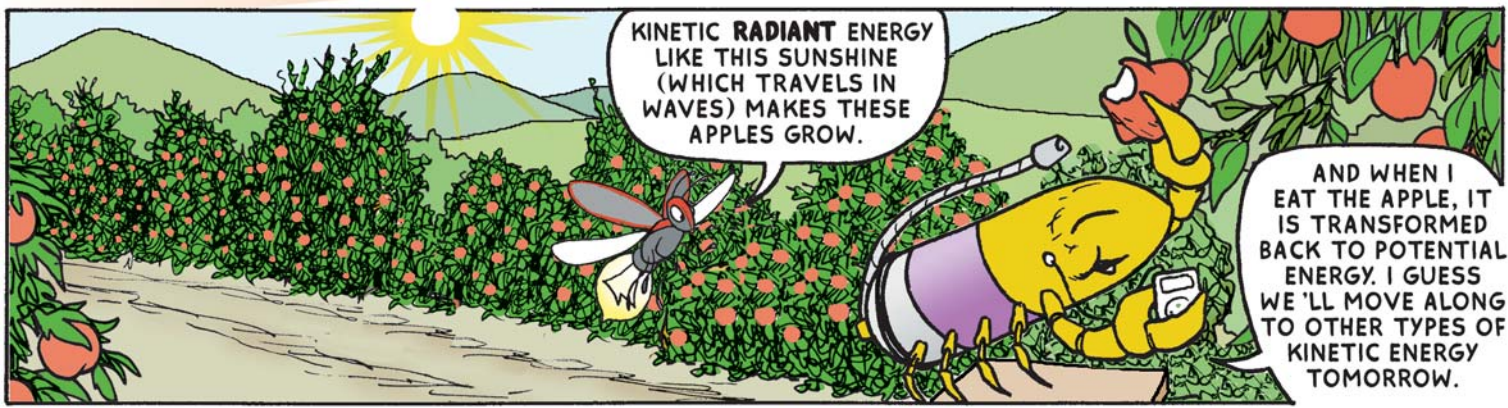
ELECTRICITY KEEPS
MY TOAST POPPING!

MECHANICAL ENERGY IS ALSO KINETIC.
NEWTON'S LAW OF MOTION SAYS THAT
AN OBJECT AT REST REMAINS AT REST
UNLESS ACTED ON BY ANOTHER FORCE.



OUR CAR WITH A FULL GAS
TANK WAS AT REST. WHEN
THE ENGINE BURNED THE
FUEL THE CAR MOVED.
THAT MOVEMENT WAS
MECHANICAL ENERGY.

CORRECT! POTENTIAL
TURNED INTO KINETIC.



KINETIC RADIANT ENERGY
LIKE THIS SUNSHINE
(WHICH TRAVELS IN
WAVES) MAKES THESE
APPLES GROW.

AND WHEN I
EAT THE APPLE, IT
IS TRANSFORMED
BACK TO POTENTIAL
ENERGY. I GUESS
WE'LL MOVE ALONG
TO OTHER TYPES OF
KINETIC ENERGY
TOMORROW.

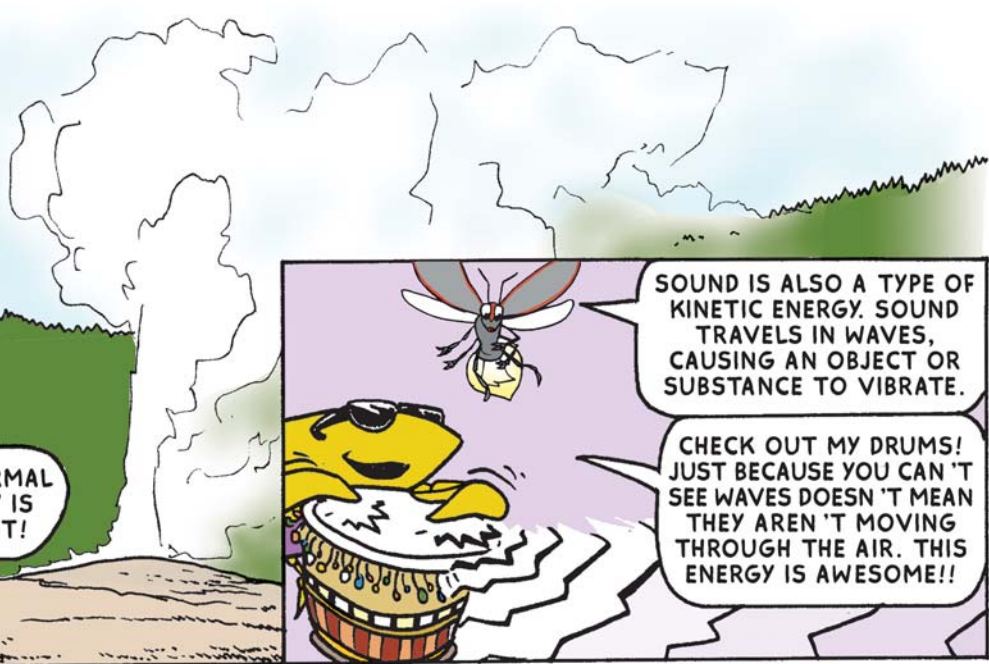
MORE KINETIC ENERGY TODAY, LIGHTNING?



JUST TWO MORE TYPES, SCORPY, AND WE'LL BE FINISHED.

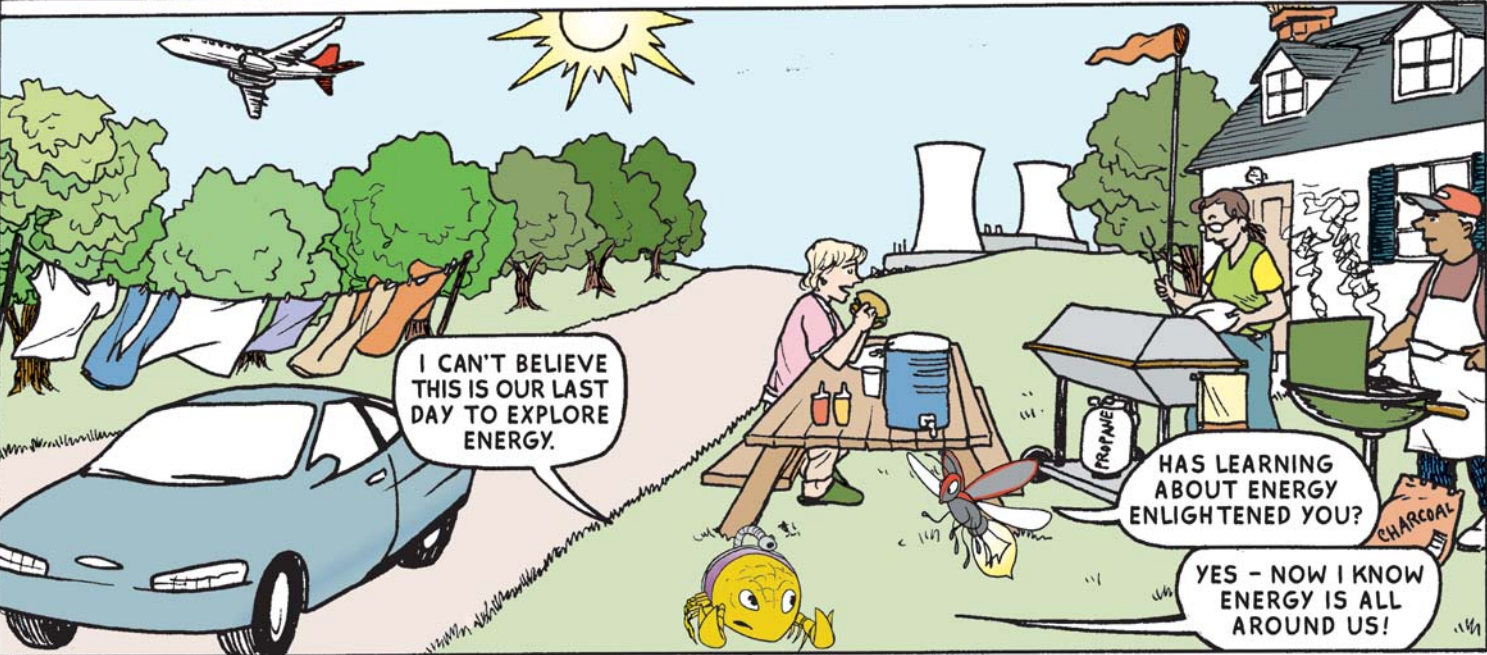
DO YOU REMEMBER GEOTHERMAL ENERGY? THIS IS DEFINITELY KINETIC ENERGY!!

GEOTHERMAL ENERGY IS A BLAST!



SOUND IS ALSO A TYPE OF KINETIC ENERGY. SOUND TRAVELS IN WAVES, CAUSING AN OBJECT OR SUBSTANCE TO VIBRATE.

CHECK OUT MY DRUMS! JUST BECAUSE YOU CAN'T SEE WAVES DOESN'T MEAN THEY AREN'T MOVING THROUGH THE AIR. THIS ENERGY IS AWESOME!!



I CAN'T BELIEVE THIS IS OUR LAST DAY TO EXPLORE ENERGY.

HAS LEARNING ABOUT ENERGY ENLIGHTENED YOU?

YES - NOW I KNOW ENERGY IS ALL AROUND US!