

Renewable Energy 101

Energy Generation Basics

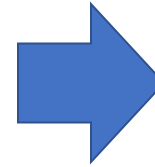
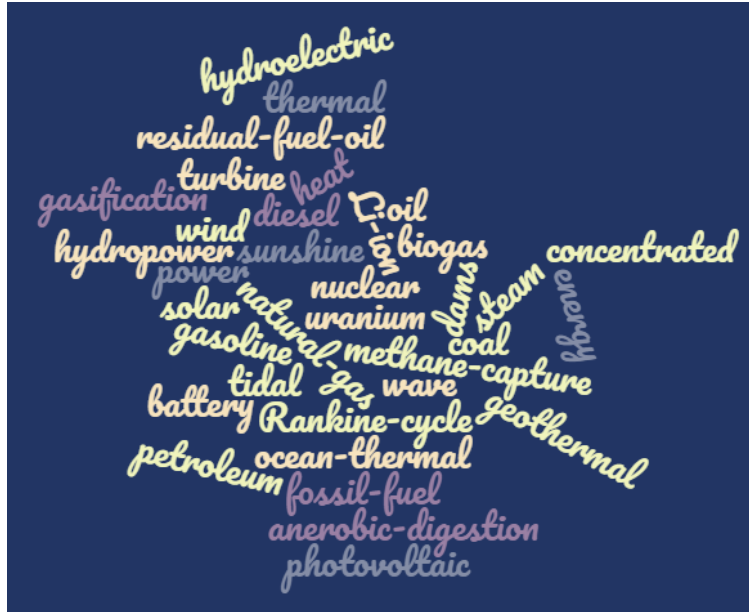
Ariel Stolz - Caribbean Green Technology Center

What is...

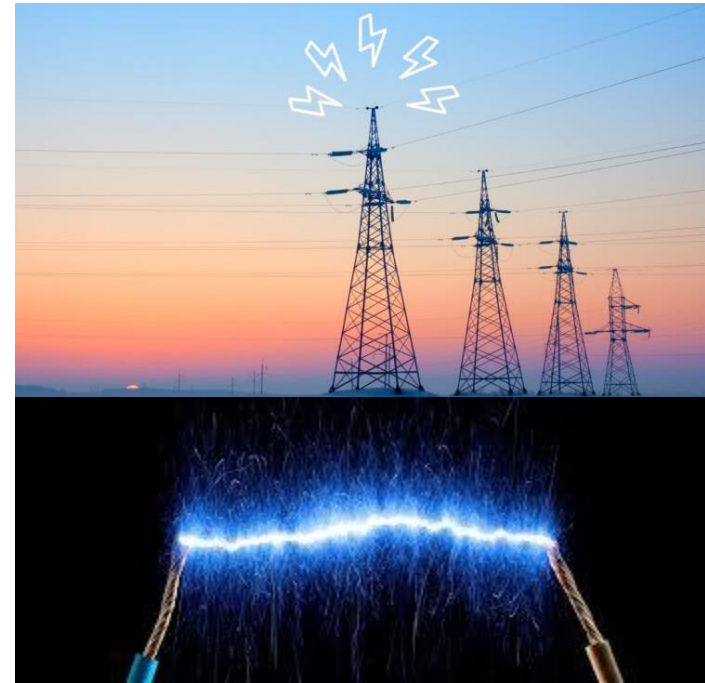


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Primary Energy Sources



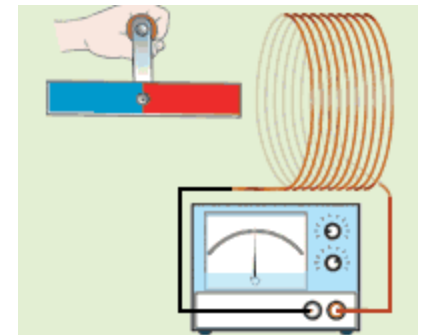
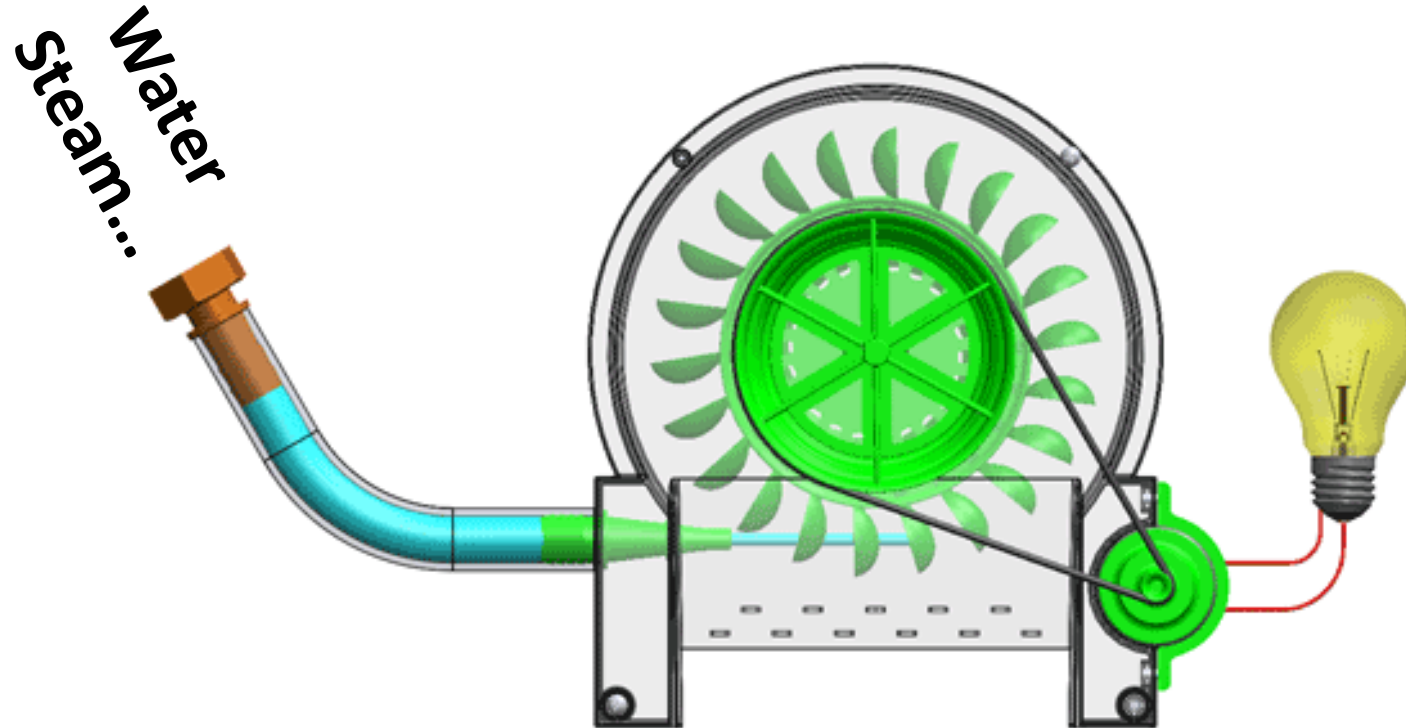
Energy Carrier



Energy Services



Electricity can be generated by spinning a turbine

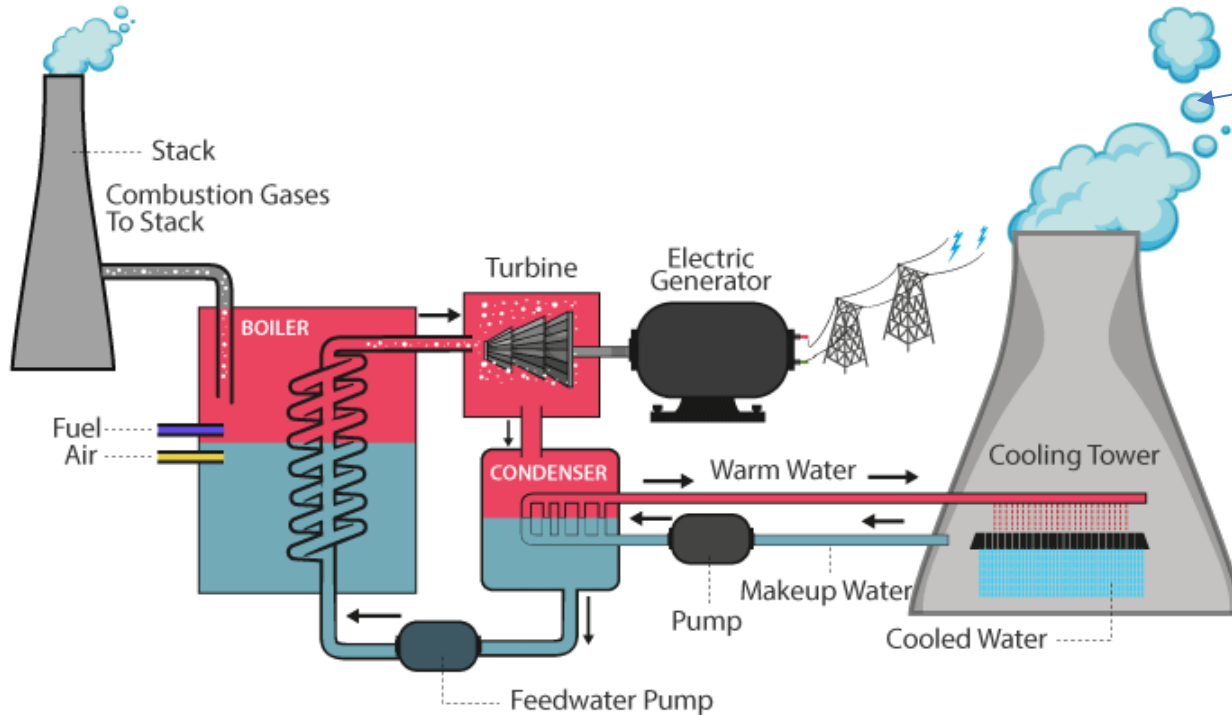


Coal, Oil and Natural Gas are burned to generate steam and spin a turbine

THERMAL POWER PLANT BLOCK DIAGRAM

BYJU'S
The Learning App

This is actually just water vapor



There are Positives and Negatives of Fossil Fuels

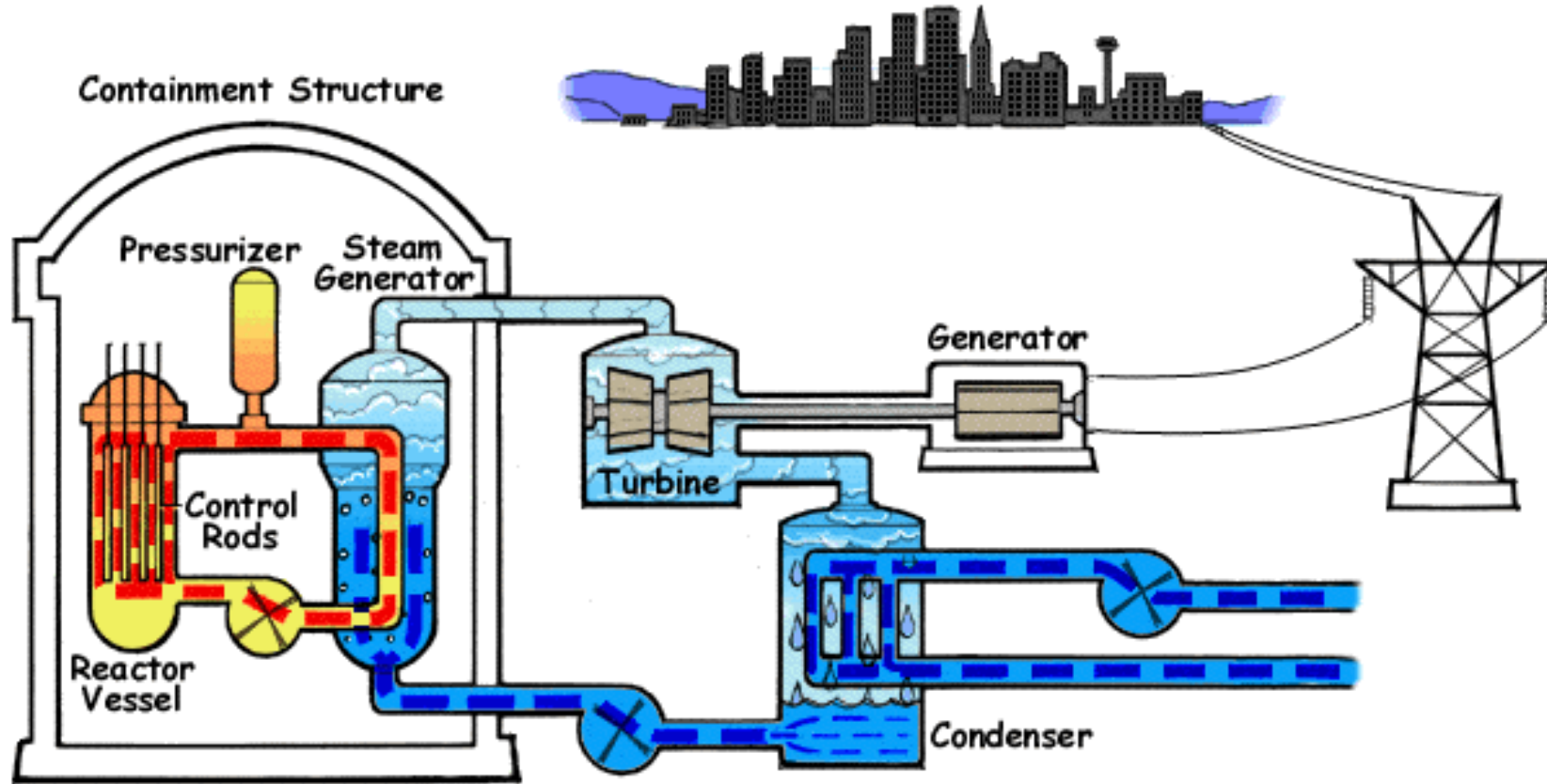
Positives

- Easy to store
- Steady source of electricity
- Abundant in the US (especially Natural gas due to fracking)
- Technological advancement means we are always finding new reserves
- Already have infrastructure built

Negatives

- Non-renewable resource
- Air pollution is dangerous for human health
- Contributes to global climate change due to greenhouse gas (CO₂eq) emissions
- In USVI we are reliant on expensive imports

Although Nuclear Energy is energy dense and has produces no emissions, nuclear waste lasts... forever



1 URANIUM FUEL PELLET
The size of your finger tip

HAS AS MUCH ENERGY AS



149 GALLONS OF OIL

or

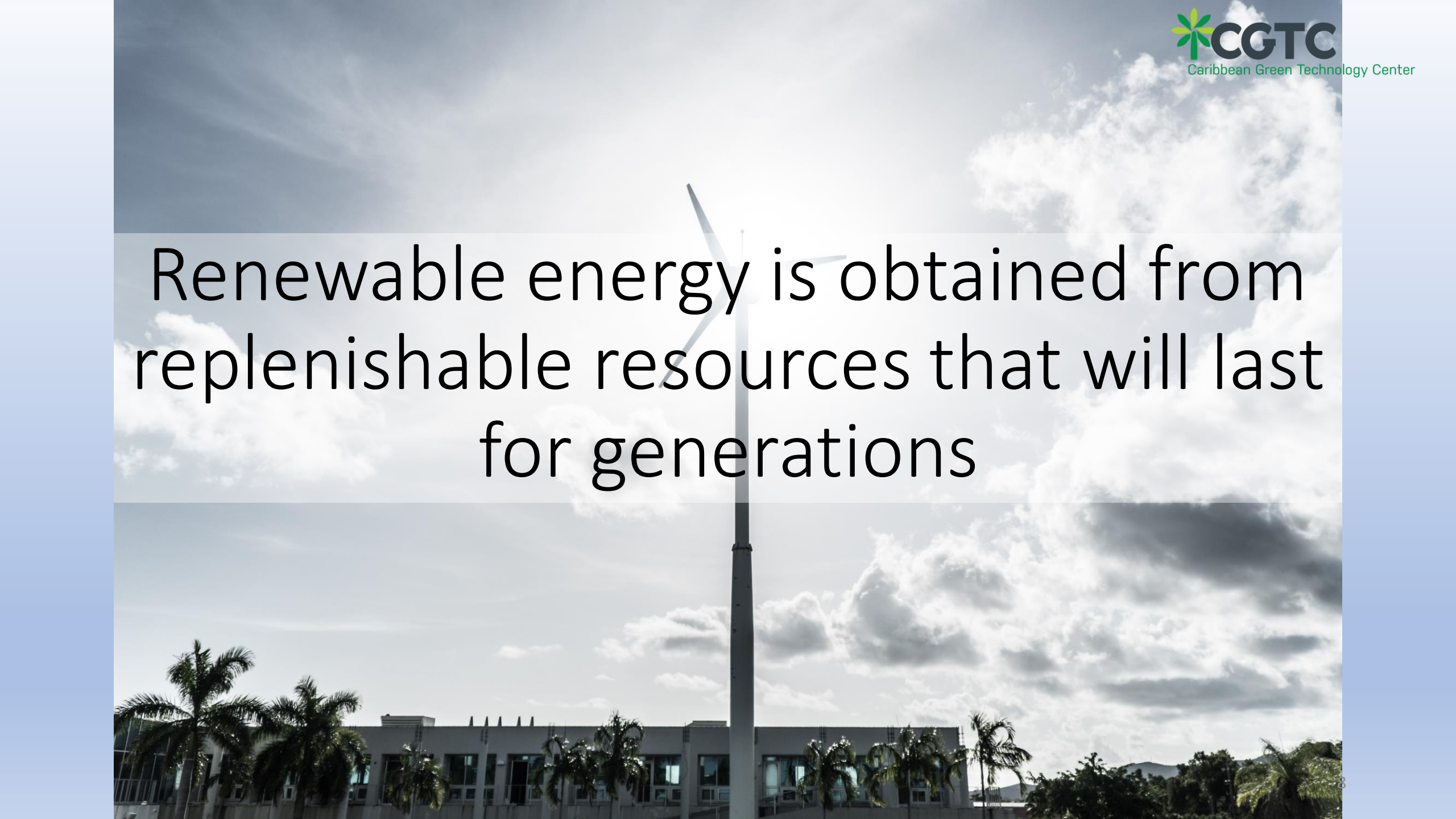


1 TON OF COAL

or



17,000 CUBIC FEET OF NATURAL GAS

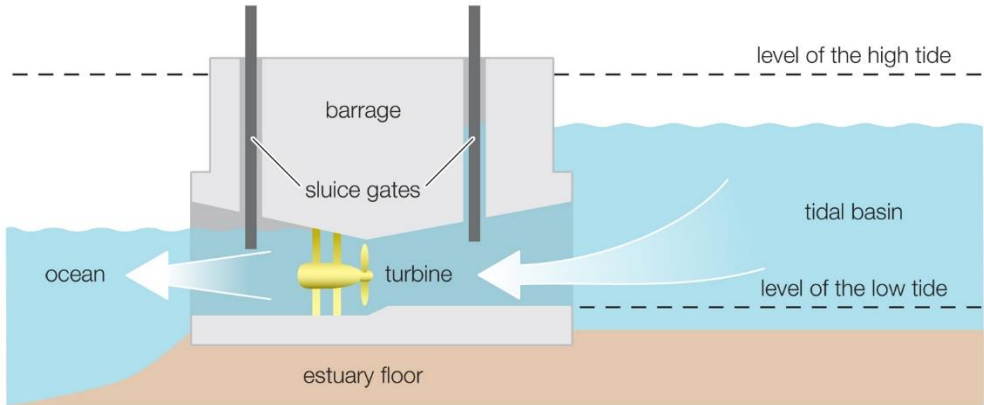


Renewable energy is obtained from
replenishable resources that will last
for generations

Hydroelectric dams have been around for a long time, wave and tidal energy are newer and are not yet commercialized.



Tidal Energy



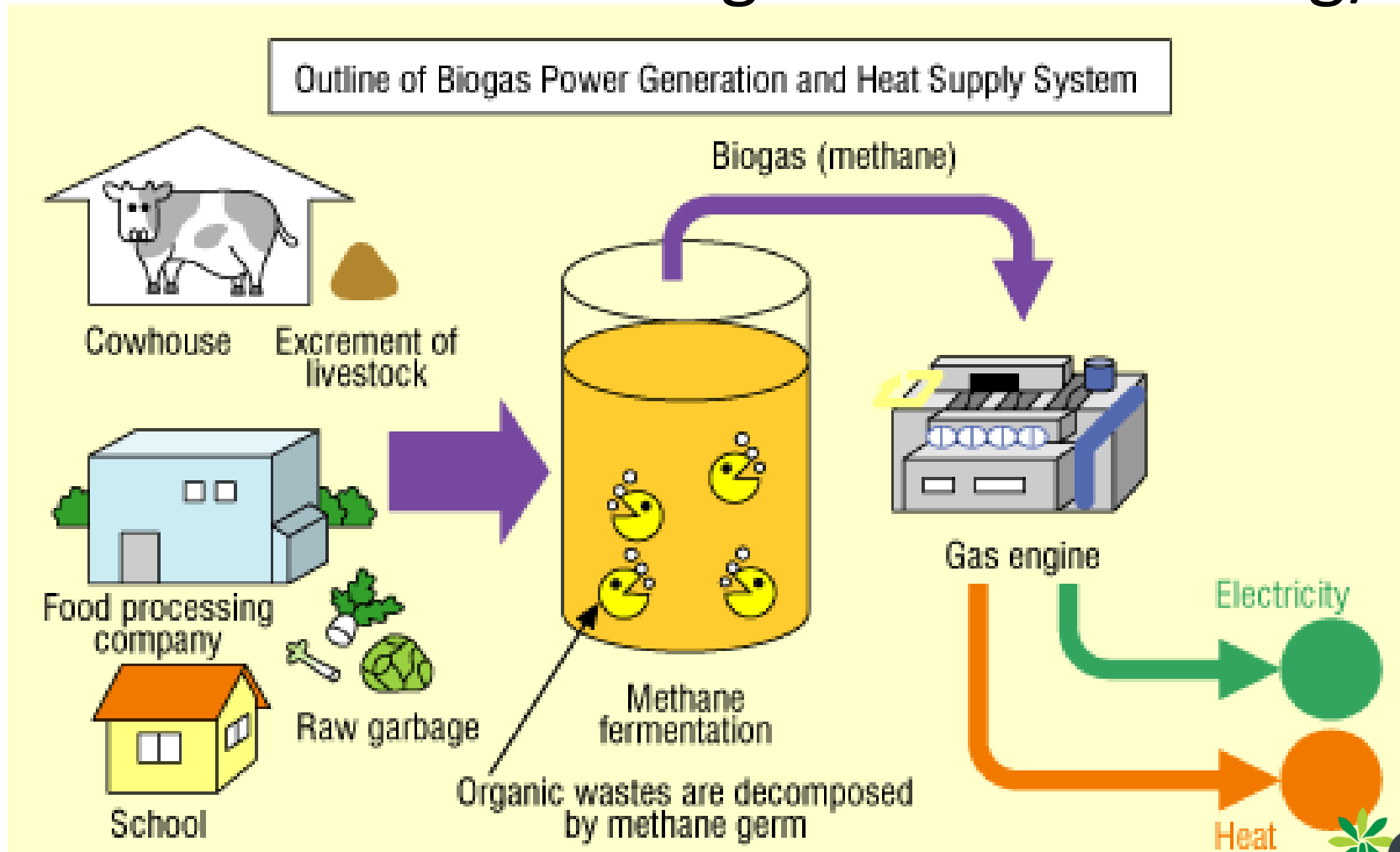
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Wind Turbines convert
wind energy to electricity
(and it doesn't require
any water)

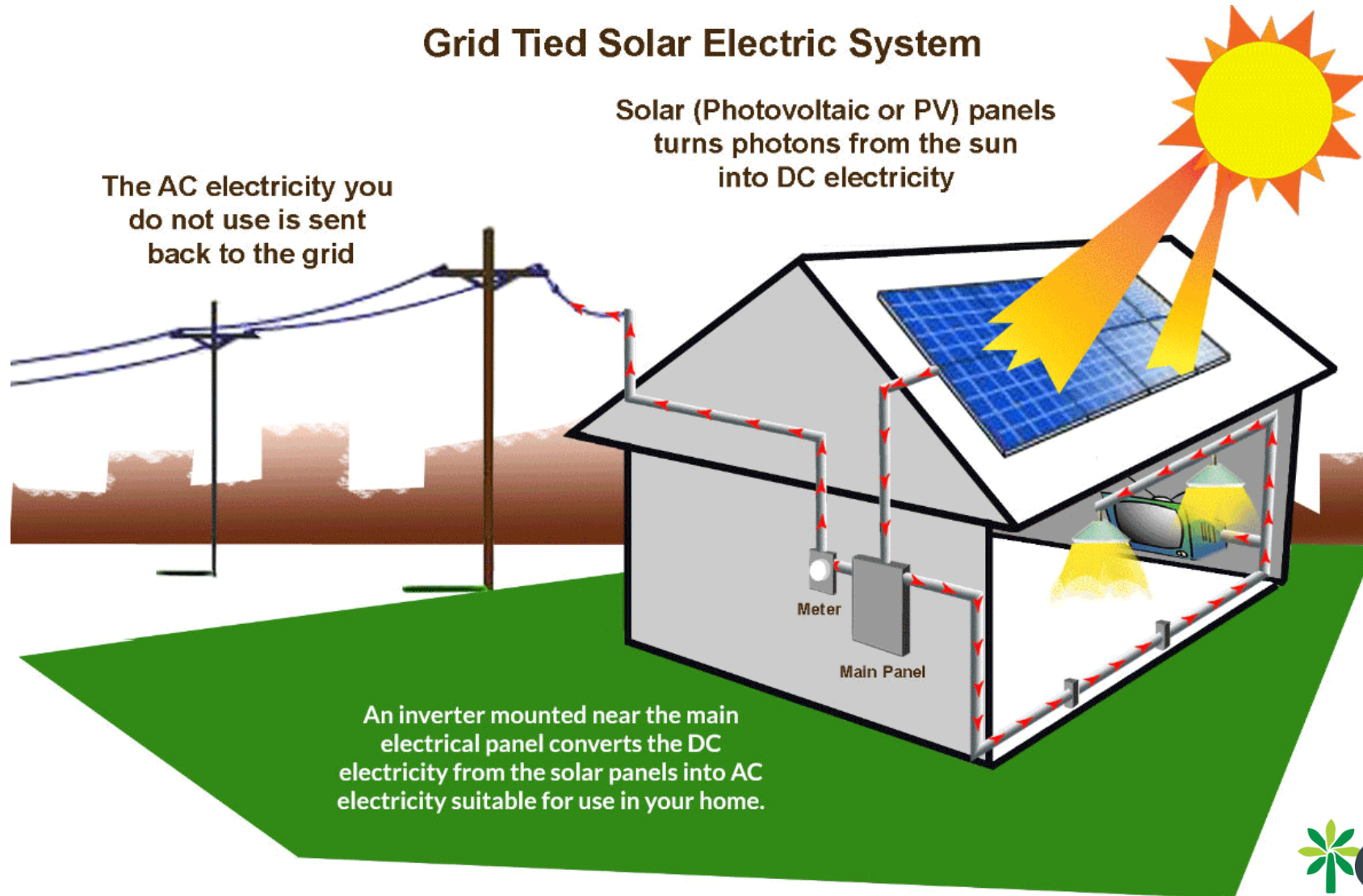


Biomass is the conversion of agricultural, food waste or Municipal Solid Waste into a gas for heat or electricity. Biomass also includes burning wood for cooking/heating.



Photovoltaic Solar Energy directly converts light photons to electricity by exciting electrons

Grid Tied Solar Electric System



There are also Positives and Negatives for Renewable Energy Sources

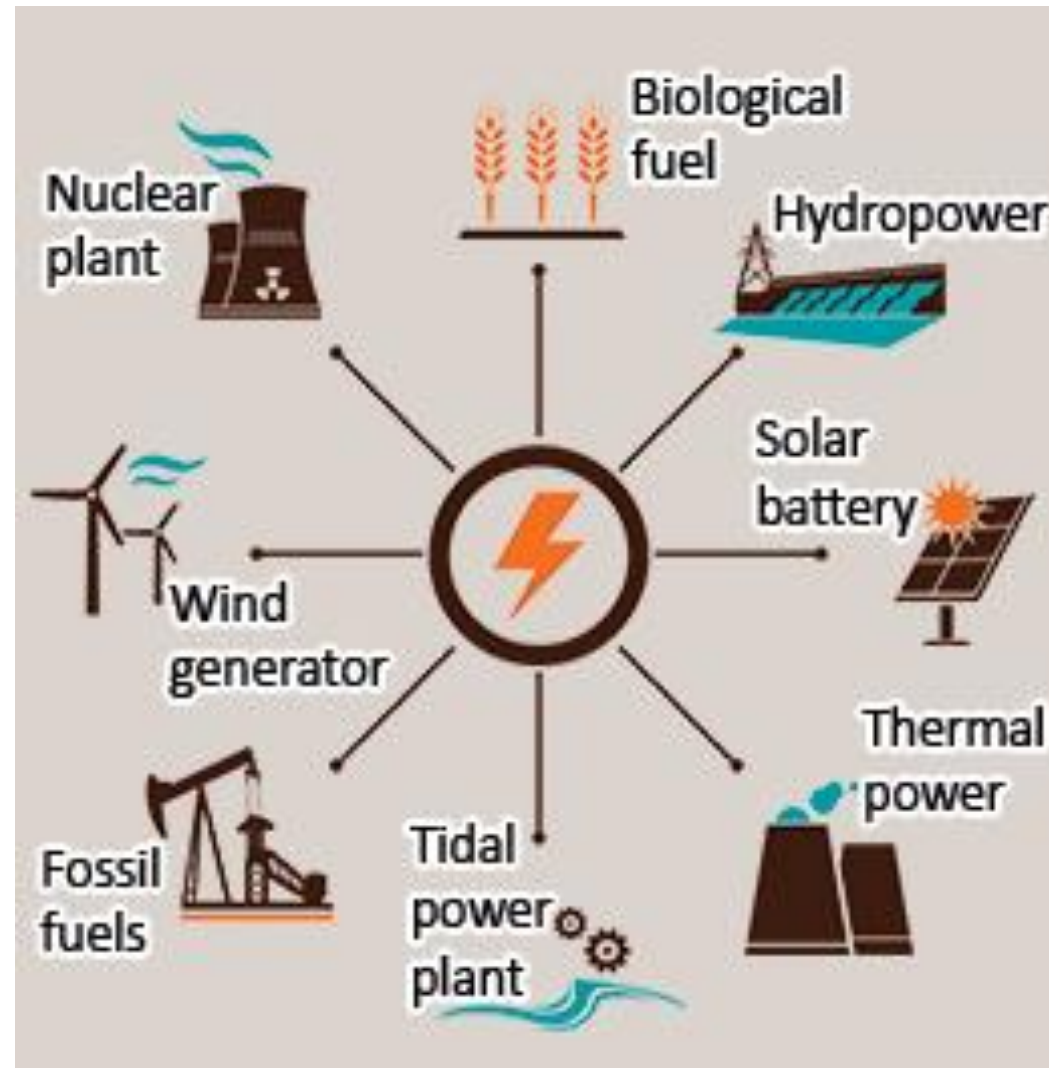
Positives

- A renewable resource means we will not run out
- Better for environment because they do not produce emissions
- Local/indigenous resource reduces our dependence on foreign fuel
- Distributed instead of centralized – microgrids can help build resilience

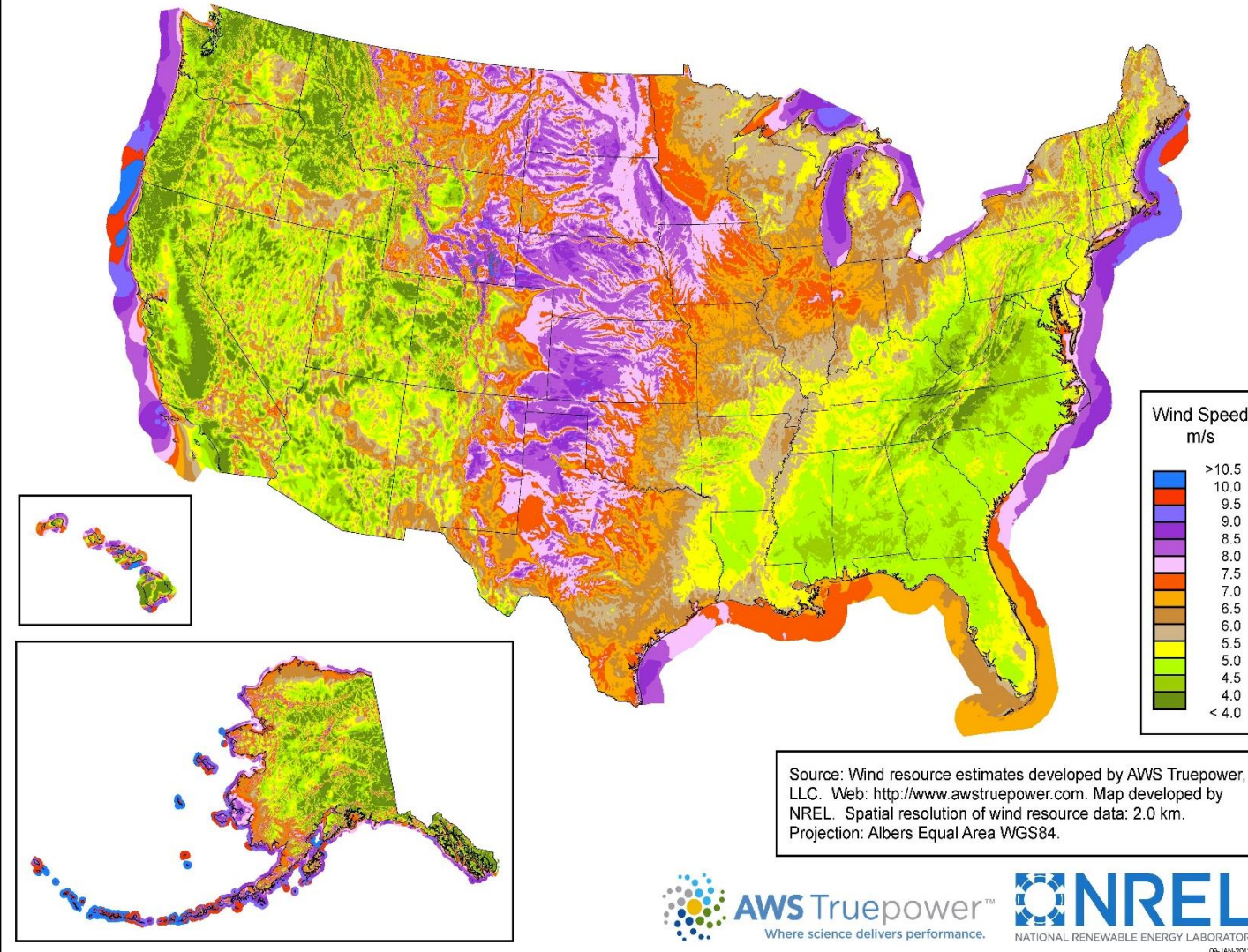
Challenges

- Solar and Wind are intermittent and it's difficult to cheaply store electricity
- High initial cost of installation
- Use of rare earth metals to produce solar panels and wind turbines
- Can be difficult to integrate into existing grid

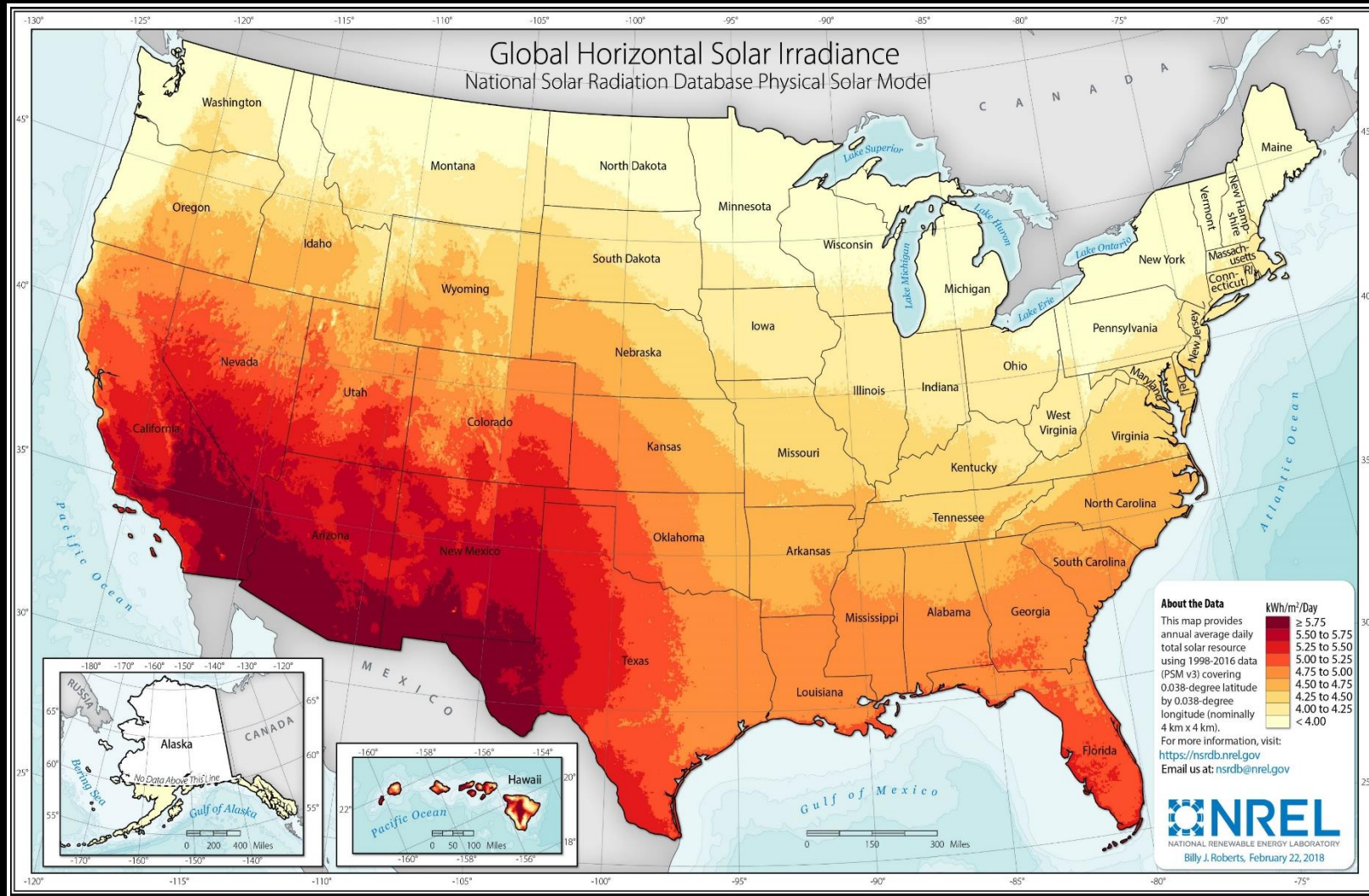
How Much Power Can We Get?



United States - Land-Based and Offshore Annual Average Wind Speed at 80 m



U.S. Wind Energy Potential



U.S. Photovoltaic Solar Energy Potential

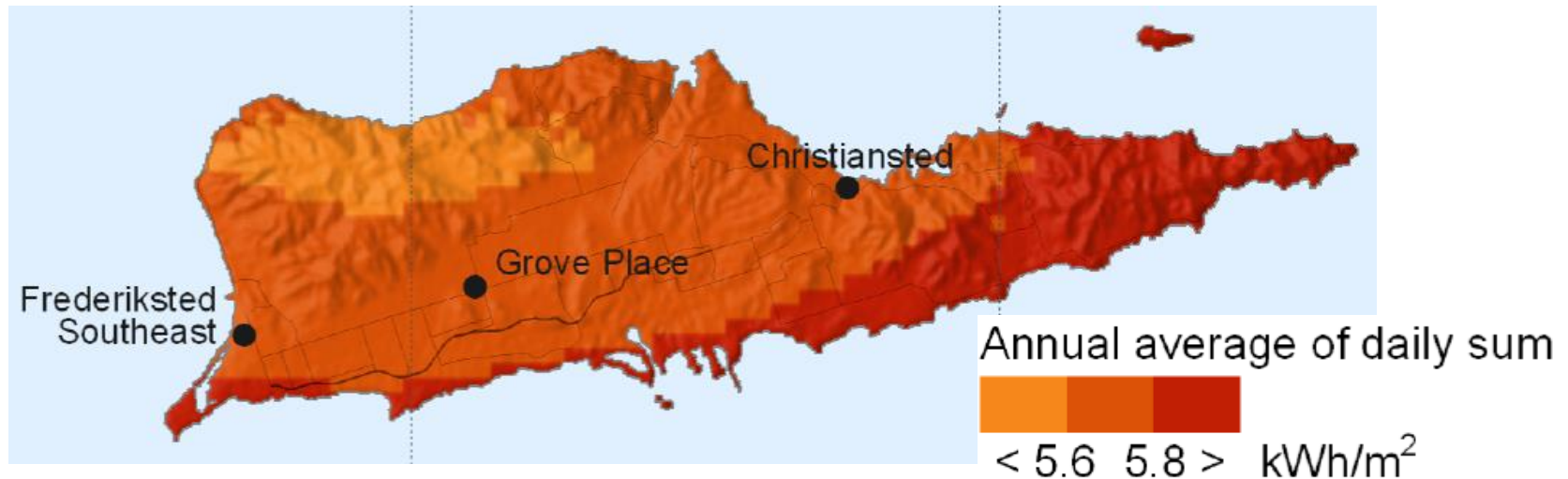
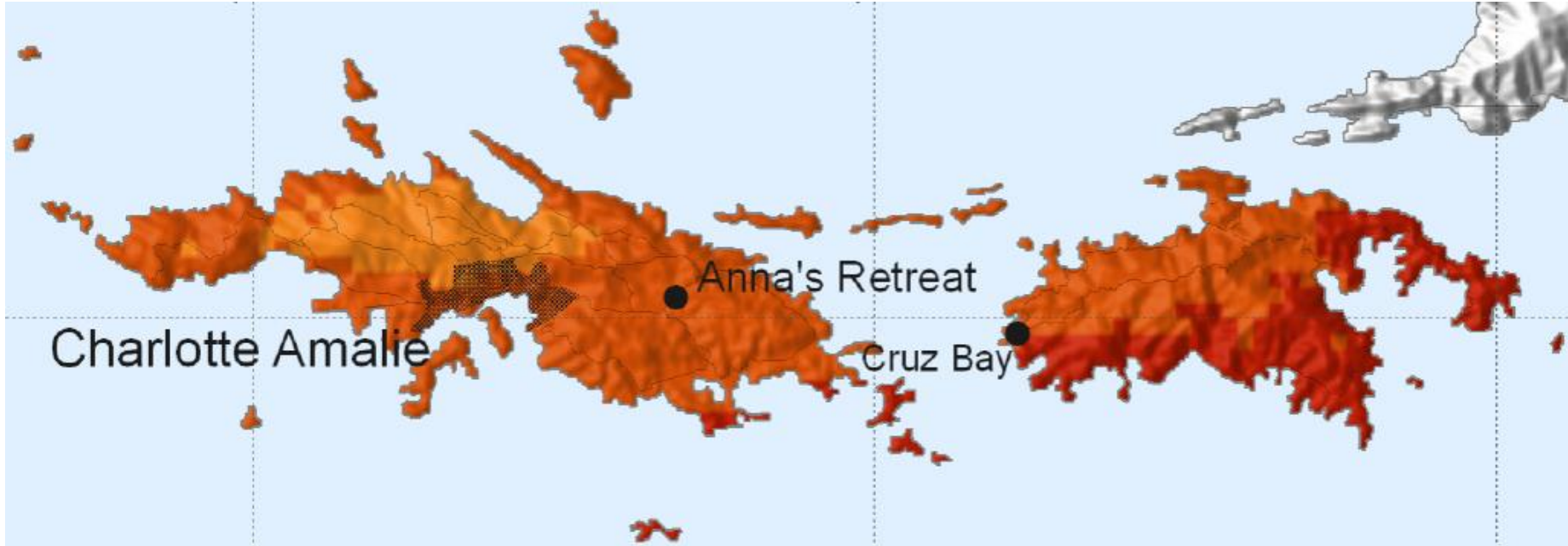
How Much Power Can We Get?

USVI Wind Potential



How Much Power Can We Get?

USVI Solar PV Potential



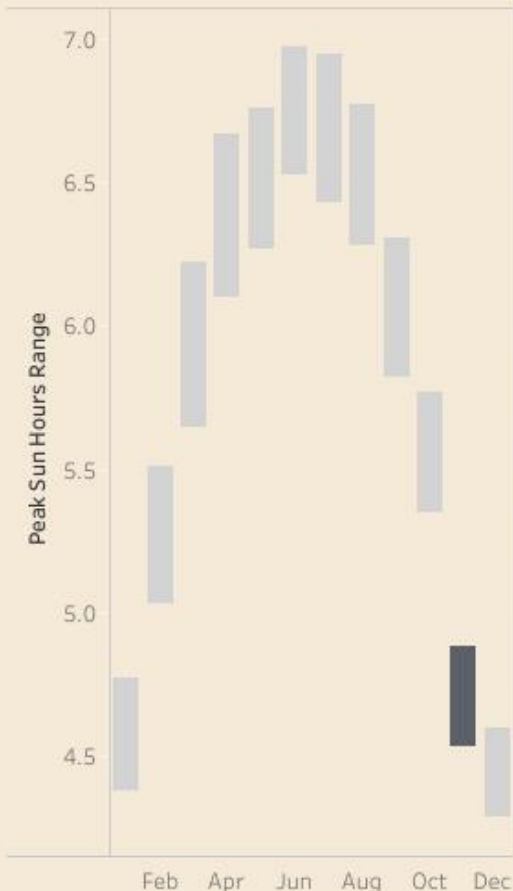
USVI Solar Radiation Map

Peak Sun Hours (PSH) are the amount of time throughout that day that the sun is shining at its full intensity (1,000 W/m²).

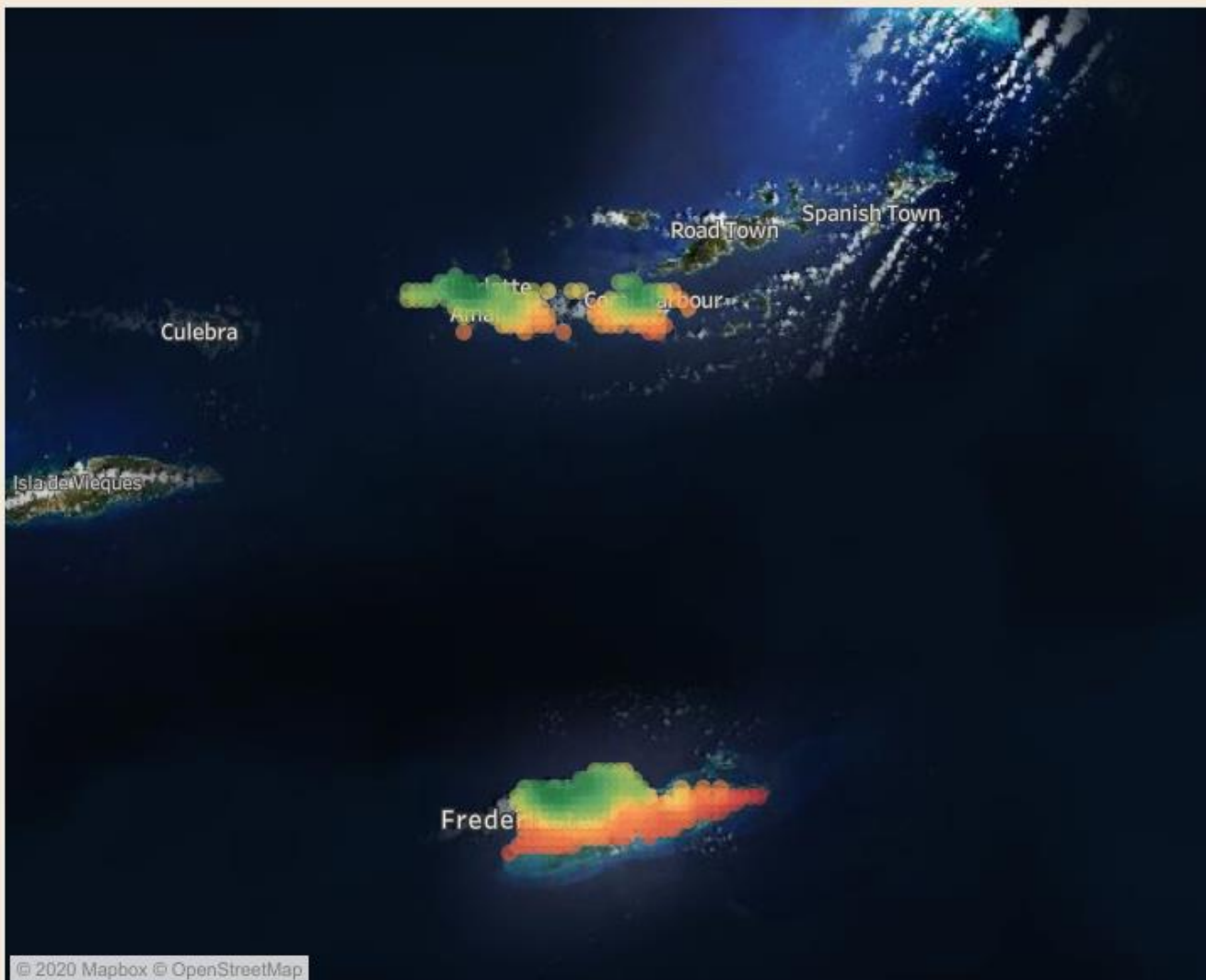
Select Month:

November

Peak Solar Hours Color Scale



Throughout the year the amount of peak sun changes as shown in the bar chart above. On average June has the most sun while December has the least amount of sun.



Calculate how much electricity your house would produce with solar!

1. How much of your roof area is available for solar panels?

Enter south.. 300

South facing roofs get the best sun!

2. How efficient is the solar photovoltaic panel?

Enter PV P.. 20%

Residential PV panels range from 15-23%. A typical panel is 20% efficient.

3. Now **hover** over or select your location on the map to calculate the monthly electricity production. Move the Month slider to see how it changes throughout the year.

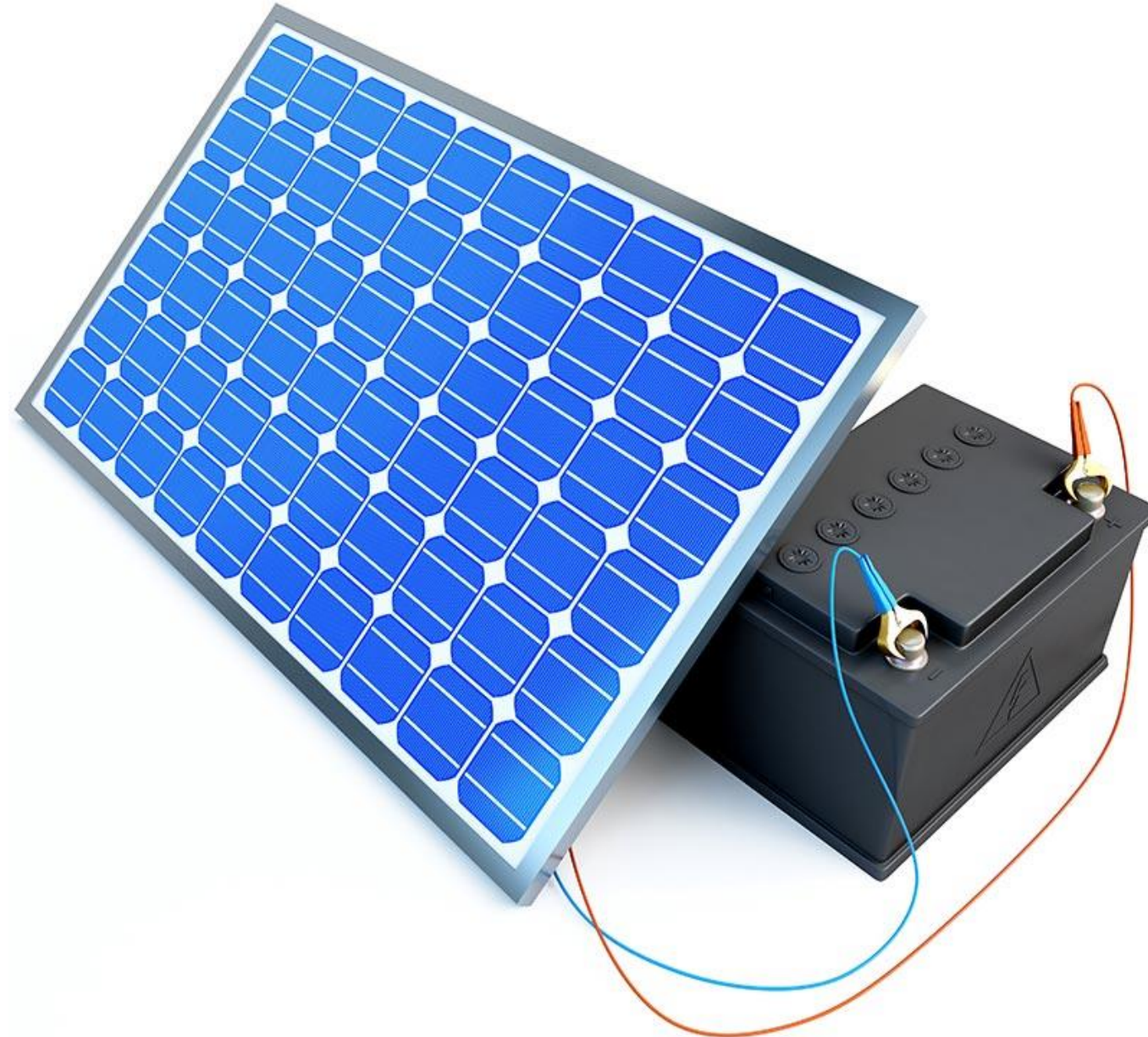
Electricity Produced Monthly in kWh:

786

Is it Enough to Keep the Lights On?



Energy Storage





Any
Questions???

Pop Quiz

Nuclear energy is a fossil fuel (T/F)

- True
- False

Which is an example of an energy carrier?

- Coal
- Petroleum
- Sunlight
- Electricity

What are examples of energy services? Choose all that apply

- Gasoline
- Mobility
- Electricity
- Lights
- Batteries
- Cooking
- Water pump

Which fossil fuel has the most GHG emissions per kWh?

- Nuclear
- Oil
- Natural Gas

The Virgin Islands gets the same amount of sun all year. (T/F)

- True
- False

Pop Quiz

Nuclear energy is a fossil fuel (T/F)

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- Water pump

Which of these fossil fuels has the most GHG emissions per kWh?

- Nuclear
- **Oil**
- Natural Gas

The Virgin Islands gets the same amount of sun all year. (T/F)

- True
- **False**

Discussion Questions

- How might the coronavirus pandemic impact the energy transition to renewables in the Virgin Islands?
- What needs to be done in the near term to ensure the Virgin Islands transition to renewables?
- Why should we care about greenhouse gas emissions (CO₂) in the Virgin Islands?
- What are some barriers to renewable energy at the household level?
- Why is it so hard to transition to renewable energy even if we know the consequences of fossil fuels? (air pollution, climate change impacts - intense hurricanes, sea level rise, etc.)
- What would a sustainable Virgin Islands look like to you? What are other (sometimes competing) aspects to consider?

Want to learn more about energy basics?

- Check out these youtube videos:
<https://www.youtube.com/playlist?list=PL7b293q4n8alo87IK74wa2iuJRVGmBxvH>
- US Energy Information Administration: <https://www.eia.gov/>
- International Energy Administration: <https://www.iea.org/>
- National Renewable Energy Laboratory maps:
<https://www.nrel.gov/gis/index.html>
- Energy Sankey Diagrams:
<https://flowcharts.llnl.gov/commodities/energy>

Units, Units, Units

Energy: capacity to do work

- Joule: $\frac{kg * m^2}{s^2}$

- kWh: 1,000 W * 1 hour

1kWh = 3.6 MJ

- BTU (British Thermal Unit):
measure of heat content

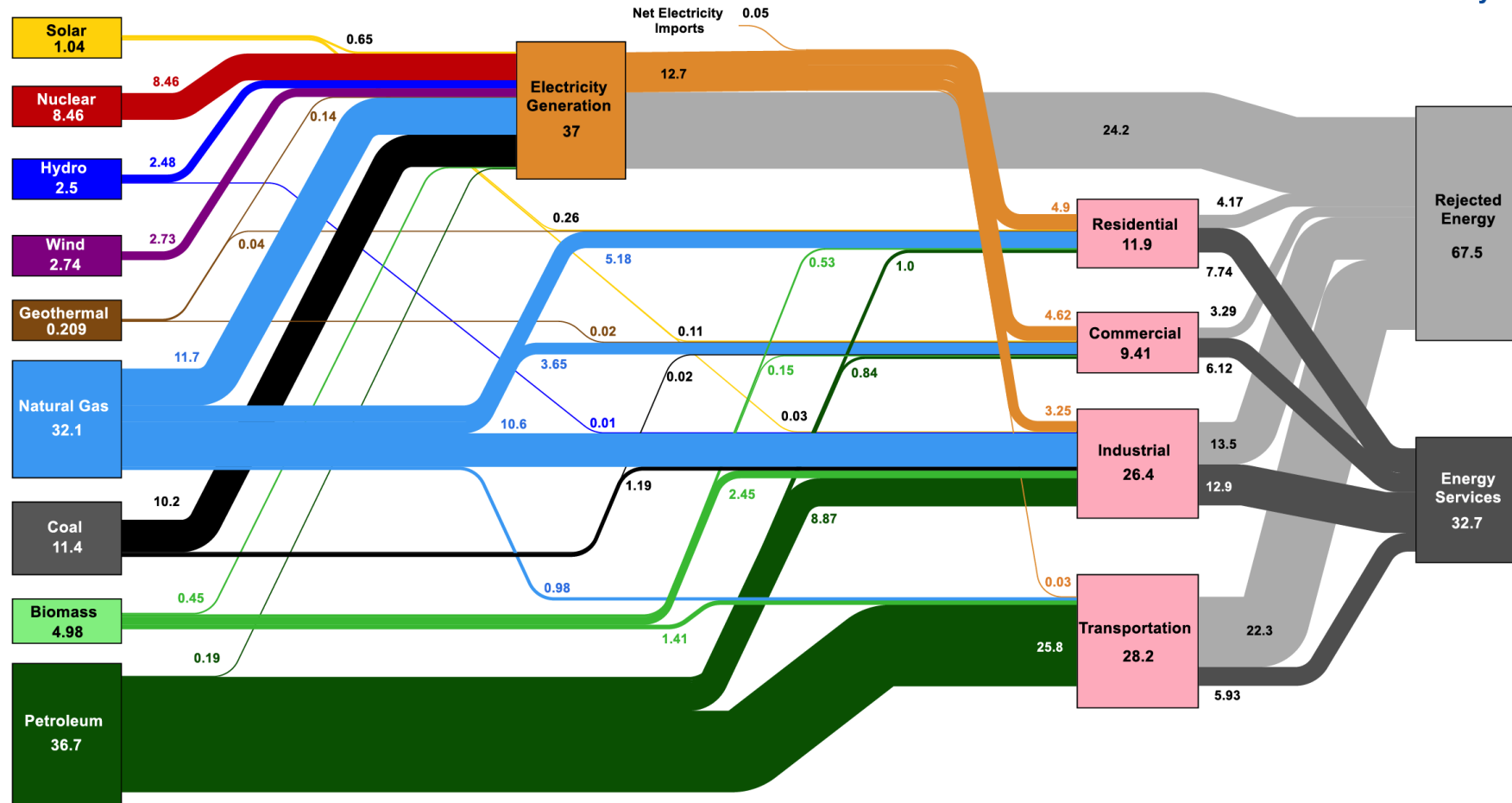
1 kWh = 3,412 Btu

Power: energy per unit of time

- Watts: Volts * Amps or J/s

What do we use energy for in the USA?

Estimated U.S. Energy Consumption in 2019: 100.2 Quads



Source: LLNL March, 2020. Data is based on DOE/EIA MBR (2019). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 21% for the transportation sector and 49% for the industrial sector, which was updated in 2017 to reflect DOE's analysis of manufacturing. Totals may not equal sum of components due to independent rounding. LLNL-WI-410527