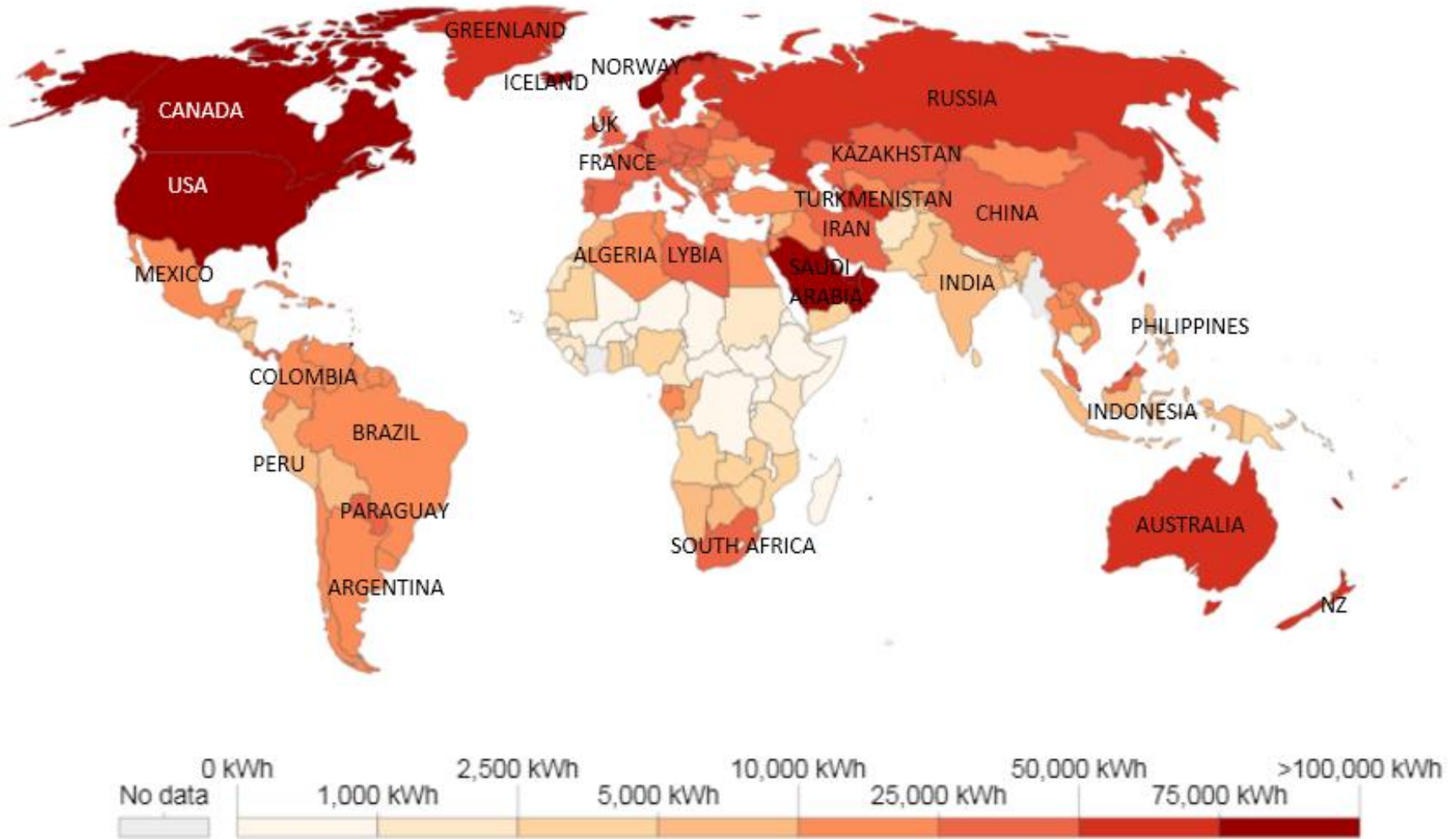




Sources of Energy

Resource Environmental Management

Energy Consumption per capita



Source: Our World in Data based on BP & Shift Data Portal

OurWorldInData.org/energy • CC BY

Note: Energy refers to primary energy – the energy input before the transformation to forms of energy for end-use (such as electricity or petrol for transport).

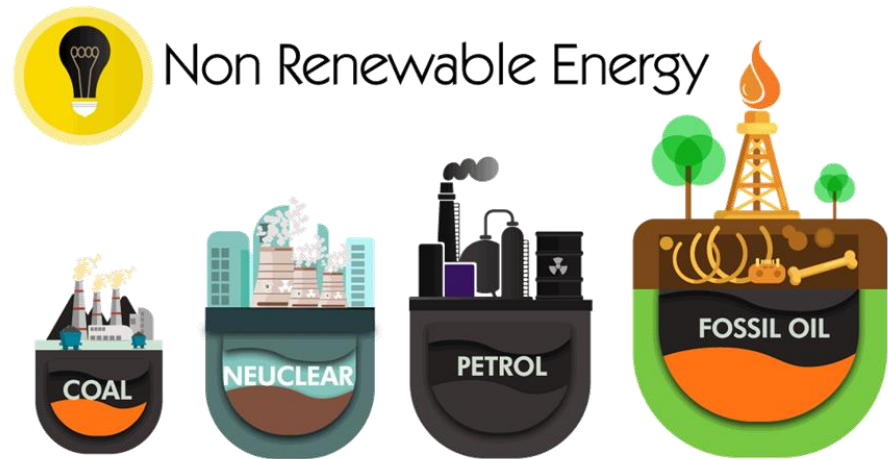
Non-Renewable Resource

- A natural resource that cannot be (naturally) replenished at a pace quick enough to keep up with consumption
- Most fossil fuels, minerals, and metal ores



Non-Renewable *Energy* Sources

- Fossil fuels
 - formed by natural processes over millions of years
 - high % of carbon
 - E.g. coal, oil and natural gas
- Uranium



Coal

- Black/brown combustible sedimentary rock
- Decay and composition of plant matter
- Mostly carbon
- Industrial Revolution
- 25% of primary energy, 40% of electricity

https://www.youtube.com/watch?v=iN6LvH_4Q3g



Coal: Advantages & Disadvantages

- ✓ Reliable / base load
- ✗ Coal mining – toxic dust, mine collapse, fire
- ✗ Combustion - toxic gases, pollution
- ✗ Coal power plants – GHGs, water pollution



Oil

- Liquid fossil fuel
- Also known as 'crude oil' or 'petroleum'
- Trapped underground
- LaBrea Tar Pits

https://www.youtube.com/watch?v=3AoygZa3d_s



Oil: Advantages & Disadvantages

- ✓ Relatively inexpensive
- ✓ Reliable source
- ✓ Boost to local economy
- ✓ Many conveniences
- ✗ Toxic combustion gases
- ✗ Oil spill risk

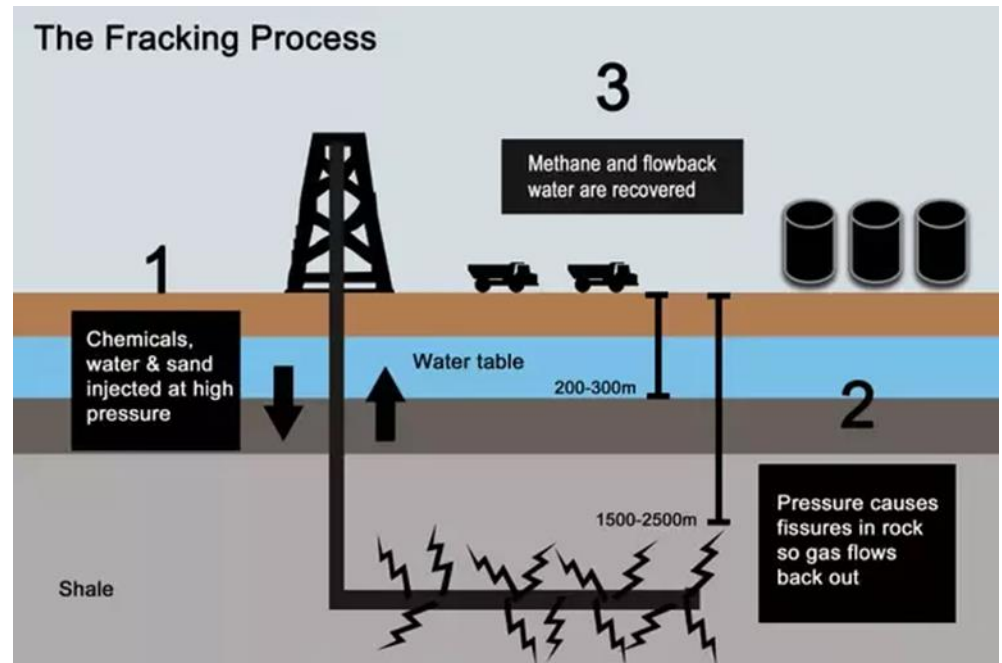
<https://www.youtube.com/watch?v=UPAqfTNiais>



Natural Gas

- Trapped underground
- Mostly methane
- Vast reserves
- Gas “fracking”

<https://www.youtube.com/watch?v=-njmj0diWu8>



Natural Gas: Advantages & Disadvantages

- ✓ relatively inexpensive
- ✓ “cleaner” fossil fuel than oil or coal
- ✗ Gas “fracking”
- ✗ Induced seismic activity
- ✗ Pollution of water



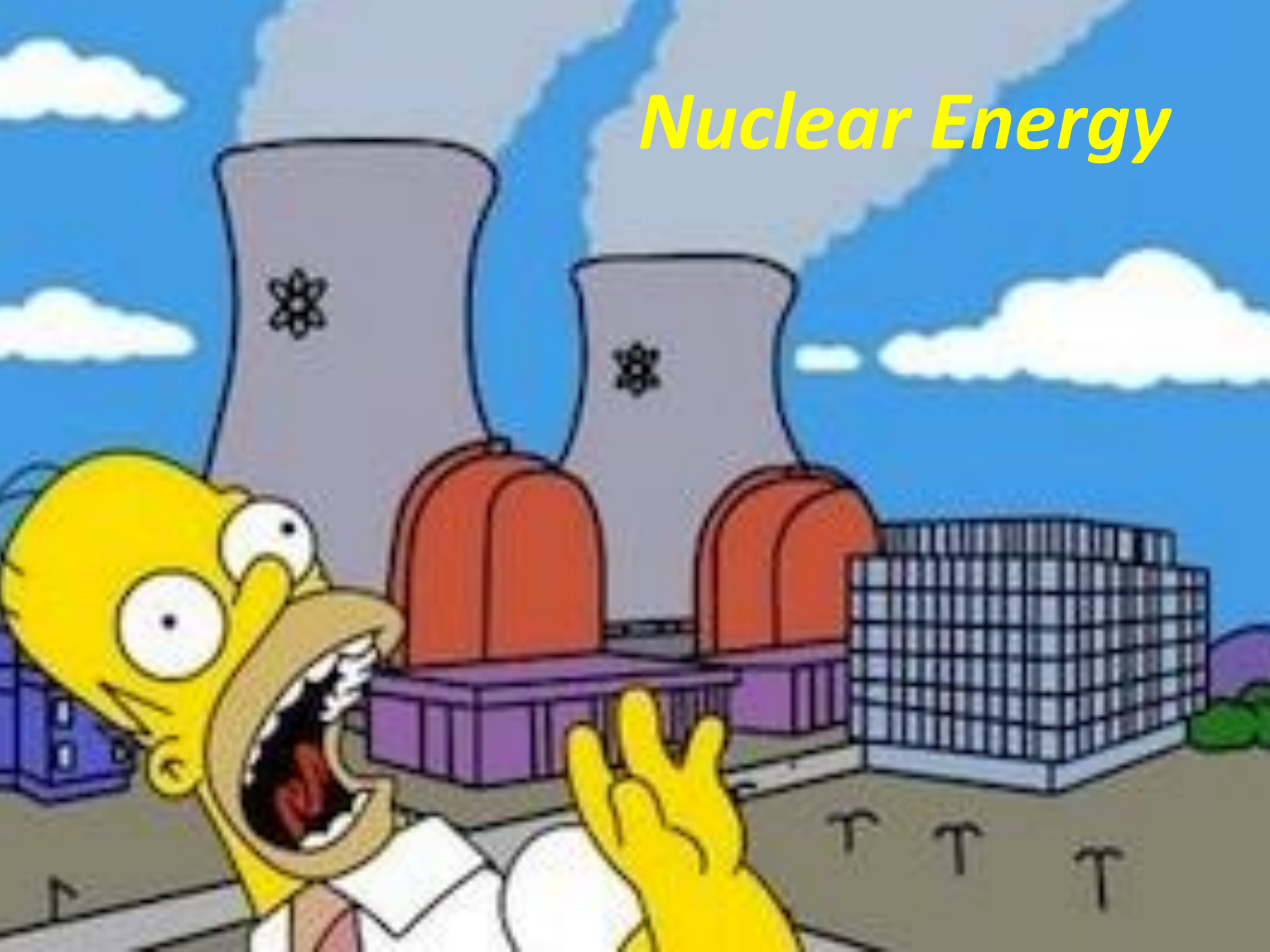
Renewable or not?

Nuclear Energy



Biomass Energy

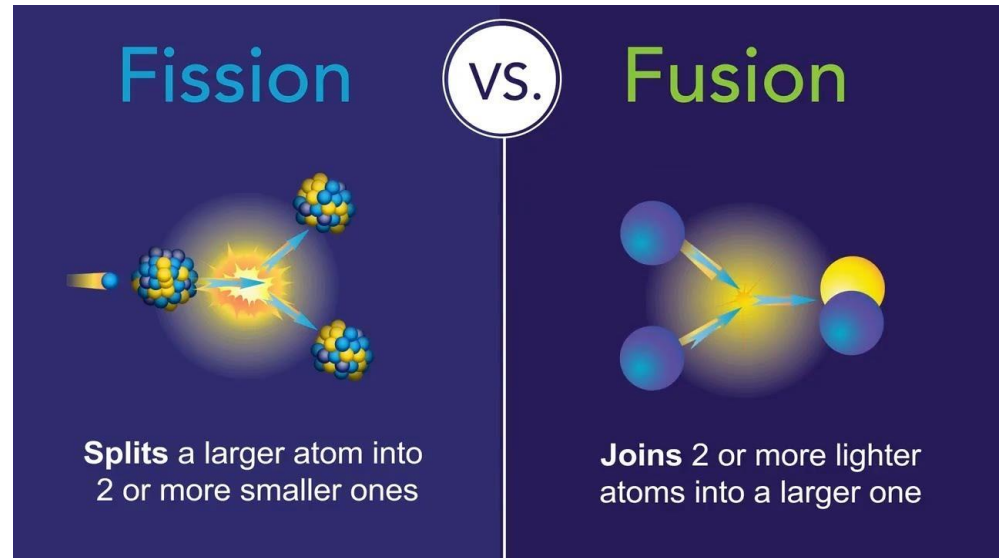
Nuclear Energy



Nuclear Energy

- Usually considered non-renewable
- Green energy?
- Uranium, Thorium
- Fission – splitting atoms

https://www.youtube.com/watch?v=44ovdxOvP_A



Nuclear Energy: Advantages & Disadvantages

- ✓ Reliable baseload
- ✓ No air pollution
- ✓ No GHGs
- ✗ Complex to build and operate
- ✗ Skills shortage
- ✗ Radioactive waste



Biomass Energy

- Uses plant energy
- Combustion to create energy
- Biomass feedstocks e.g. corn, soy, wood.
- Renewable or not?

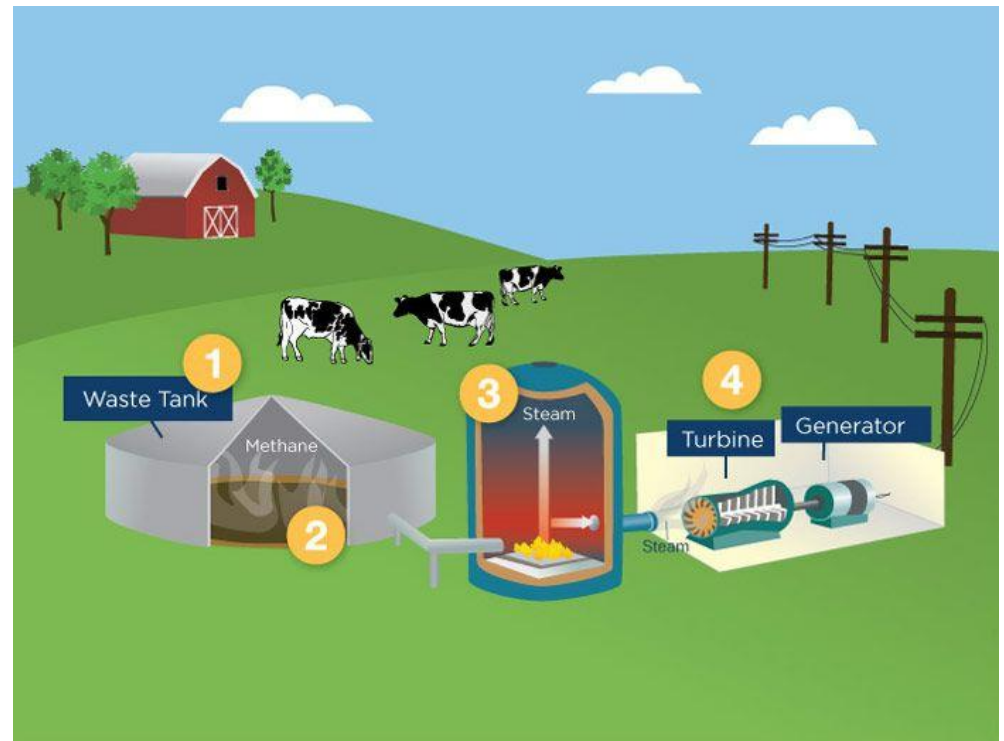


Biomass Energy: Advantages & Disadvantages

- ✓ Less reliance on fossil fuels
- ✓ Cheaper
- ✓ Widely available
- ✓ Carbon neutral
- ✓ Agricultural byproduct

- ✗ Not as efficient as some fossil fuels
- ✗ Not entirely clean
- ✗ Large land requirement

<https://www.youtube.com/watch?v=yHWcddUZ35s>



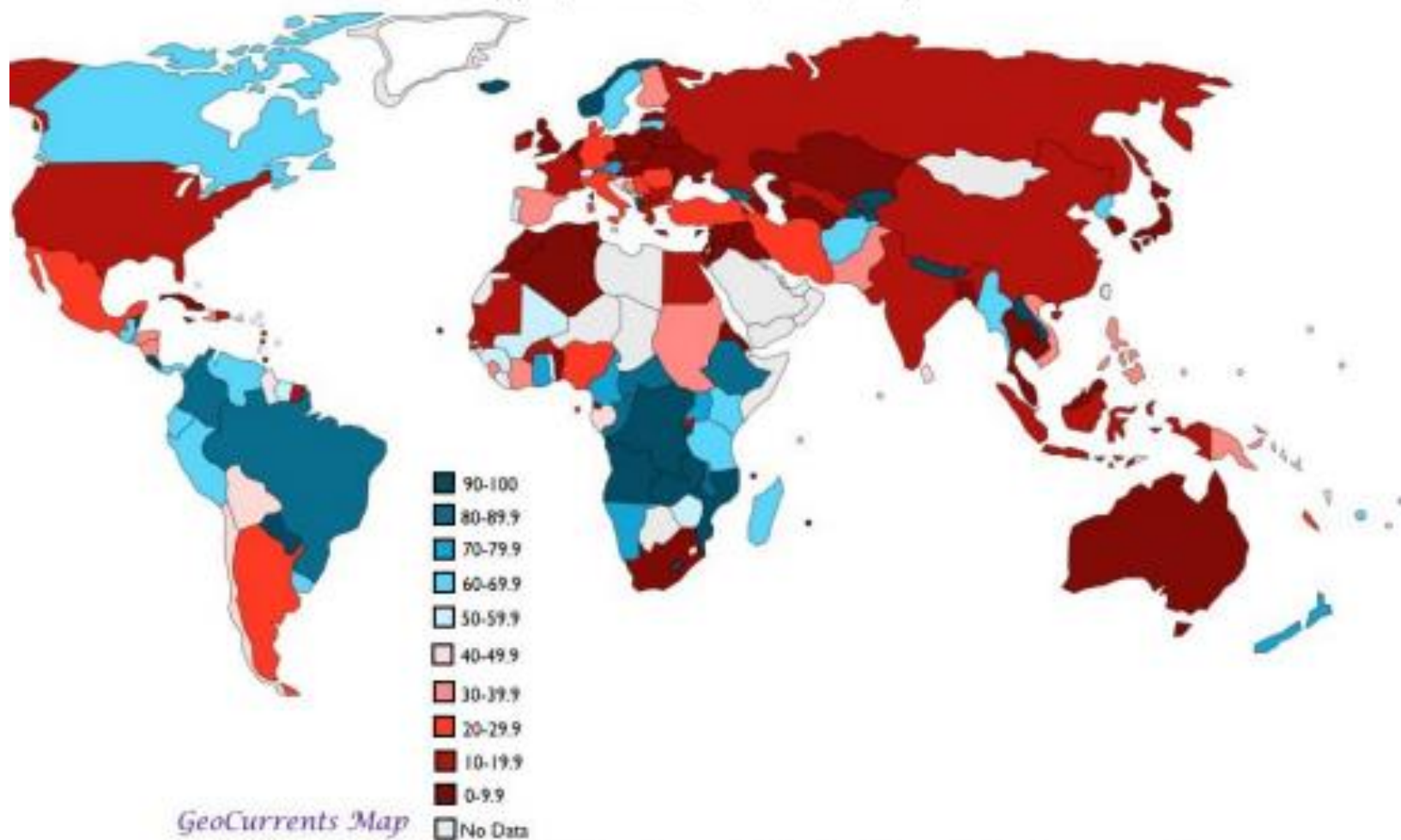
Renewable Energy Sources

- A natural resource that CAN be replenished fast enough to keep up with consumption
- Solar
- Wind
- Geothermal
- Hydropower.



Percentage of Electricity Generation from Renewable Sources

(Hydro, Geothermal, Solar, Biomass, Wind)



GeoCurrents Map

Data Source: http://en.wikipedia.org/wiki/List_of_countries_by_electricity_production_from_renewable_sources

Solar Energy

- **Active** or **Passive**
- Active – PV cells, mirrors
- Passive – building orientation

<https://www.youtube.com/watch?v=FgjfJGfusdE>



Solar Energy: Advantages & Disadvantages

- ✓ Long life
- ✓ No pollution
- ✗ Expensive
- ✗ Variable sunshine
- ✗ Fabrication - harmful chemicals & GHGs.
- ✗ Complex to recycle

<https://www.youtube.com/watch?v=YQba3ENhIKA>



Wind Energy

- Harvest wind energy
- Wind turbines
- Blades drive generator
- Up to 100m tall



Wind Energy: Advantages & Disadvantages

- ✓ High efficiency
- ✓ Cheap electricity
- ✓ Clean energy
- ✗ Not always windy
- ✗ Bird strike

<https://www.youtube.com/watch?v=Z5c50-hcD0>



Geothermal Energy

- Underground heat
- Natural or induced steam
- Steam-driven generator



Geothermal Energy: Advantages & Disadvantages

- ✓ No fuel requirement
- ✓ No harmful air emissions
- ✗ Not always windy
- ✗ Cooling water can be contaminated
- ✗ Seismic risks
- ✗ Water pollution

<https://www.youtube.com/watch?v=DFQrE91kZwk>



Hydroelectric Energy

- Dam or reservoir
- discharge feeds turbine
- Generator creates electricity

<https://www.youtube.com/watch?v=OC8Lbyeyh-E>



Hydro Energy: Advantages & Disadvantages

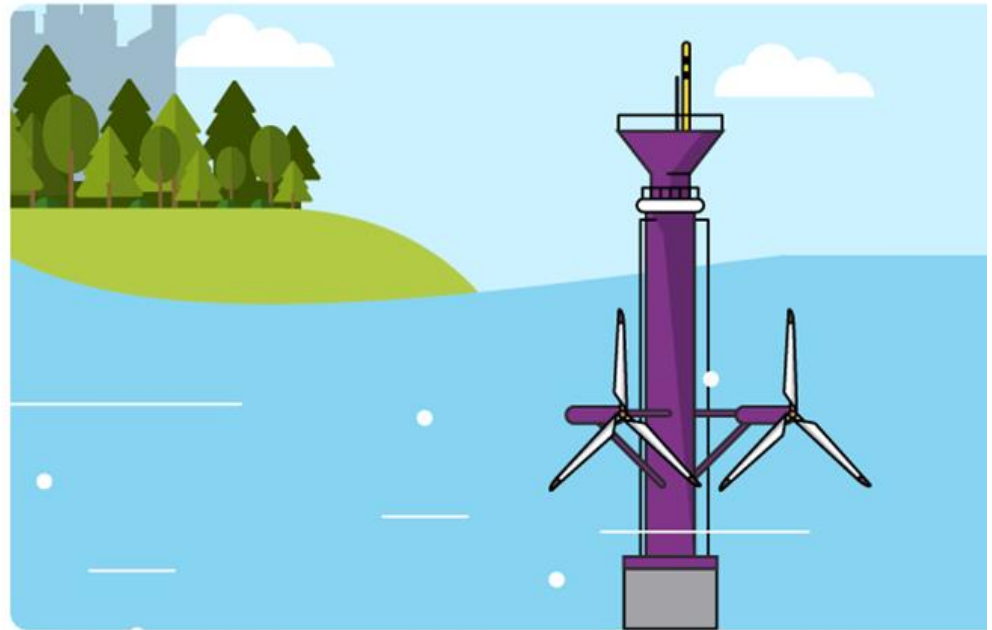
- ✓ Reasonably inexpensive
- ✓ Reasonably independent of weather
- ✓ Can be built on existing dam
- ✗ Ecological damage due to dam construction
- ✗ Impacts of drought



Tidal Energy

- Harness wave forces of the ocean to generate electricity

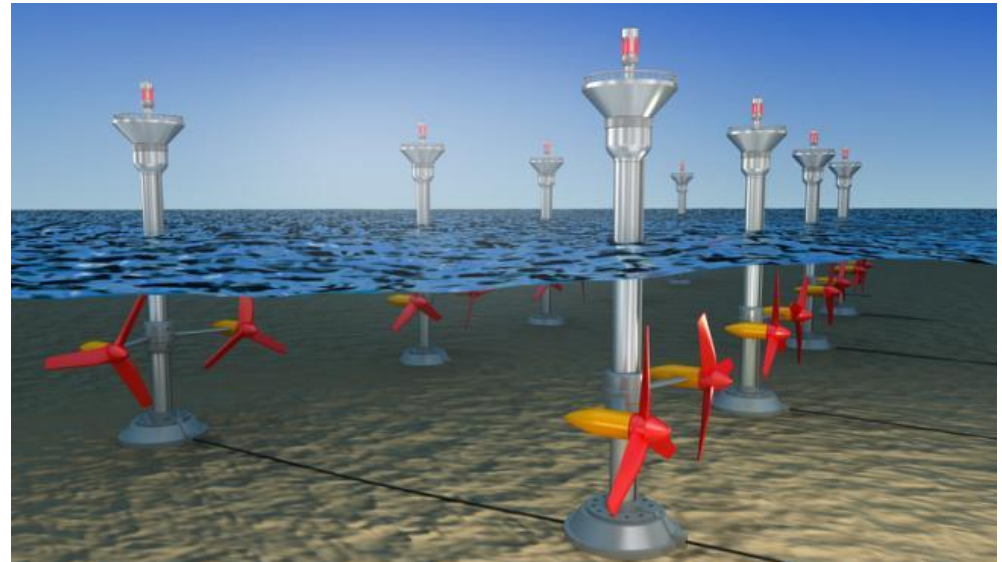
<https://www.youtube.com/watch?v=gcStpg3i5V8>



Tidal Energy: Advantages & Disadvantages

- ✓ No fuel consumption
- ✓ No emissions
- ✓ Large quantities
- ✓ Efficient
- ✓ Low running costs
- ✓ renewable

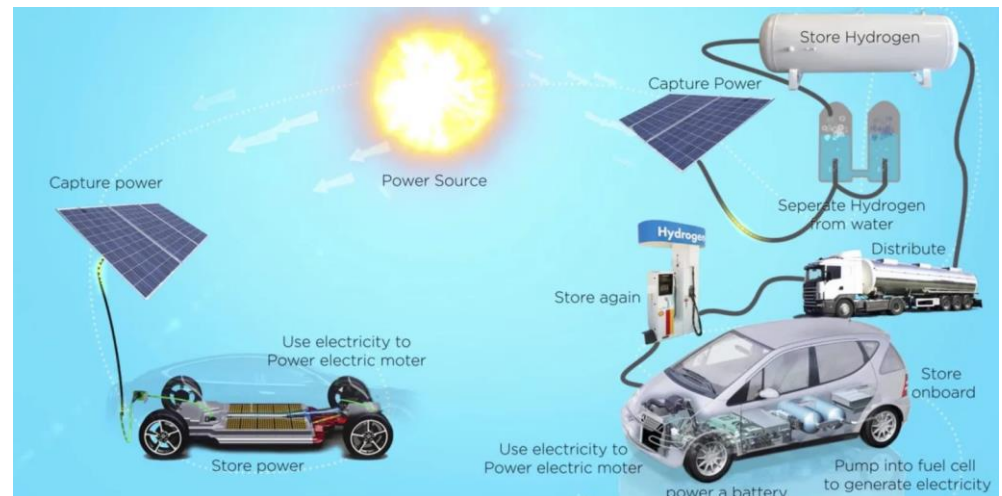
- ✗ High construction cost
- ✗ Impacts on marine life
- ✗ Limits on location
- ✗ Variable tidal forces



Hydrogen Cells

- Energy carrier
- Used in fuel cells to
- Diverse sources
- Various methods and technologies
- Steam methane forming
- Electrolysis
- Biological processes

<https://www.youtube.com/watch?v=a4pXAmljdUA>



Battery Technology

- Energy storage
- Balance demand & production
- Improving technology
- Improved viability of renewables

<https://www.youtube.com/watch?v=tjazxj3HA-0>

