

# Energy

Part 2

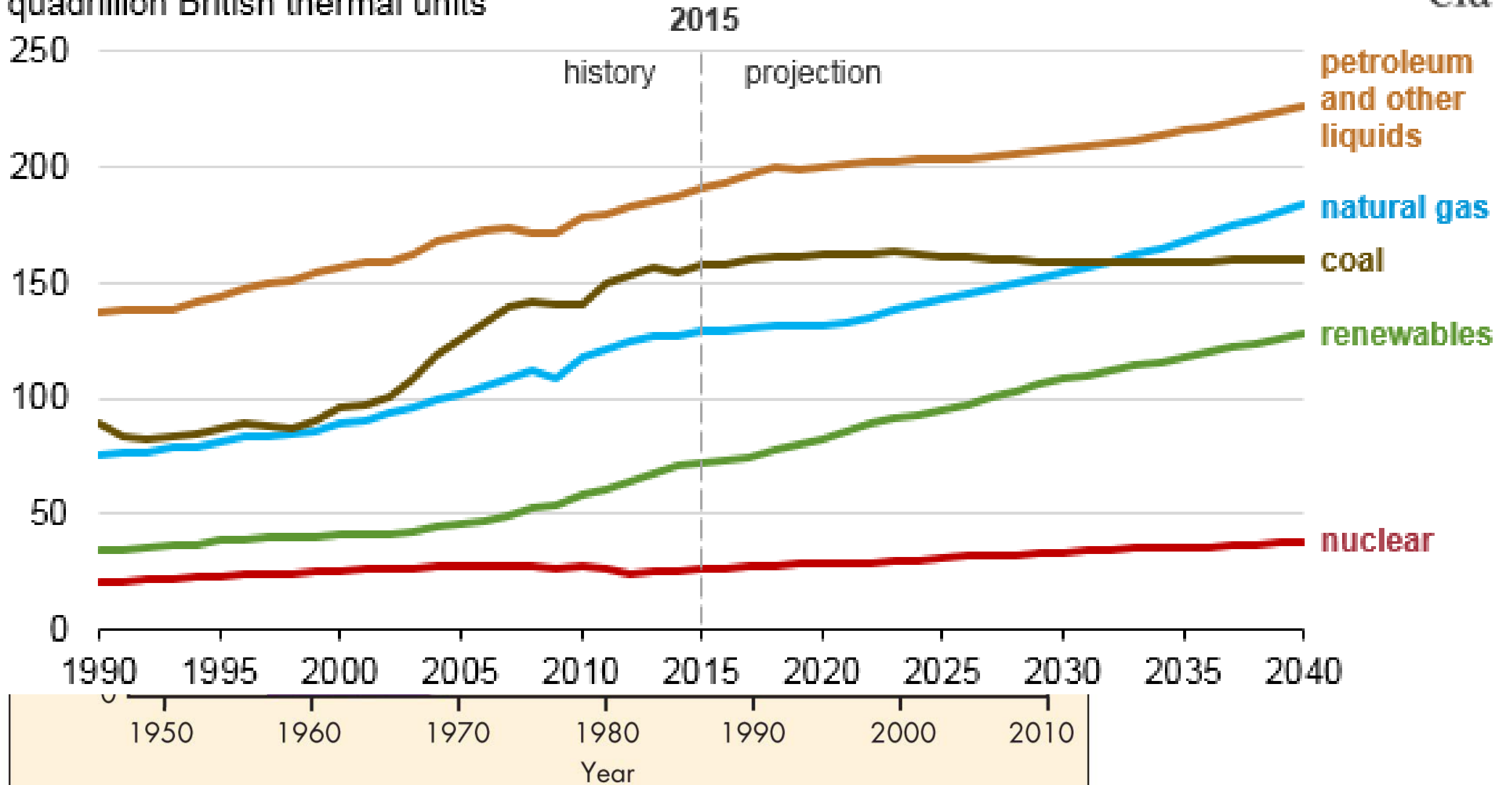
# The Great Way, Wu-Men Huikai

The Great way has no gate;  
There are a thousand paths to it.  
If you pass through the barrier,  
You walk the universe alone.



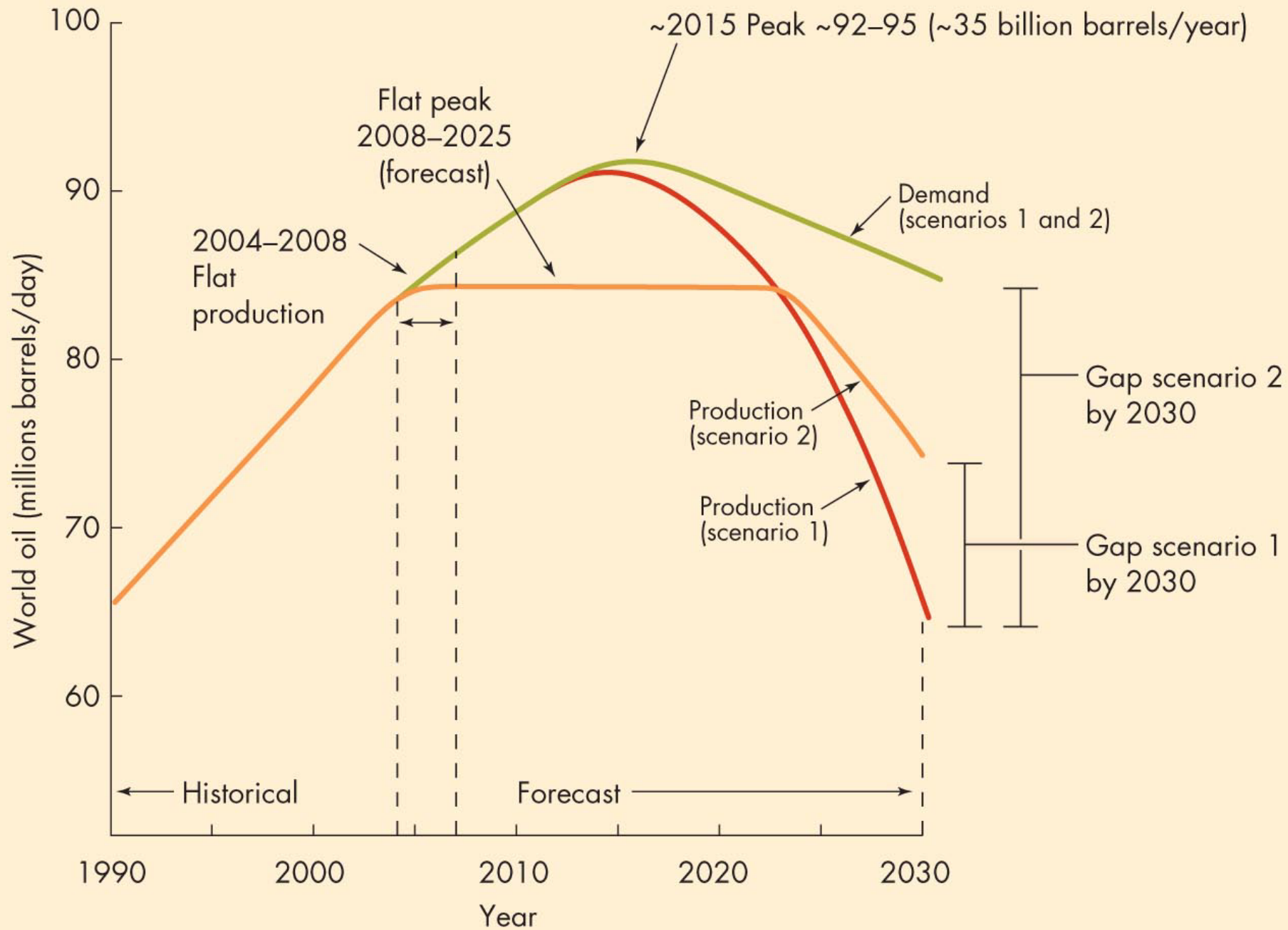
# World energy consumption by energy source (1990-2040)

quadrillion British thermal units

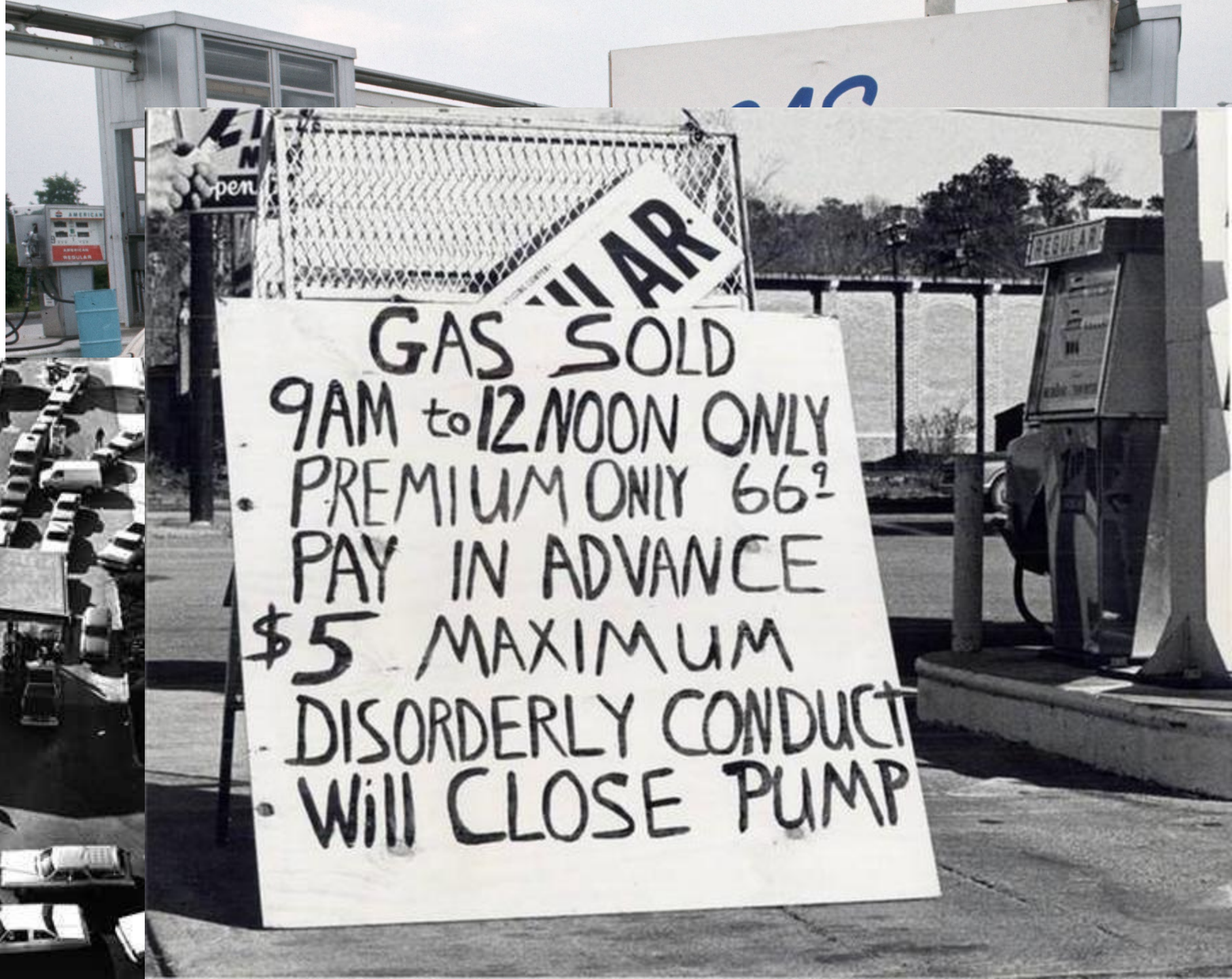


Oil Production

Production



1974

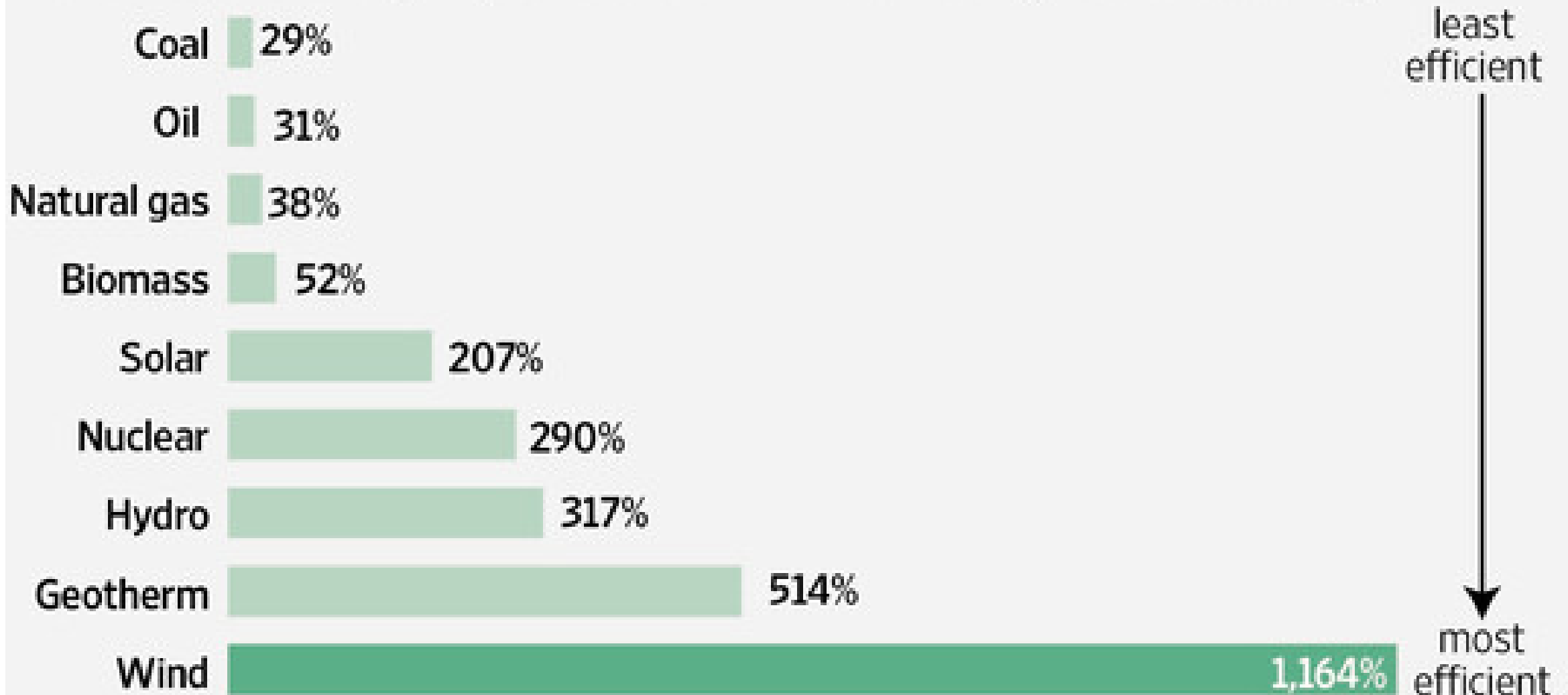


# Organization of Petroleum Exporting Countries (OPEC)

- 1960 - Iran, Iraq, Kuwait, Saudi Arabia and Venezuela
- Qatar (1961), Indonesia (1962), Libya (1962), the United Arab Emirates (1967), Algeria (1969), Nigeria (1971), Ecuador (1973), Gabon (1975), Angola (2007), Equatorial Guinea (2017) and Congo (2018)
- Mission 'Coordinate and unify the petroleum policies of its member countries and ensure the stabilization of oil markets, in order to secure an efficient, economic and regular supply of petroleum to consumers, a steady income to producers, and a fair return on capital for those investing in the petroleum industry'

# Energy Efficiency

Percentage of energy input retained when converting fuel to electricity

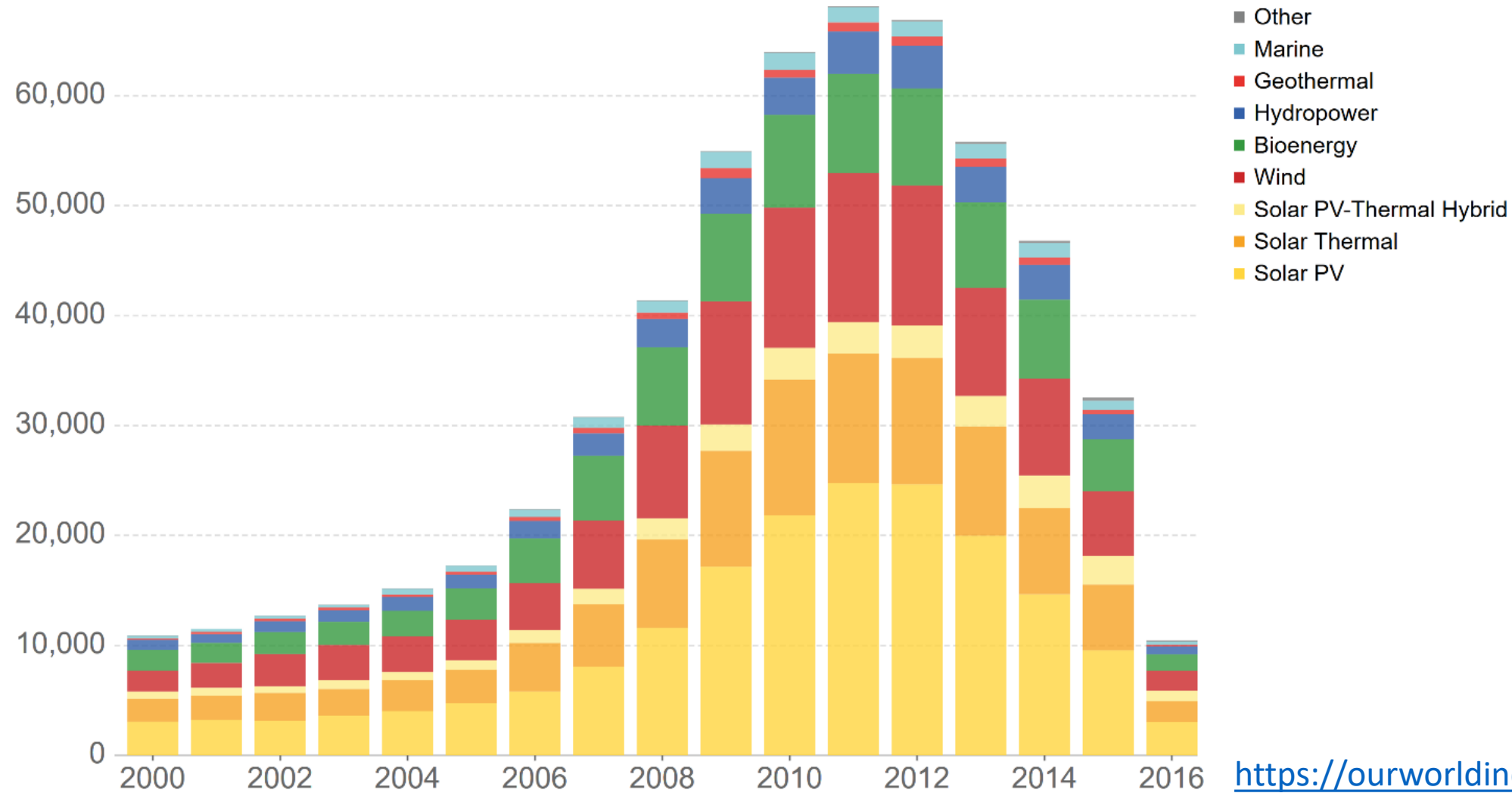


Source: Energy Points

The Wall Street Journal

# Number of patents filed for renewable energy technologies, World

Global number of patents filed under each renewable technology category per year. Note that figures for 2014-16 may be subject to a time lag; processing times of patent applications vary and some patents submitted over this period may not yet be recorded in statistics. These figures will be updated with time if additional patent applications are recorded.



<https://ourworldindata.org/renewable-energy>



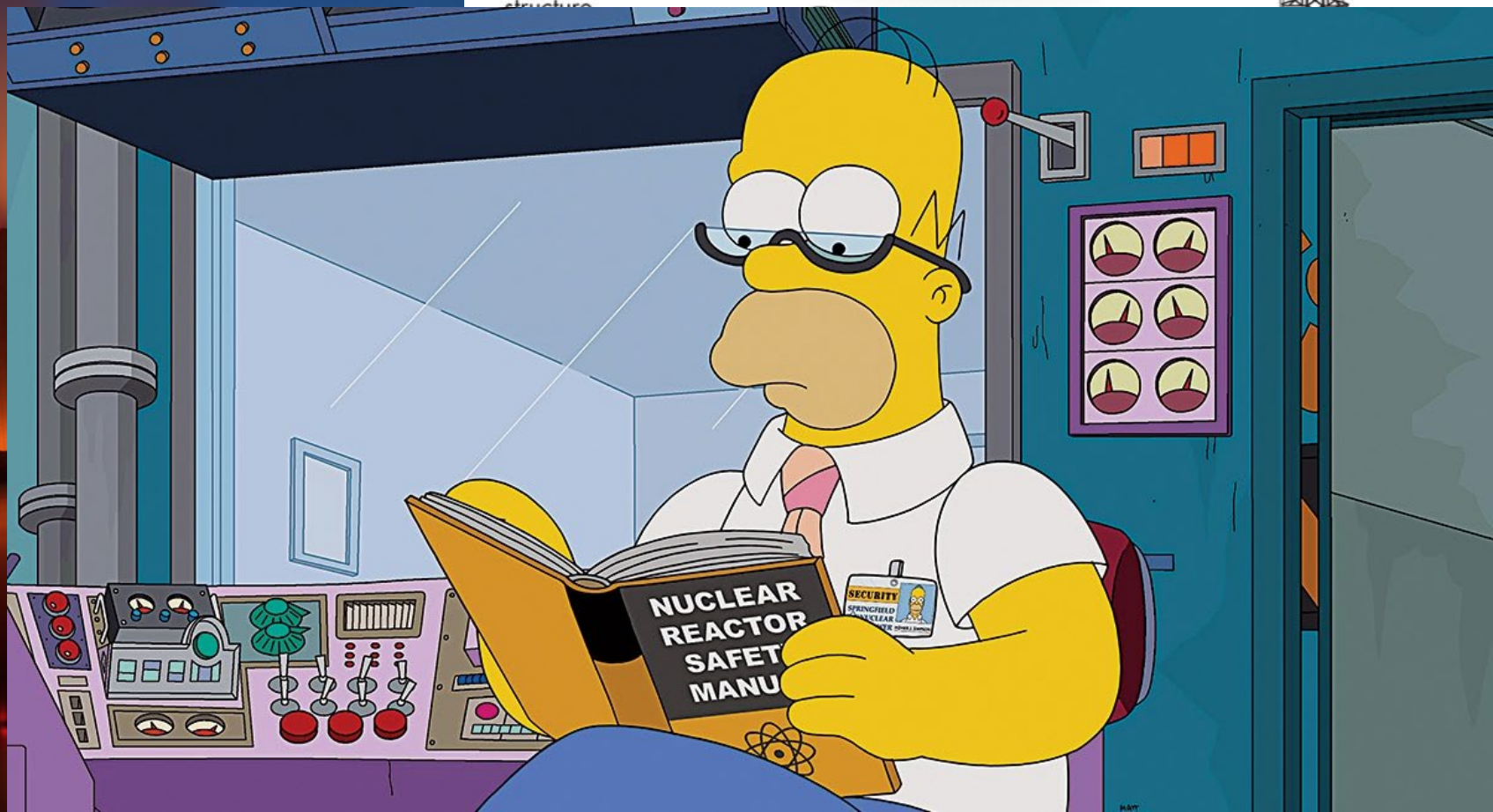
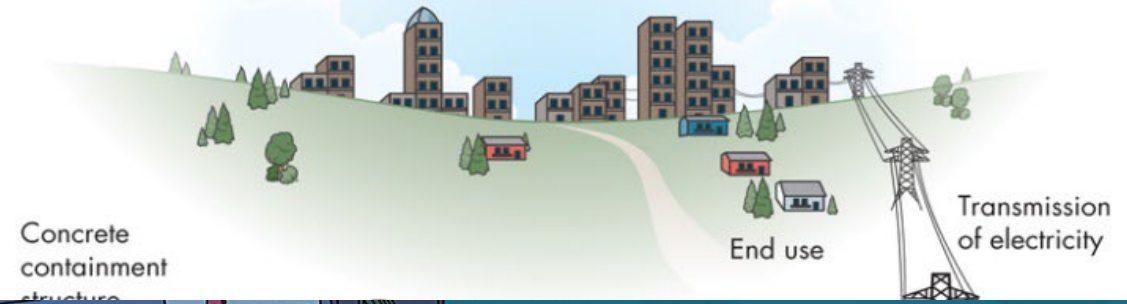
# Energy – The good, the bad, the ugly

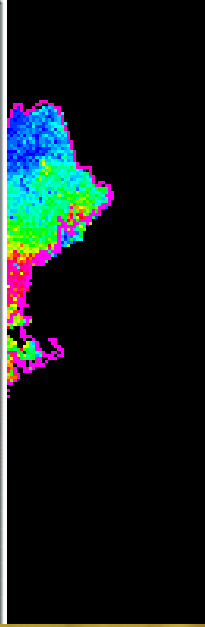
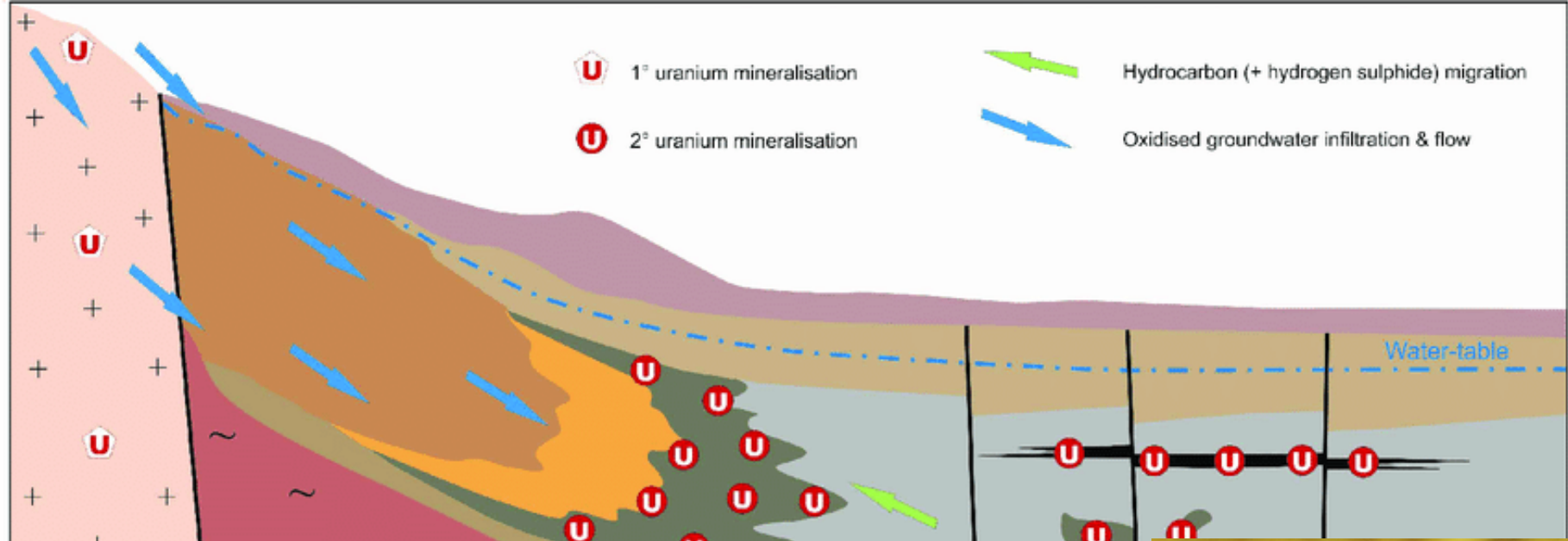
- Advantages

- Disadvantages

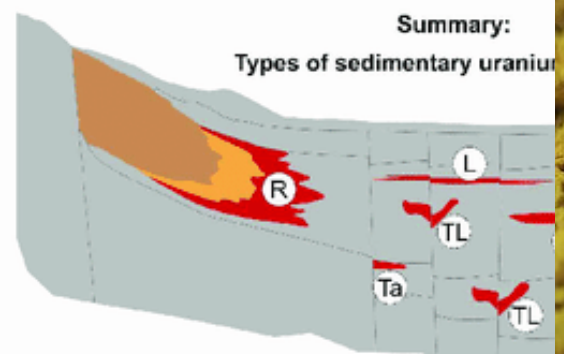
Unintended Consequences

# Nuclear Energy

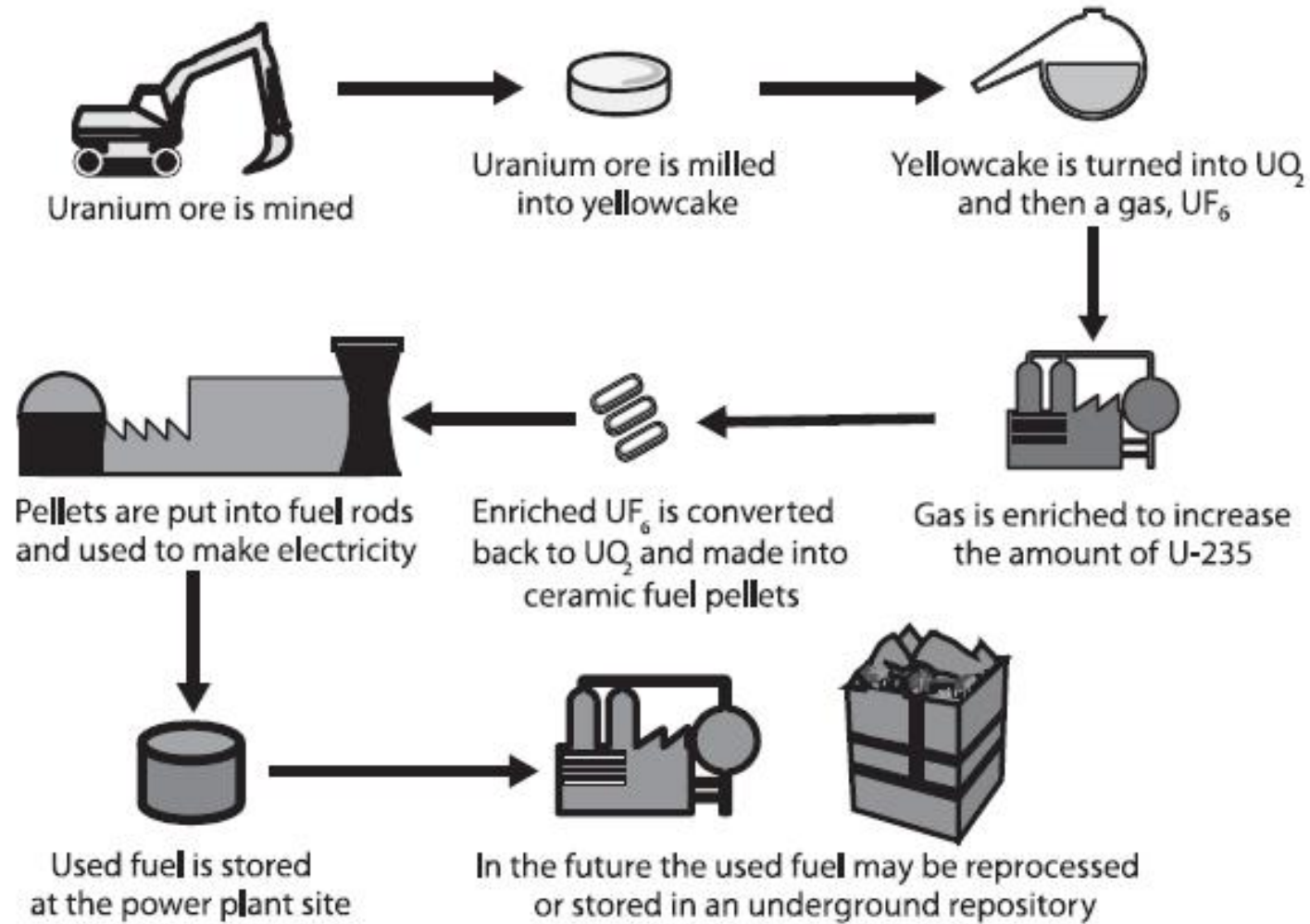




- Surficial, alluvial apron
- Upper, confining claystone
- Reduced sandstone containing lignite / coal
- Hematitic sandstone
- Goethitic sandstone
- Uranium ore envelope
- Lower, claystone aquitard
- Reduced sandstone
- Uranium ore envelope
- Undiff. crystalline basement
- Uraniferous granite



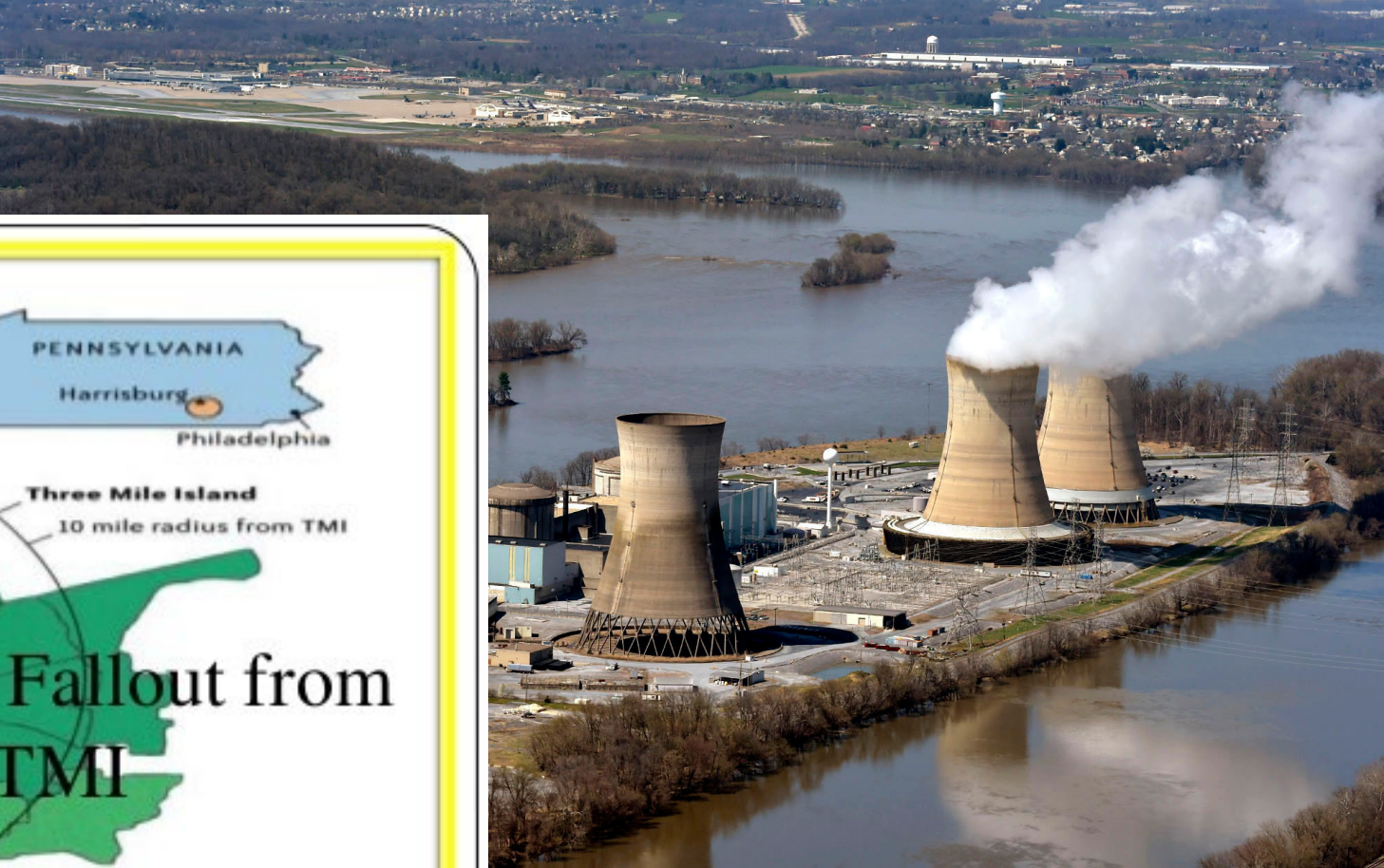
# Uranium Fuel Cycle



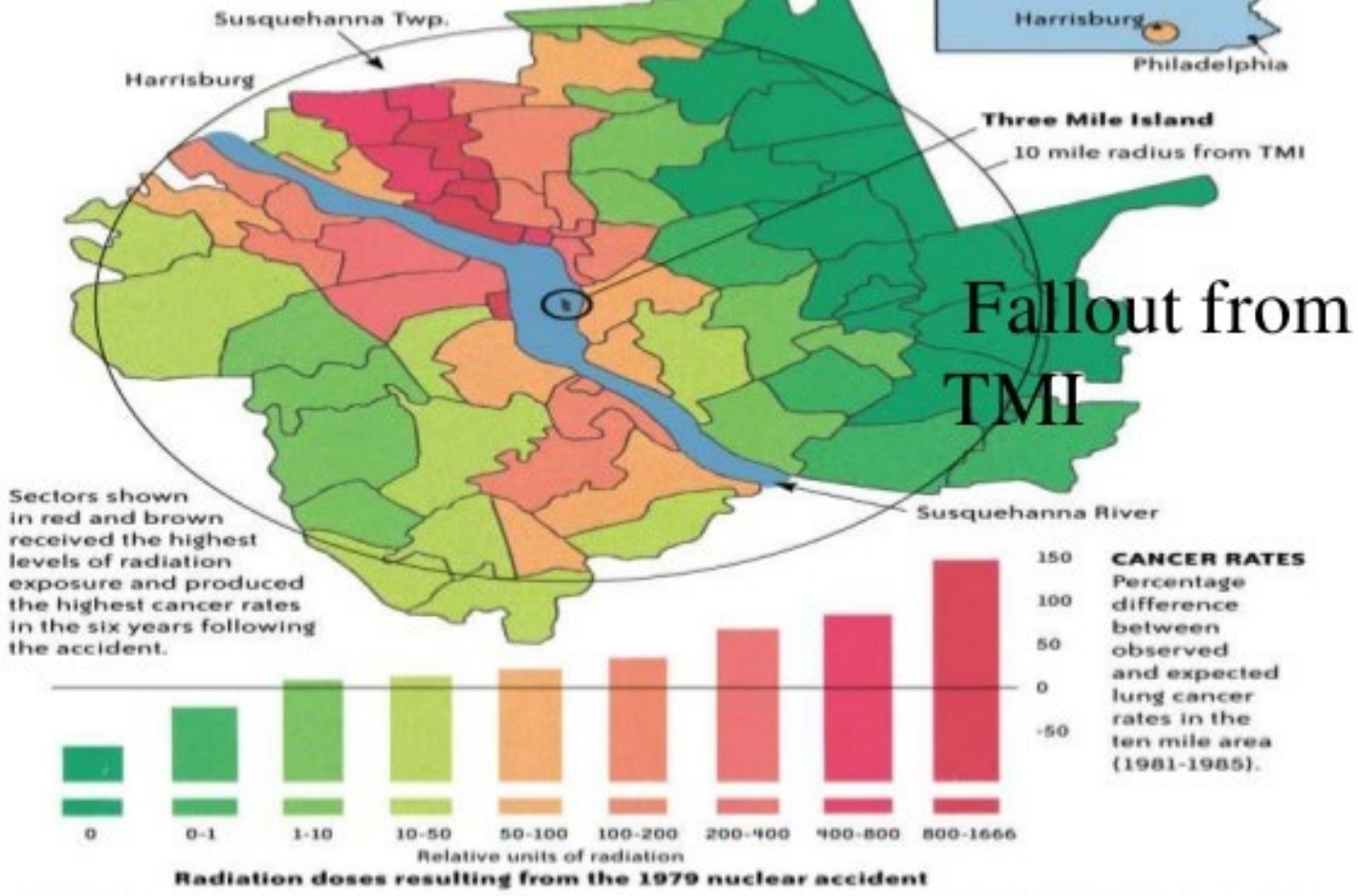
Isotope	Half-Life (Years)
U-234	$2.455 \times 10^5$
U-235	$7.038 \times 10^8$
U-238	$4.468 \times 10^9$



# Three Mile Island



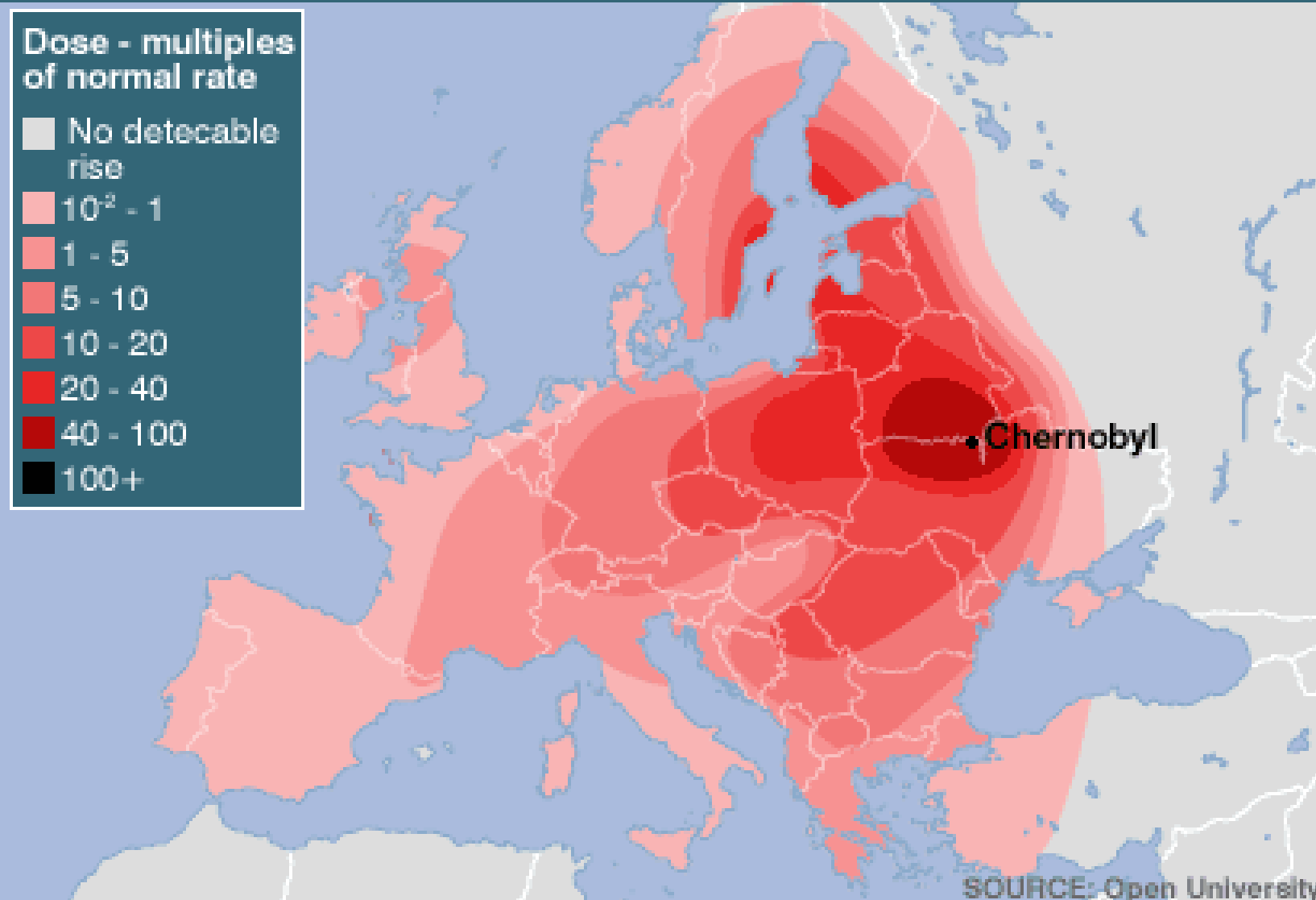
## Radiation emissions and cancer incidence within 10 miles of TMI



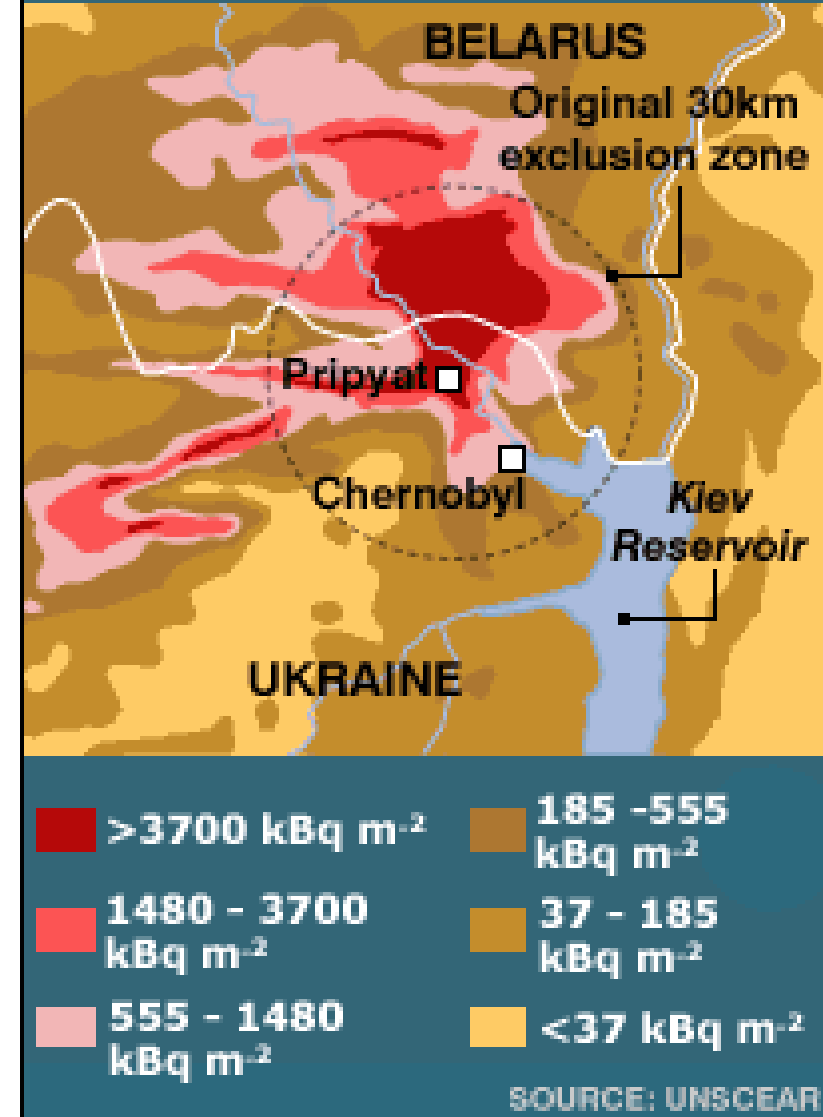
# Chernobyl



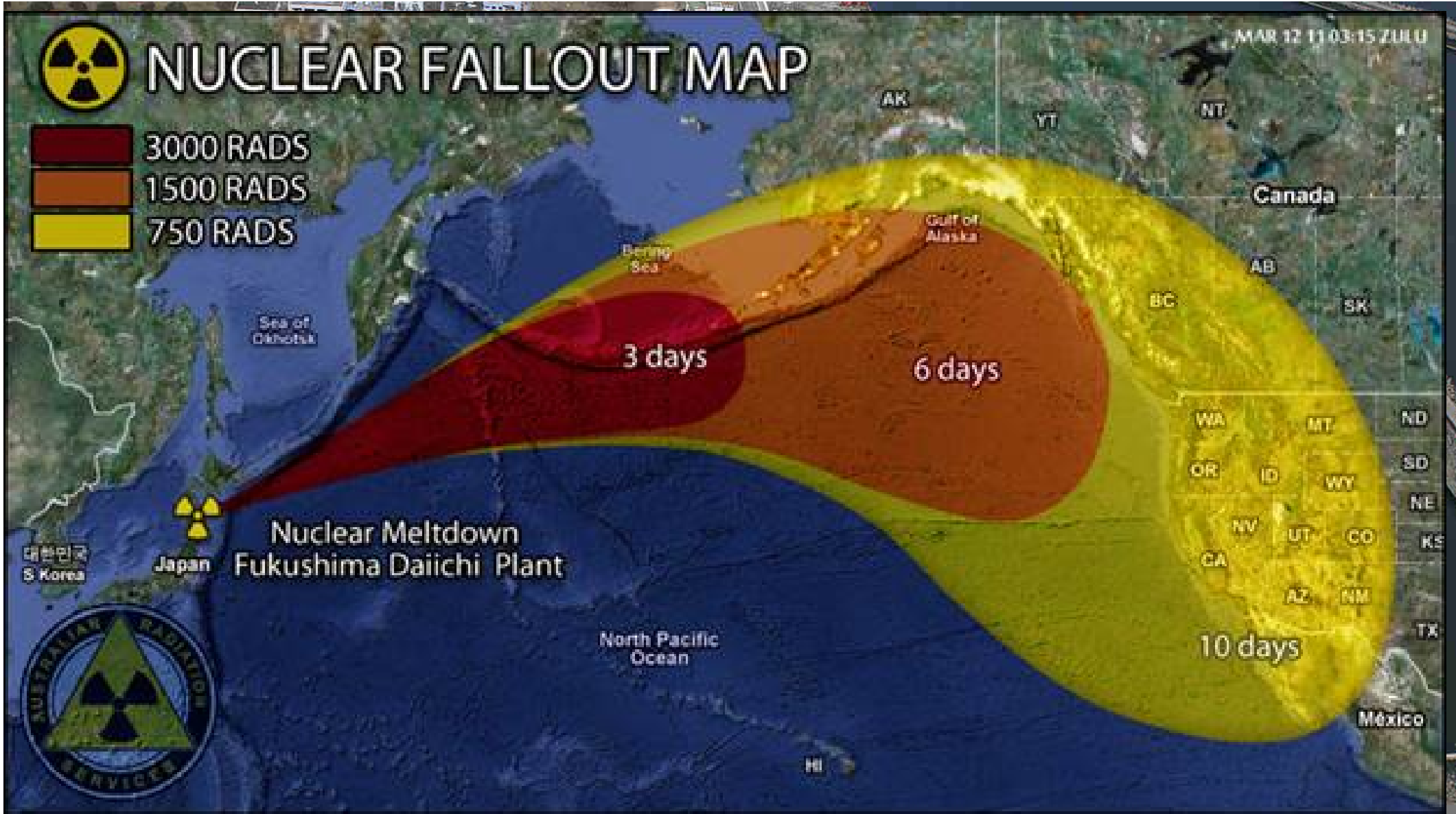
INCREASED RADIATION DOSE ACROSS EUROPE - 3 MAY 1986



CAESIUM DEPOSITION



# Fukushima, Japan



# Radiation and the human body

In microsieverts  $\mu\text{Sv}$

Effects

800,000 - 16,000,000

Radiation dose of first responders to Chernobyl

Above 7,000,000

Instant radiation dose - vomiting, internal bleeding, death within 2 weeks

3,000,000

50% chance of dying within 60 days if untreated

680,000

Highest dose received by a worker at 2011 Fukushima disaster

350,000

Approx dose rate if you lived in Chernobyl's "Red Forest" area for one year

20,000

Annual limit for nuclear workers in Europe

10,000

Instant radiation from a whole body CT scan

100

Annual natural background radiation in US

1,000

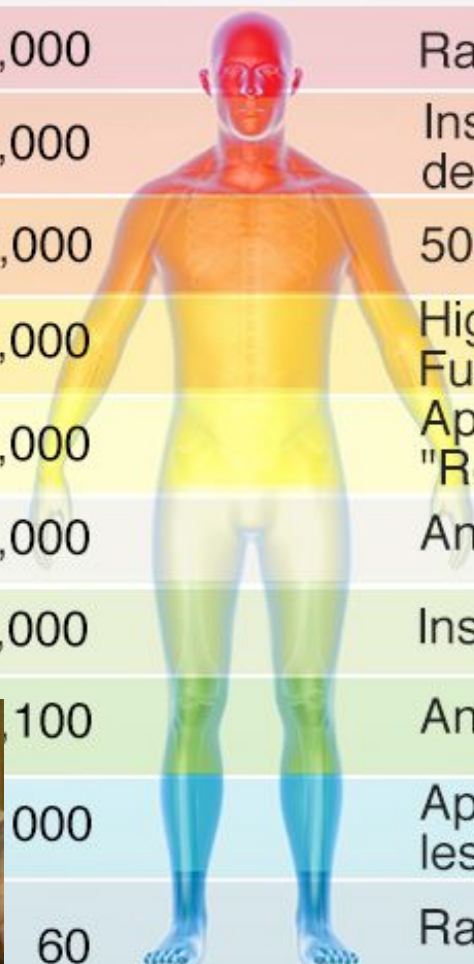
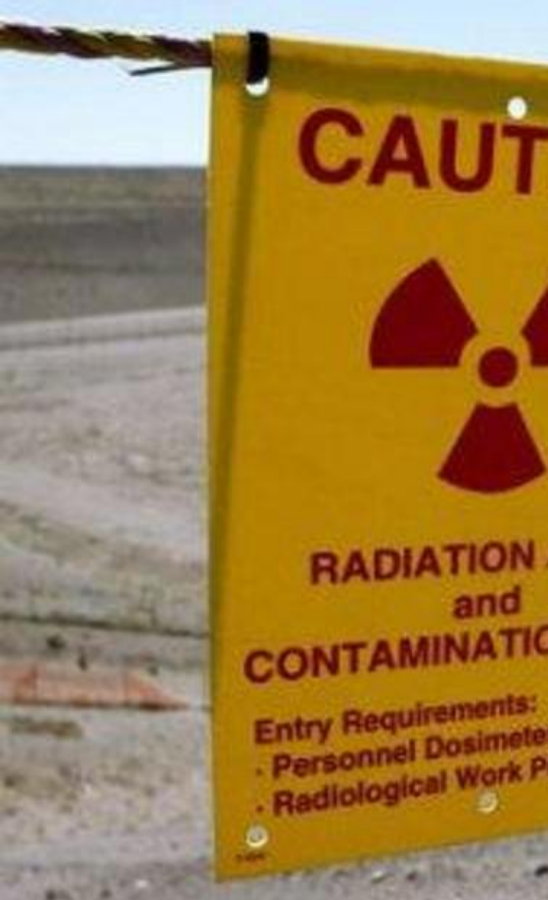
Approx annual dose above natural background in the less contaminated parts of Chernobyl Exclusion Zone

60

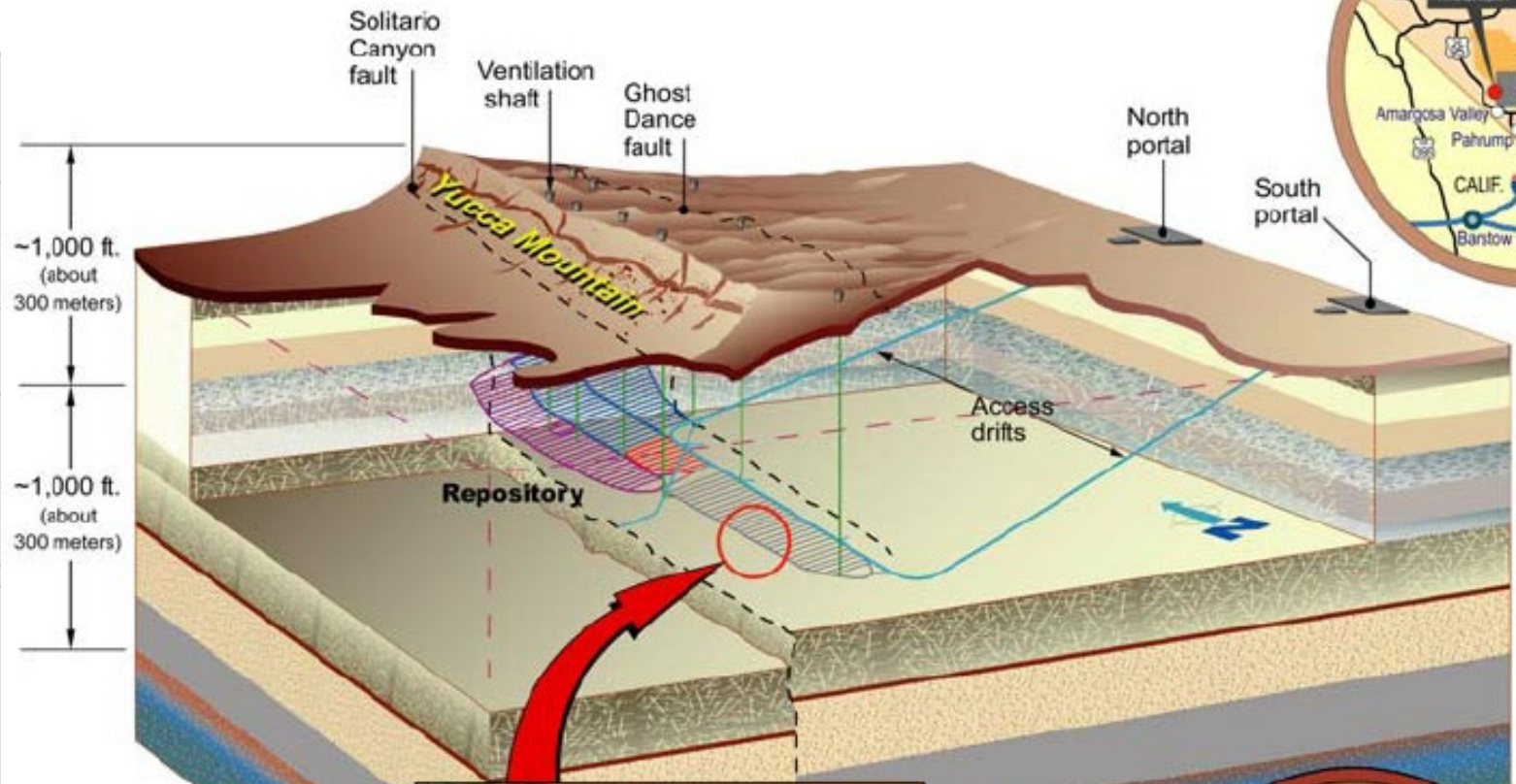
Radiation dose from a London to Los Angeles flight

For purposes, not to scale

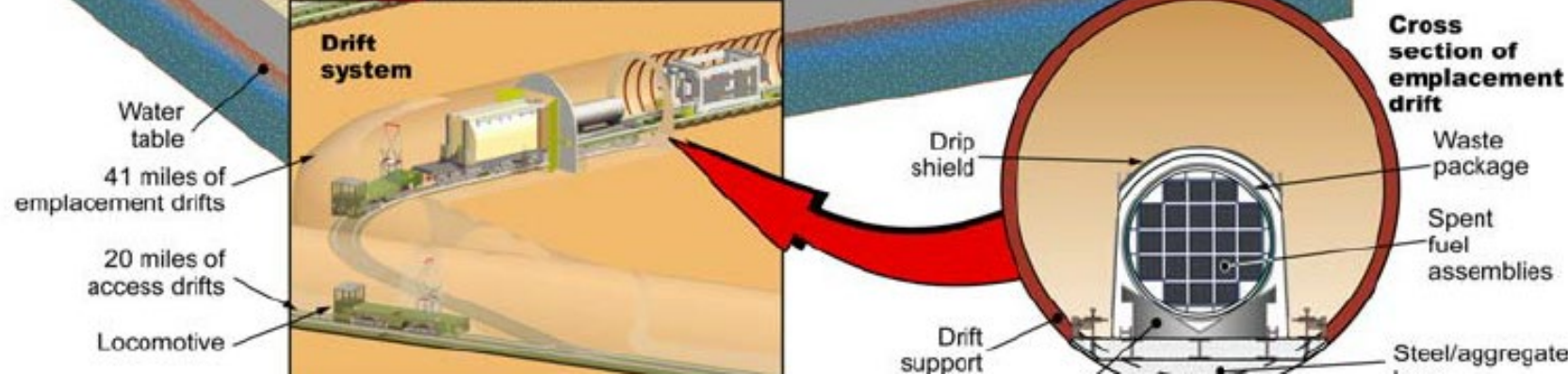
Source: International Atomic Energy Agency, American Nuclear Society, Prof. J.T. Smith School of Environmental Sciences, University of Portsmouth







Simplified geology (tilting and faults not shown)



●  
★

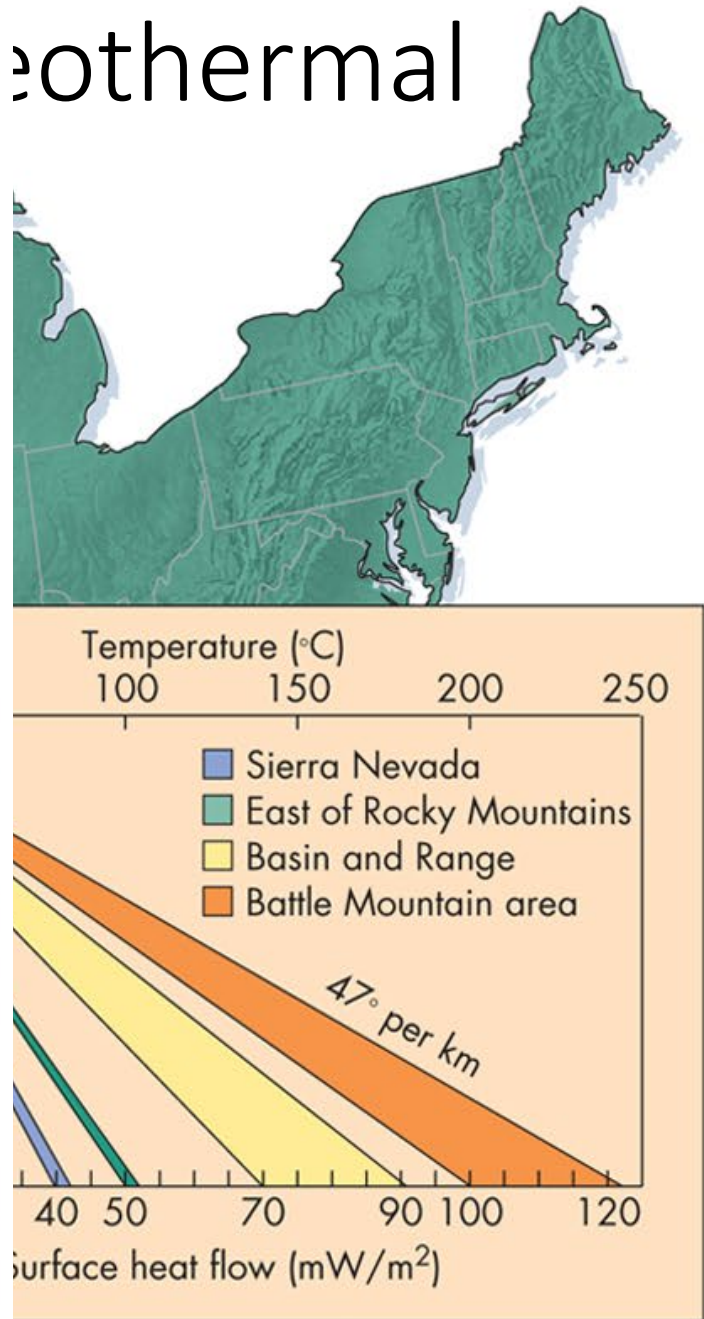
(b)

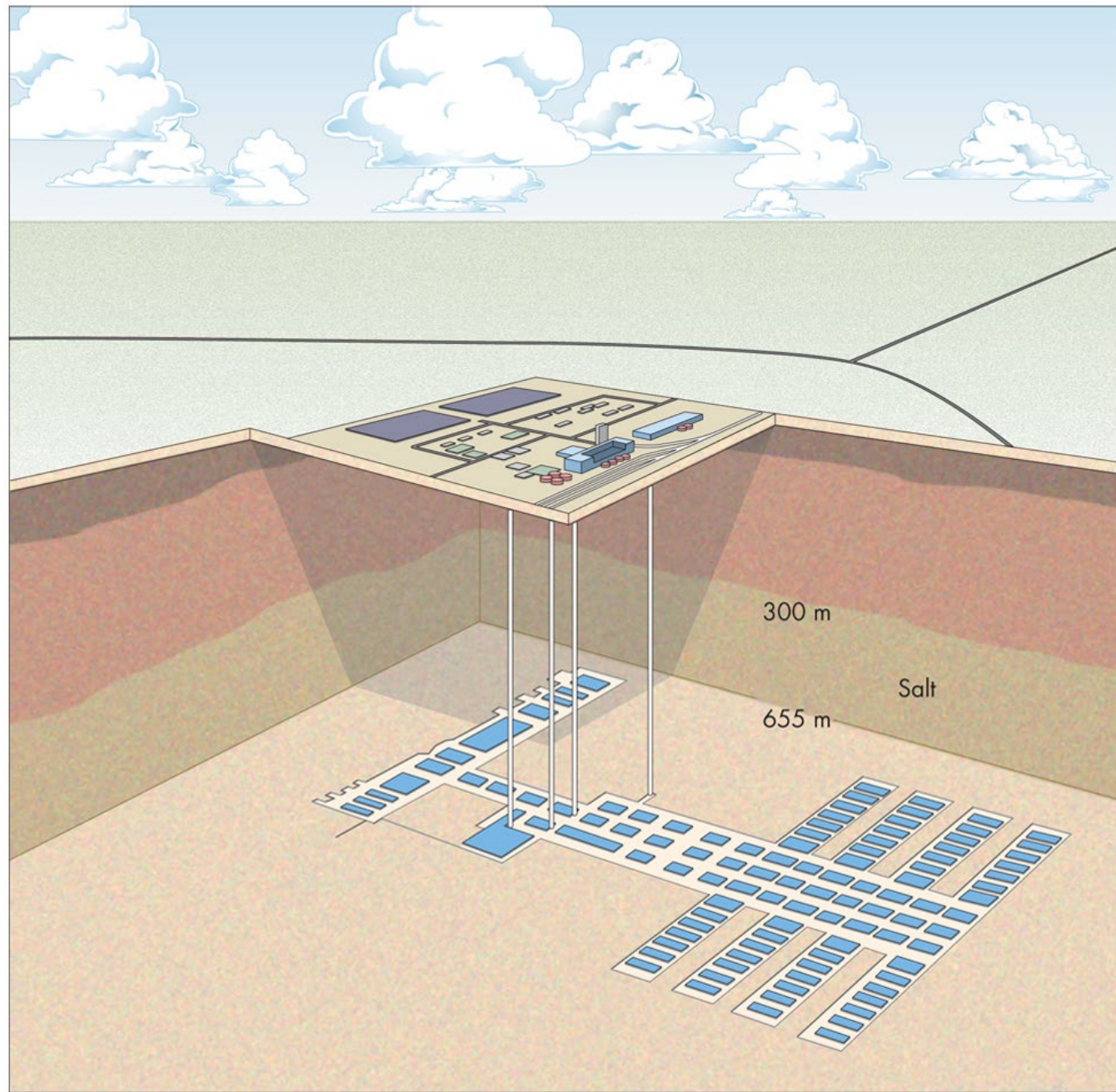
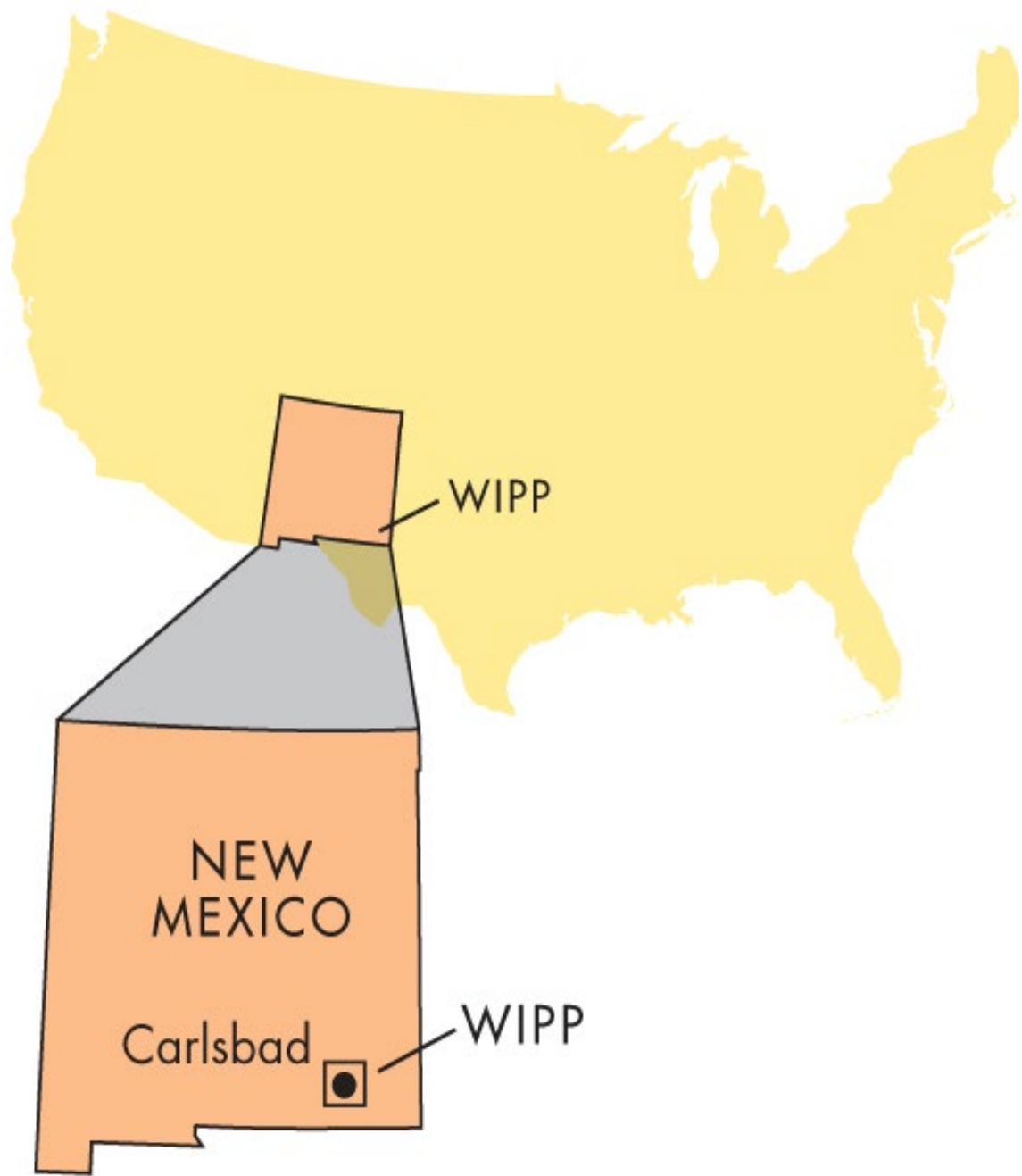


**EXPLANATION**  
Heat flow, in milliwatts per square meter

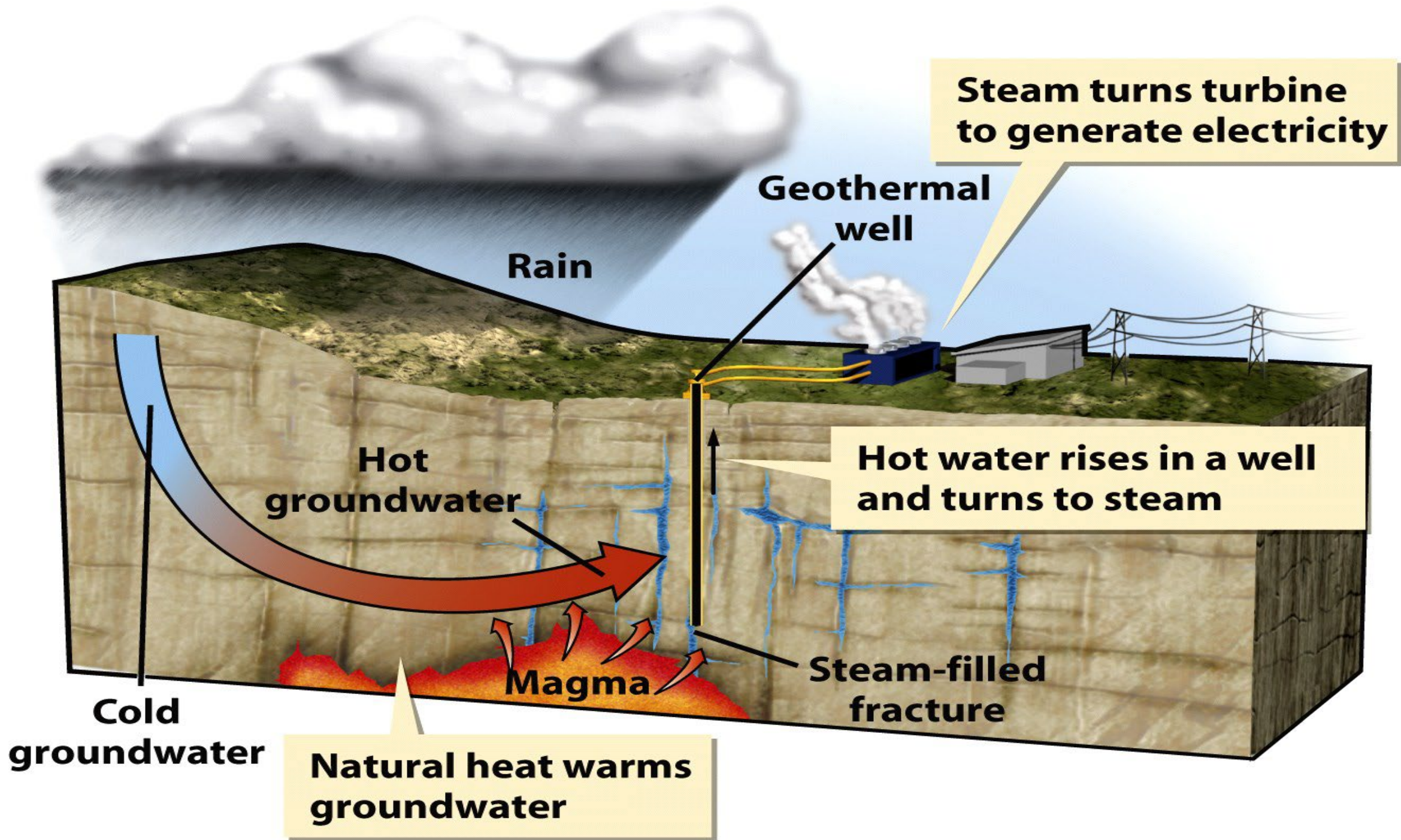
- Less than 40
- From 40 to 60
- From 60 to 100
- Greater than 100
- Power plant location

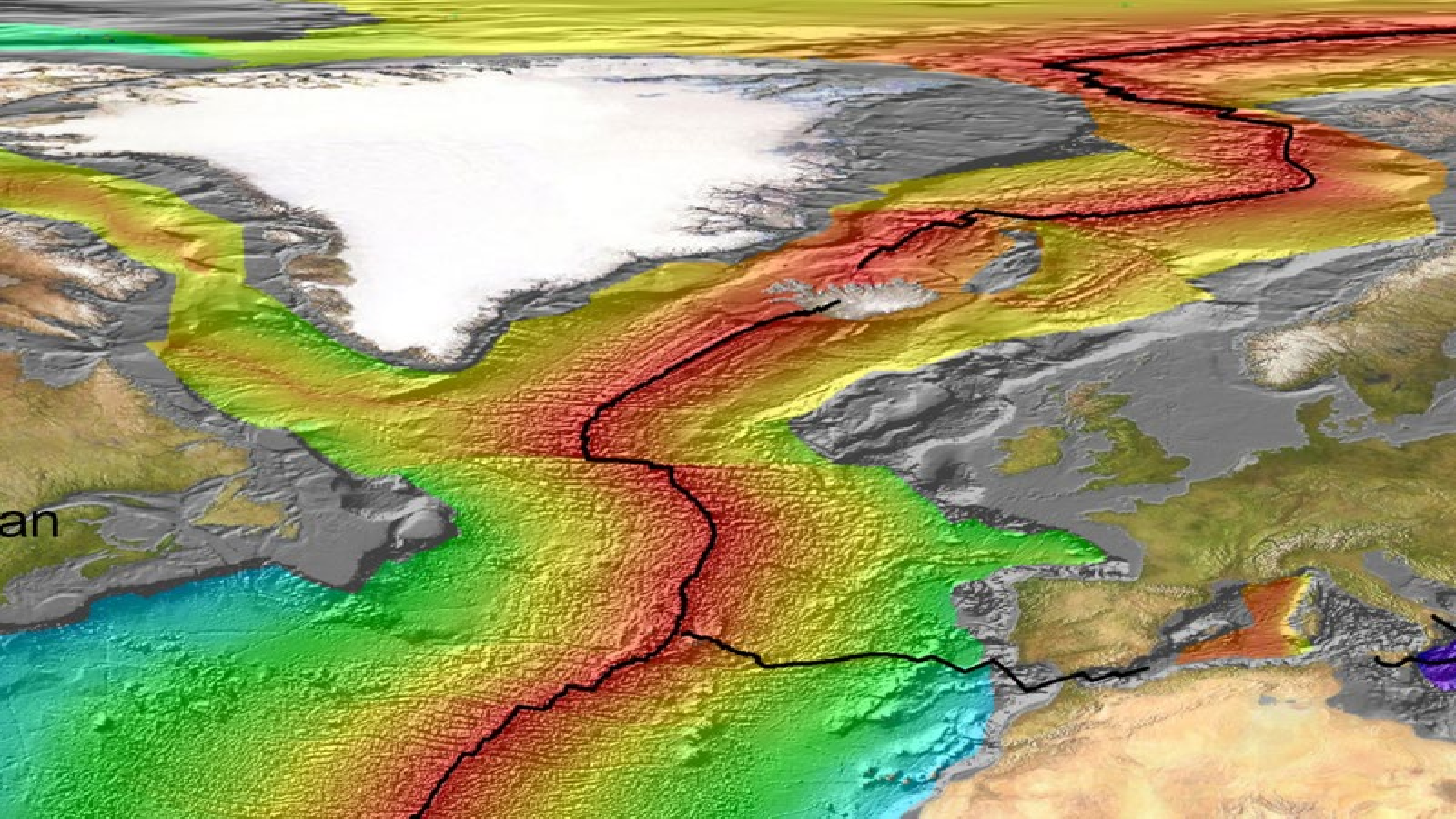
# Geothermal



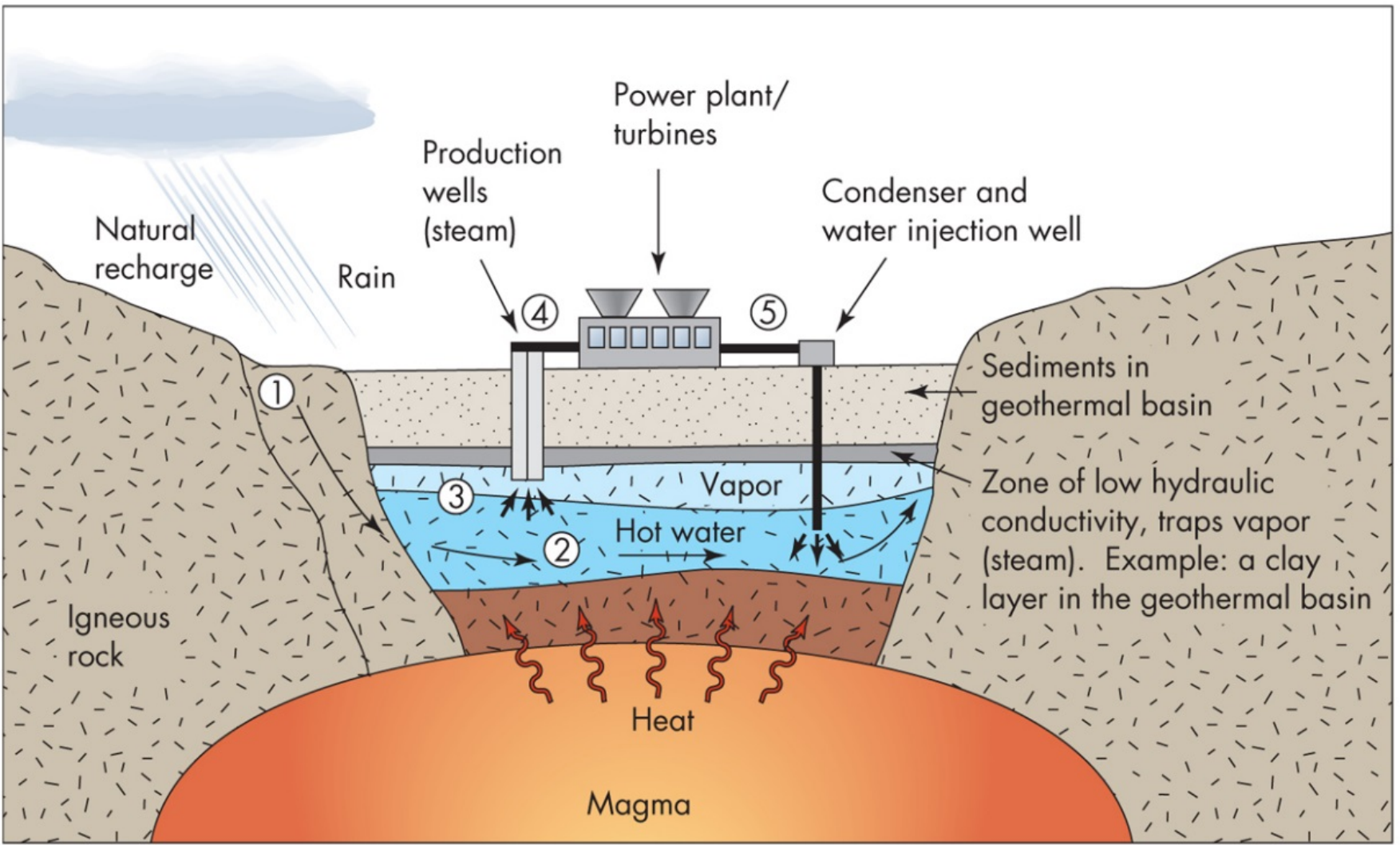


# Renewable energies





an



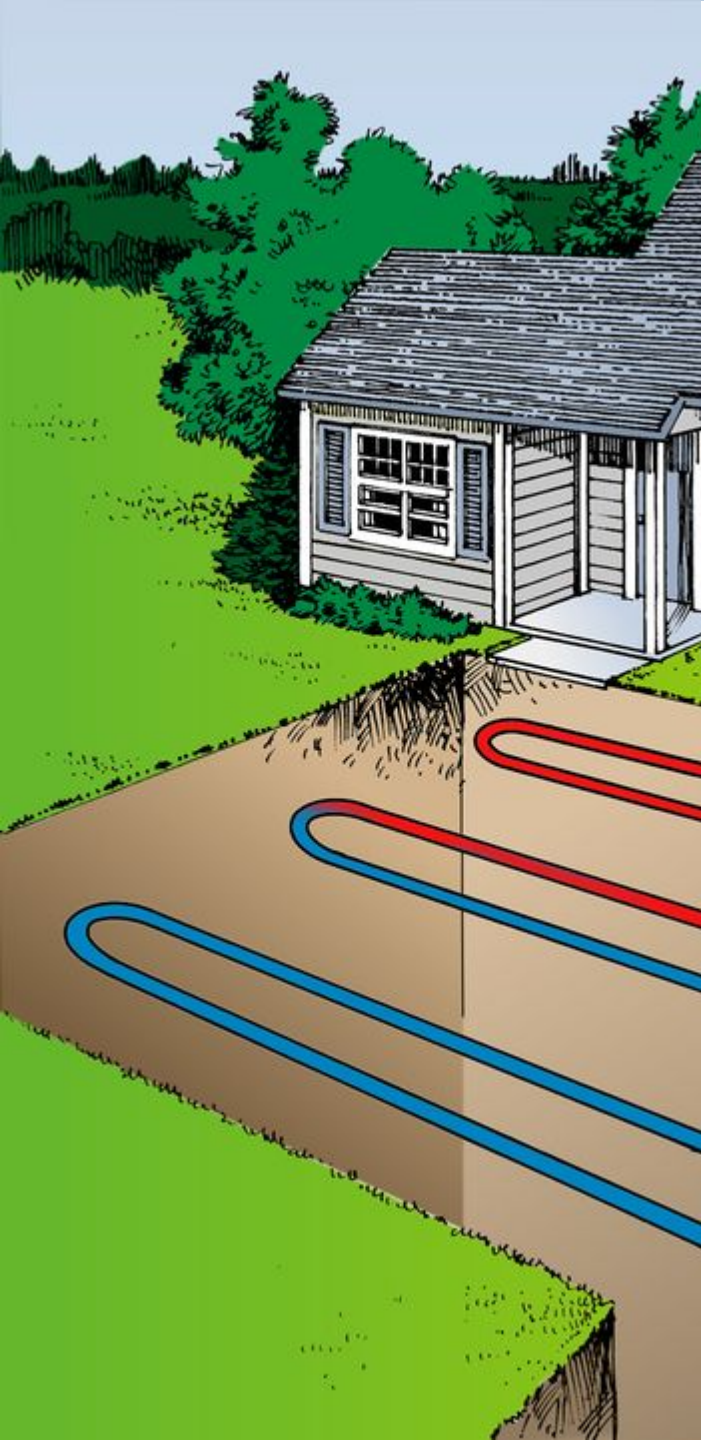
→ Direction of water flow

1. Natural recharge of water from rain
2. Hot water produced by Earth processes
3. Steam to production well
4. Steam to turbines to produce electricity
5. Water is injected back into ground



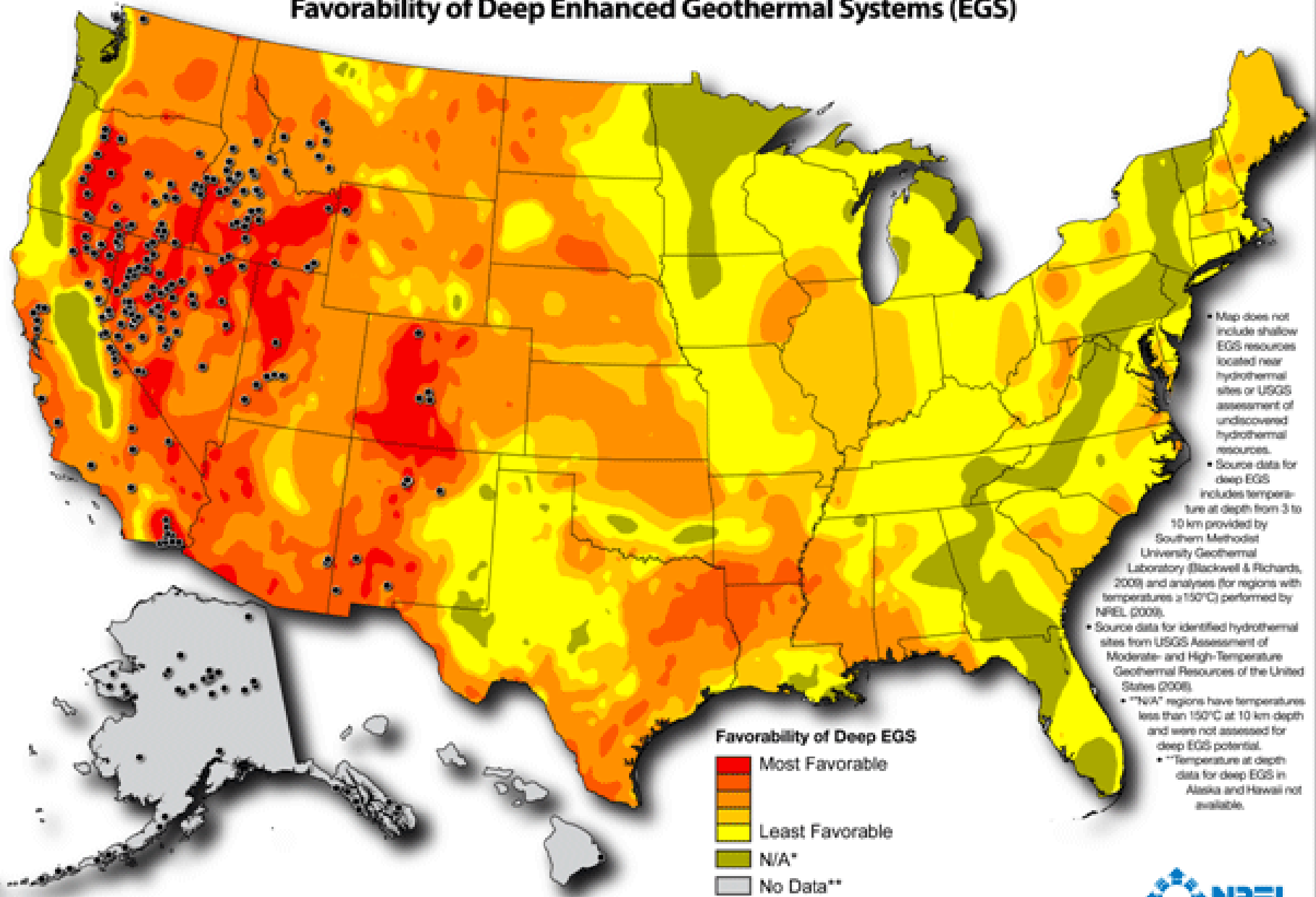






# Geothermal Resource of the United States

## Locations of Identified Hydrothermal Sites and Favorability of Deep Enhanced Geothermal Systems (EGS)



### Favorability of Deep EGS

- Most Favorable
- Favorable
- Least Favorable
- N/A\*
- No Data\*\*

● Identified Hydrothermal Site ( $\geq 90^{\circ}\text{C}$ )

- Map does not include shallow EGS resources located near hydrothermal sites or USGS assessment of undiscovered hydrothermal resources.
- Source data for deep EGS includes temperature at depth from 3 to 10 km provided by Southern Methodist University Geothermal Laboratory (Blackwell & Richards, 2008) and analyses for regions with temperatures  $\geq 150^{\circ}\text{C}$  performed by NREL (2009).
- Source data for identified hydrothermal sites from USGS Assessment of Moderate- and High-Temperature Geothermal Resources of the United States (2008).
- \*"N/A" regions have temperatures less than  $150^{\circ}\text{C}$  at 10 km depth and were not assessed for deep EGS potential.
- \*\*Temperature at depth data for deep EGS in Alaska and Hawaii not available.

This map was produced by the National Renewable Energy Laboratory for the US Department of Energy. October 13, 2009 Author: Billy J. Roberts



# Geothermal issues – 0

- Water use and contamination
- Air contamination
- Land use
- Emissions – Climate change

<https://www.ucsusa.org/resources/environmental-impacts-geothermal-energy>

## PROS AND CONS of geothermal energy

### PROS

Reliable source  
of power



Small land footprint



Usable for large and  
small-scale installations



### CONS

Location dependent



High initial costs



Surface instability



# HOW SOLAR WORKS

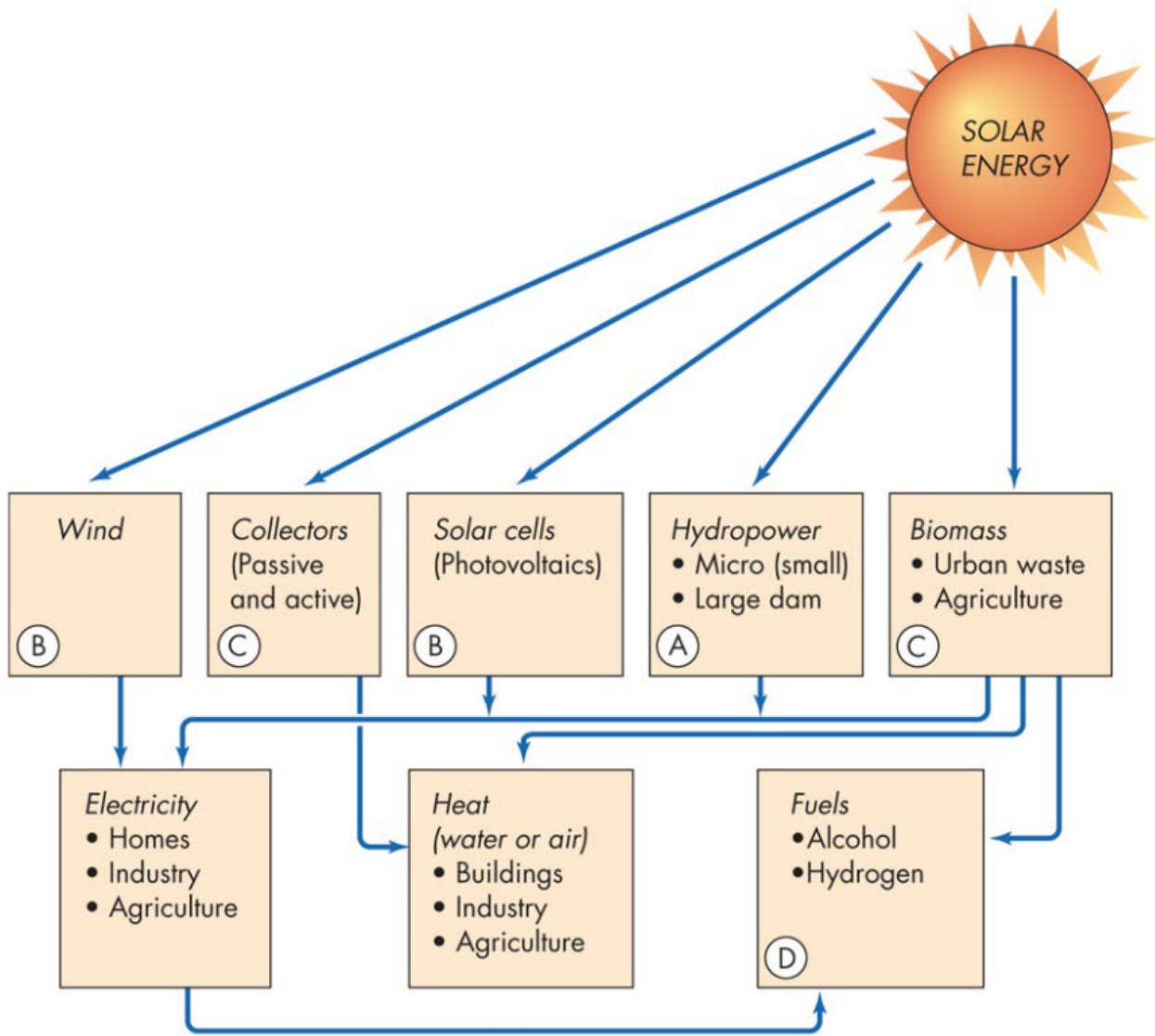
**1** Solar panels convert the sun's energy into electricity.

**2** A control device changes this electricity, enabling it to power electrical items.

**3** The electricity then passes through a breaker box to outlets in the building.

**4** Items such as a refrigerator and lamp can plug into the outlets for power.





- (A) Produces most electricity from renewable solar energy
- (B) Rapidly growing, strong potential; wind and solar are growing at 30% per year!
- (C) Used today; important energy source
- (D) Potentially a very important fuel to transition from fossil fuels







# Tengger Desert Solar Park – 1500MW – China



中国储能网  
[www.escn.com.cn](http://www.escn.com.cn)





# Solar

- Resources
- Battery storage



**Pros**

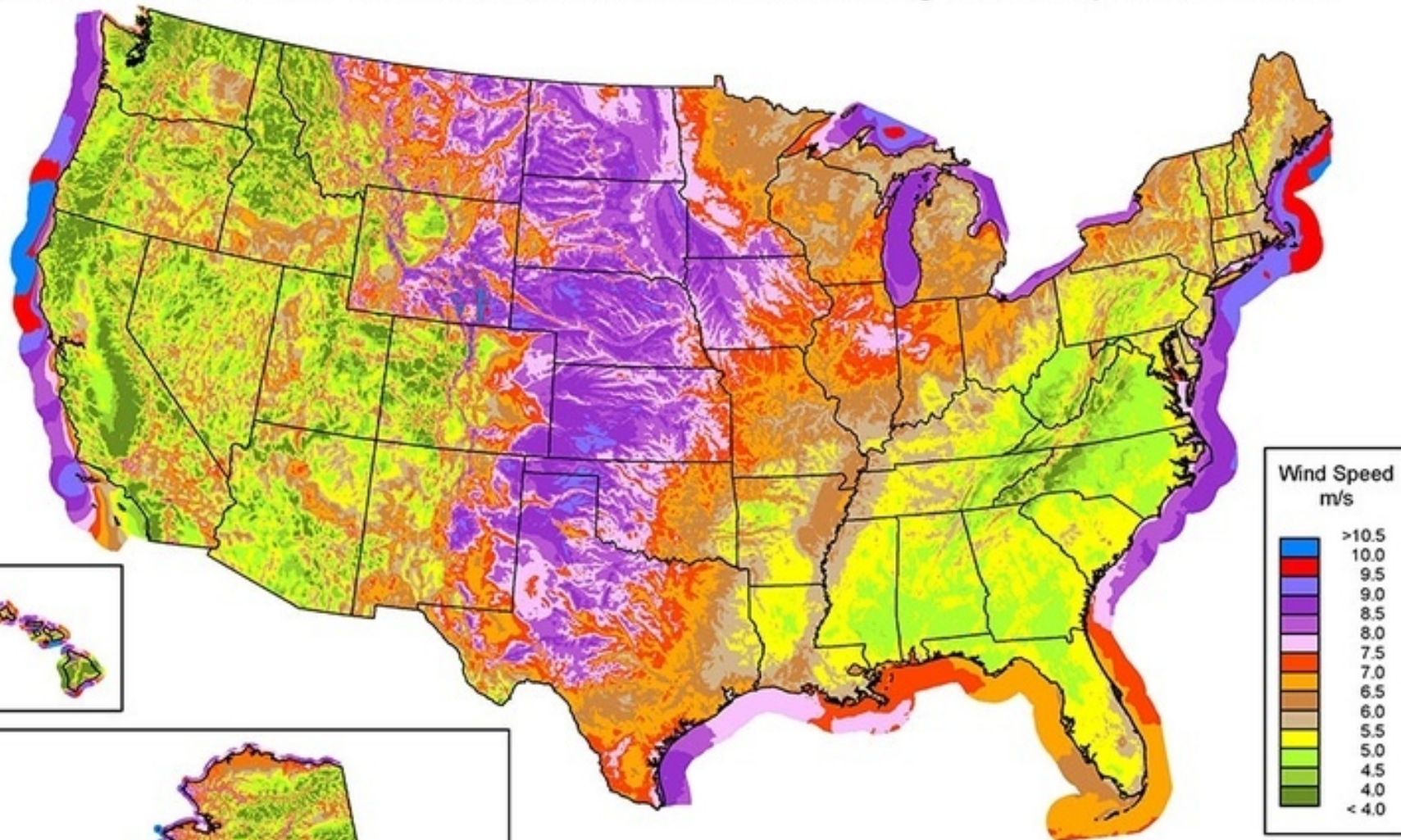
- Free electricity
- Freedom from rising utility rates
- Adds value to your home
- Lots of financing options available
- Ease of use
- Freedom Forever customers get additional piece of mind

**Cons**

- High upfront investment
- Space requirements
- Solar systems are hard to move



# United States - Land-Based and Offshore Annual Average Wind Speed at 100 m



Source: Wind resource estimates developed by AWS Truepower, LLC. Web: <http://www.awstruepower.com>. Map developed by NREL. Spatial resolution of wind resource data: 2.0 km. Projection: Albers Equal Area WGS84.

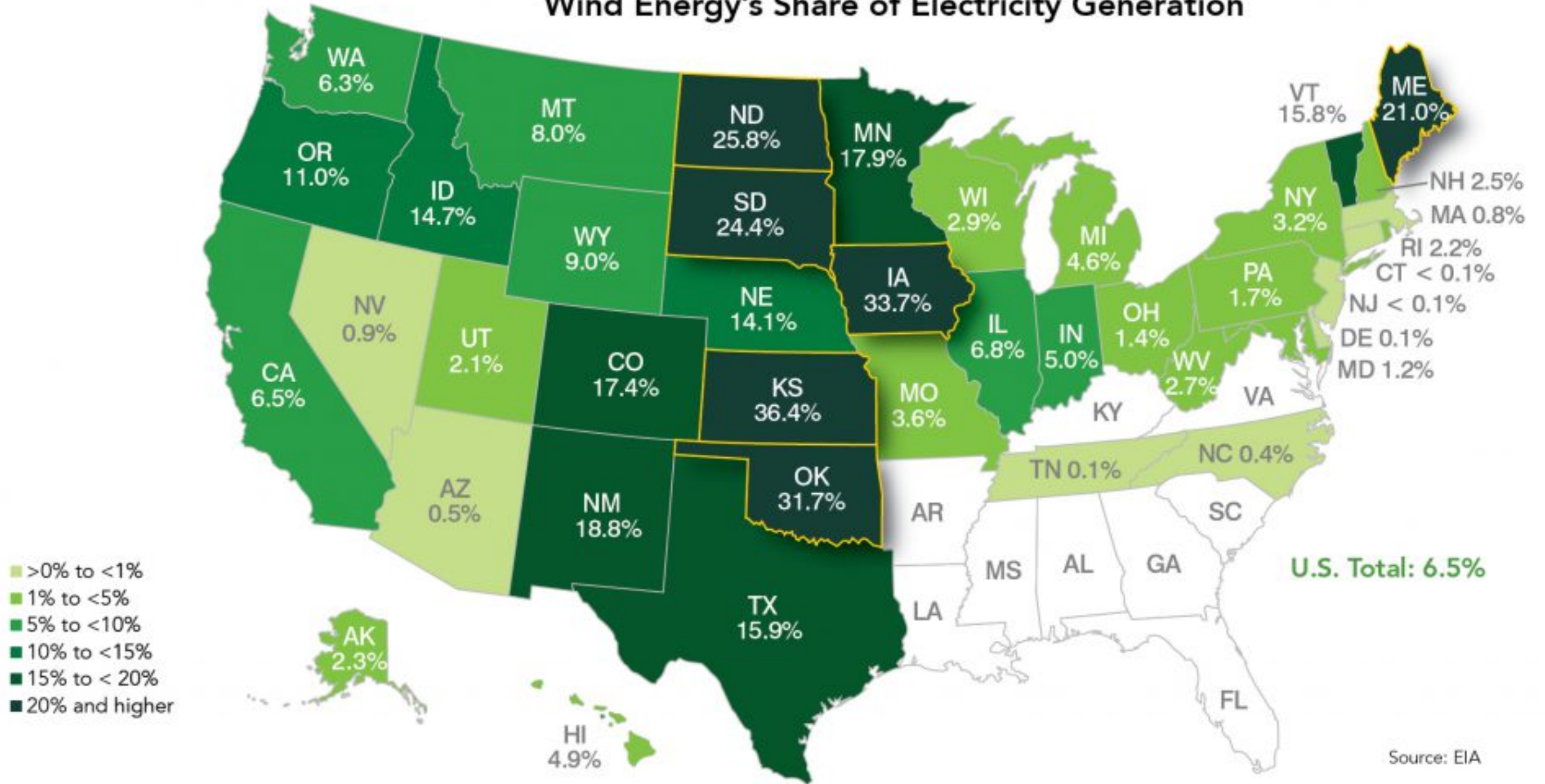


**AWS Truepower™**  
Where science delivers performance.

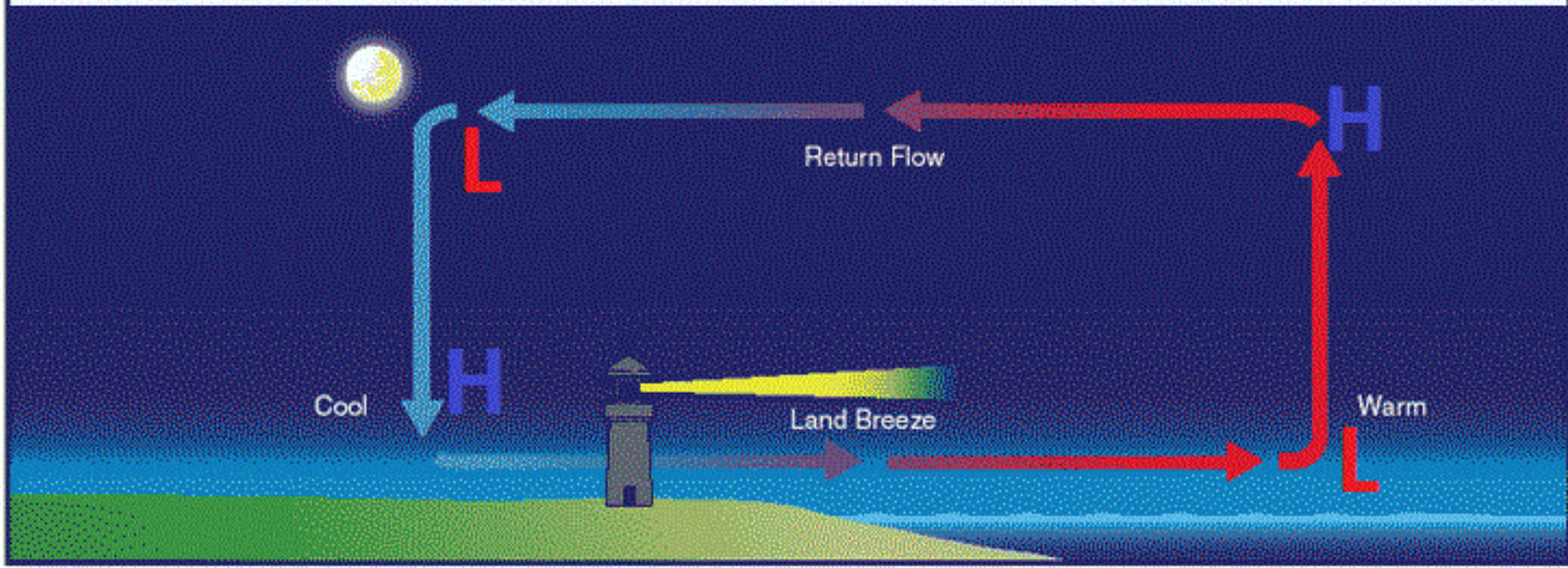
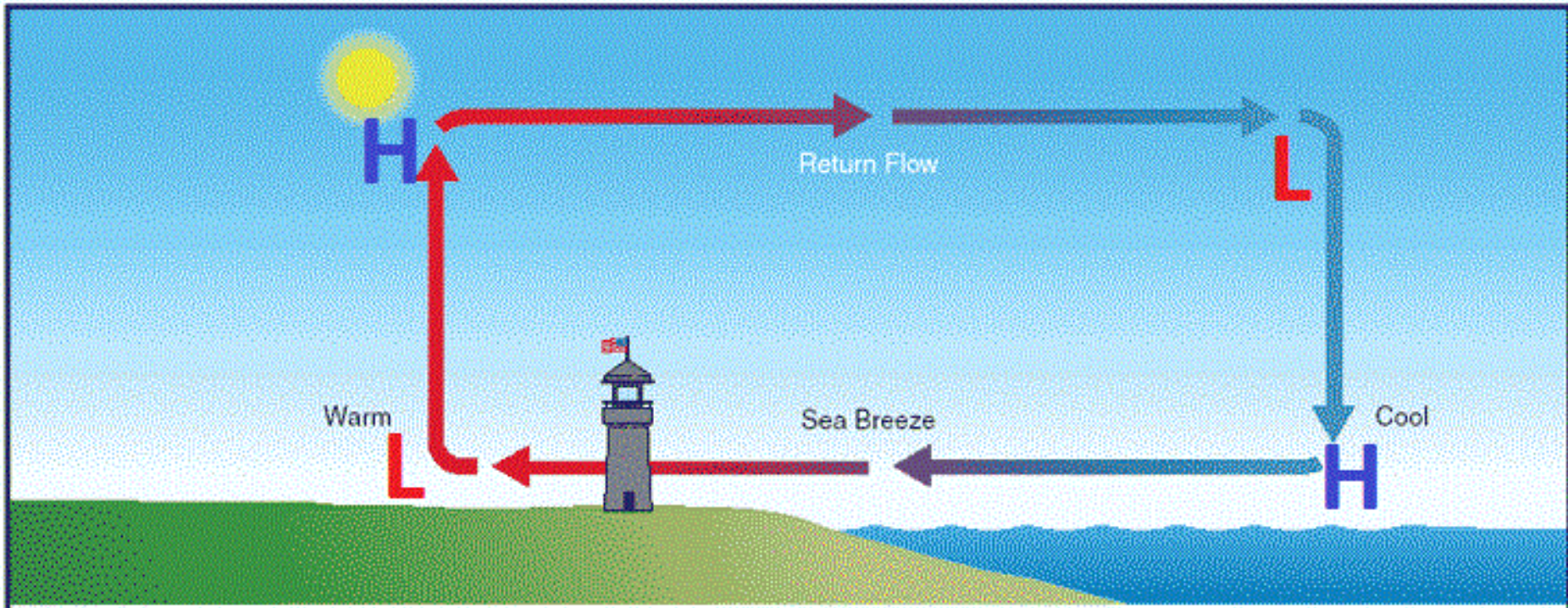
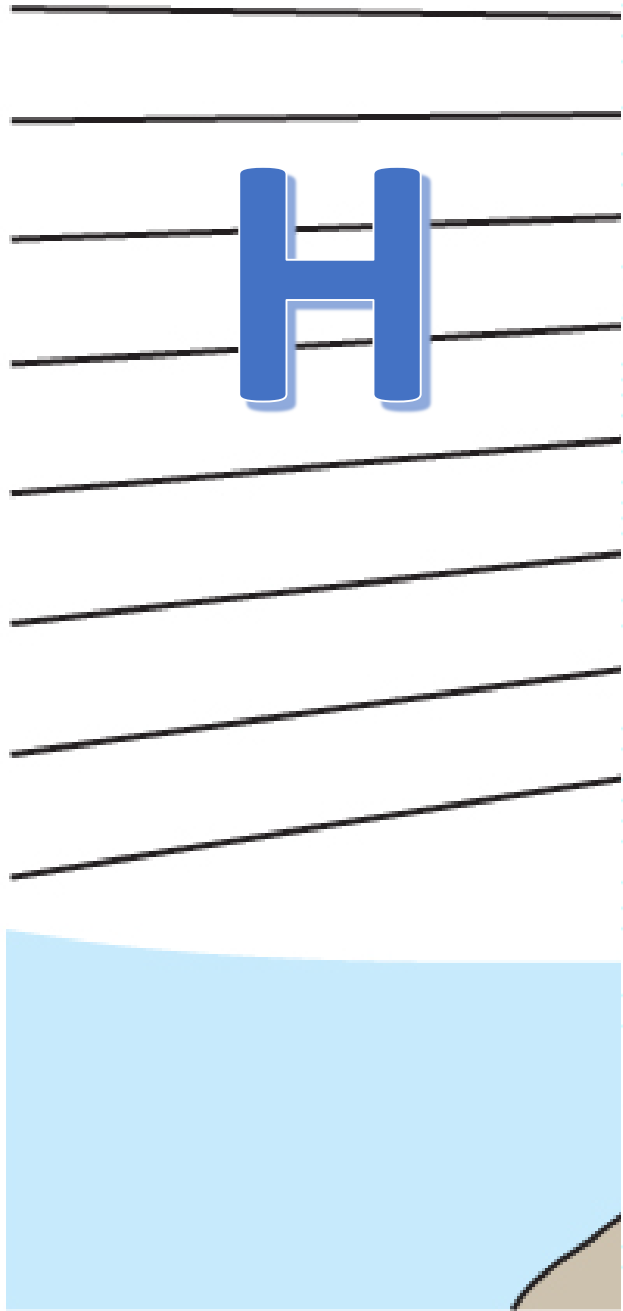


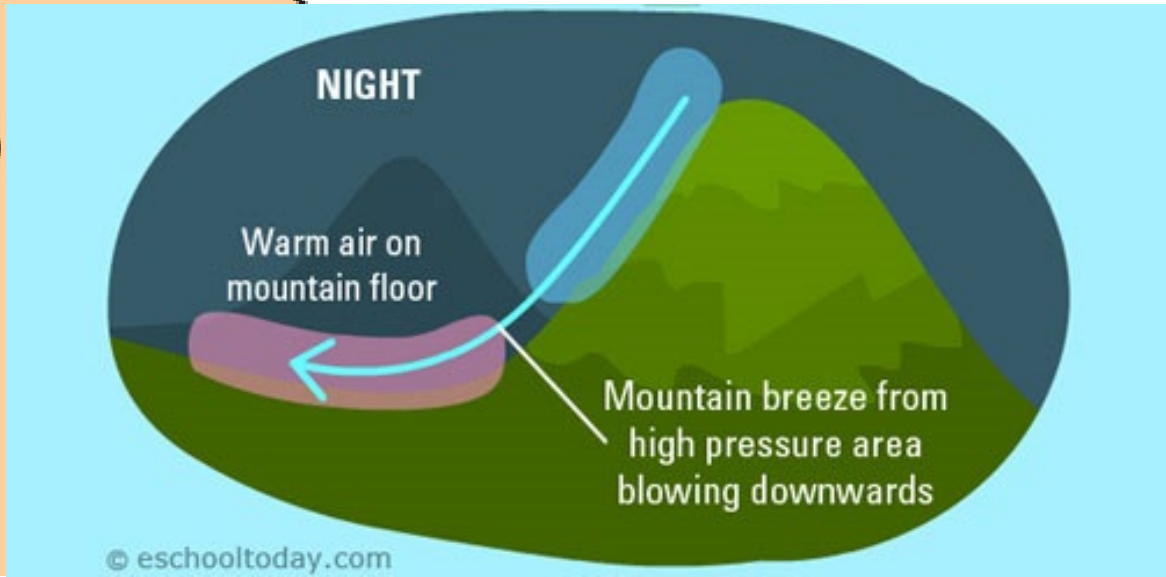
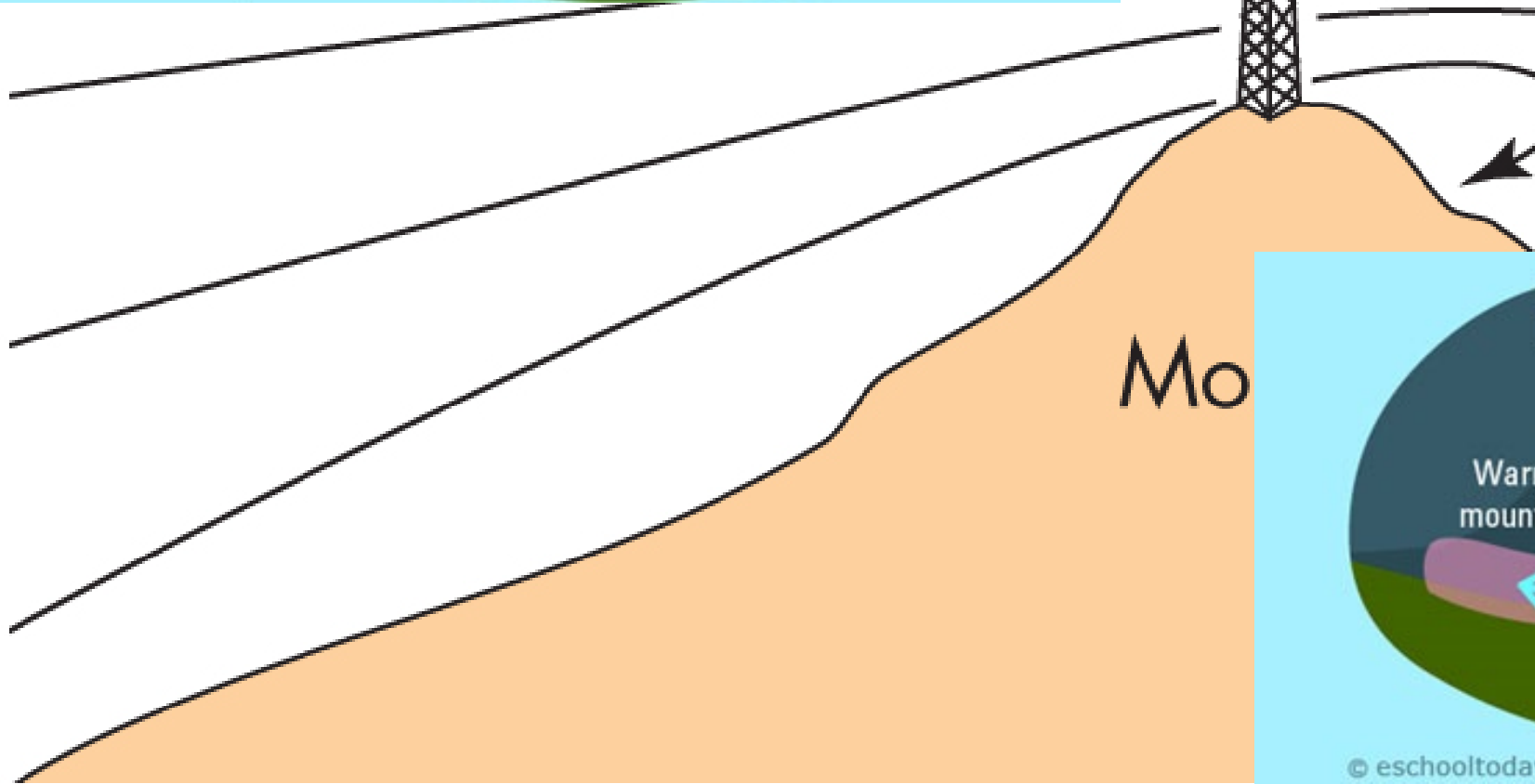
**NREL**  
NATIONAL RENEWABLE ENERGY LABORATORY

# Wind Energy's Share of Electricity Generation



Source: EIA









# Wind



## PROS AND CONS of wind energy

### PROS

Renewable & clean  
source of energy



Low operating costs



Efficient use of  
land space



### CONS

Resources and  
Recycling?



Intermittent



Noise and  
visual pollution



Some adverse  
environmental impact

# Pacific Marine Energy Center

Cables bring power to shore and connect to utilities

Research vessel

Wave devices under test

Operations & storage

6 Nautical miles from shore

Electrical and controls

Office space & Visitor's center

Buried cable back to shore

Sub sea cables

Sub sea pod

Research device

Anchoring infrastructure not shown





# PROS AND CONS of hydropower

## PROS

Renewable  
source of energy



Pairs well with  
other renewables



Can meet peak  
electricity demand



## CONS

Some adverse  
environmental impact



Expensive up-front



Lack of  
available reservoirs



## TABLE 15.1 Energy Policy: What Is Being Discussed

1. Promote conventional energy sources: Use much more natural gas, with the objective to reduce our reliance on energy from foreign countries.
2. Encourage alternative energy: Support subsidies for wind energy and other alternative energy sources such as solar geothermal, hydrogen, and biofuels (ethanol and biodiesel). Increase the amount of biofuel (ethanol) mixed with gasoline sold in the United States.
3. Provide for energy infrastructure: Ensure that electricity is received over a dependable modern infrastructure.
4. Promote conservation measures: Set higher efficiency standards for federal buildings and for household products. Require what is now waste heat from power generation and industrial processes be used to produce electricity or other products . Recommend fuel-efficiency standards for cars, trucks, and SUVs. Provide new tax credits to install energy-efficient windows and appliances in homes. Provide a tax credit for purchasing a fuel-efficient hybrid or clean-diesel vehicle.
5. Seriously consider nuclear power: Recognize that nuclear power plants can generate large amounts of electricity without emitting air pollution or contributing to climate change (global warming).
6. Promote research: Develop alternative energy sources; find innovative ways to improve coal plants and help construct cleaner coal plants; determine how to safely tap into the vast amounts of oil trapped in oil shale and tar sands; and develop pollution-free automobiles.