

# Unit 3: Matter & Energy Flow on Earth

## Objectives:

E2.2B - Identify differences in the origin and use of renewable (e.g., solar, wind, water, biomass) and nonrenewable (e.g., fossil fuels, nuclear [U-235]) sources of energy.

E2.4A - Describe renewable and nonrenewable sources of energy for human consumption, compare their effects on the environment, and include overall costs and benefits.

# Sources of Energy\*

**Natural resources** are things found naturally on the Earth, both living and nonliving, that have a value to humans in some way. Natural resources usually fall under two categories, **renewable resources** and **nonrenewable resources**.

A **renewable resource** is something that can be replaced in a reasonable amount of time.

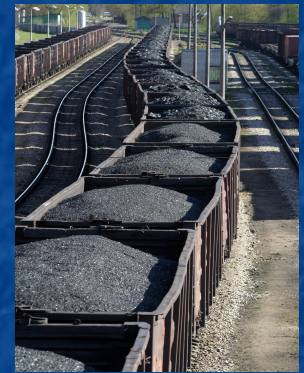
Examples of renewable resources include water, soil, air, and wildlife, along with renewable energy resources like wind, solar, geothermal, and biomass.



# Sources of Energy\*

A **nonrenewable resource** is something that cannot be replaced rapidly enough by natural processes, or that exists in fixed quantities on the Earth.

Examples of nonrenewable resources include minerals and fossil fuels (which include oil, coal, or natural gas)



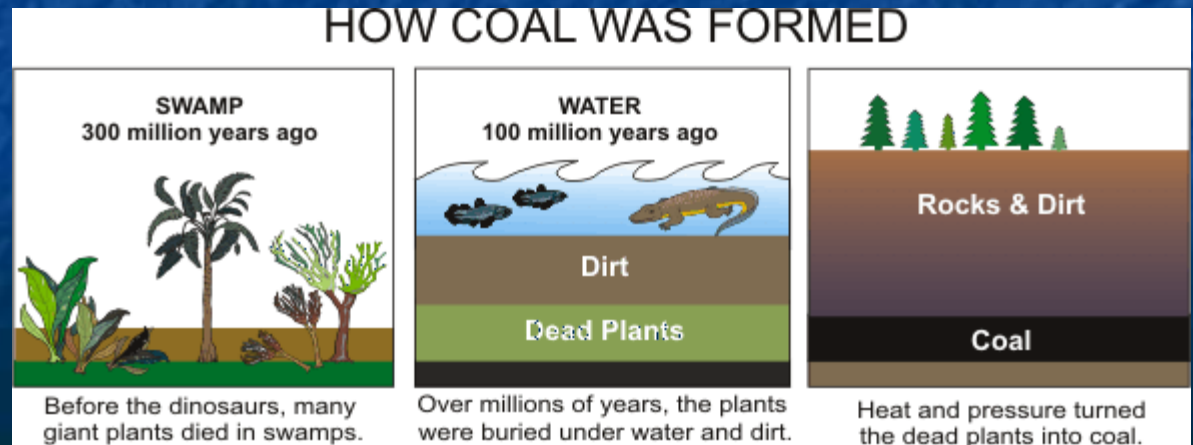
# U.S. Energy Production (2006)

Type of Energy Source	Production %
Coal - NR	33.5 %
Natural Gas - NR	30.1 %
Crude Oil - NR	15.3 %
Nuclear - NR	11.6 %
Biomass - R	4.5 %
Hydroelectric - R	4.1 %
Geothermal - R	0.5 %
Wind - R	0.4 %
Solar - R	0.1 %

# Fossil Fuels

An alternate path that carbon can take through an ecosystem occurs when the bodies of plants and animals are buried deep in the Earth for millions of years. These carbon-containing organisms are then exposed to the great heat and pressure below the Earth's surface. This causes chemical changes that transform the long-dead organisms into what we call **fossil fuels**.

\*Common **fossil fuels** include oil and coal. Oil is the remains of once living plankton that collected at the bottom of the ocean and became buried by sediments. Coal is the dead remains of plants that were buried in swamps millions of years ago.\*



# Nonrenewable Resources\*



***Coal (fossil fuel) -***

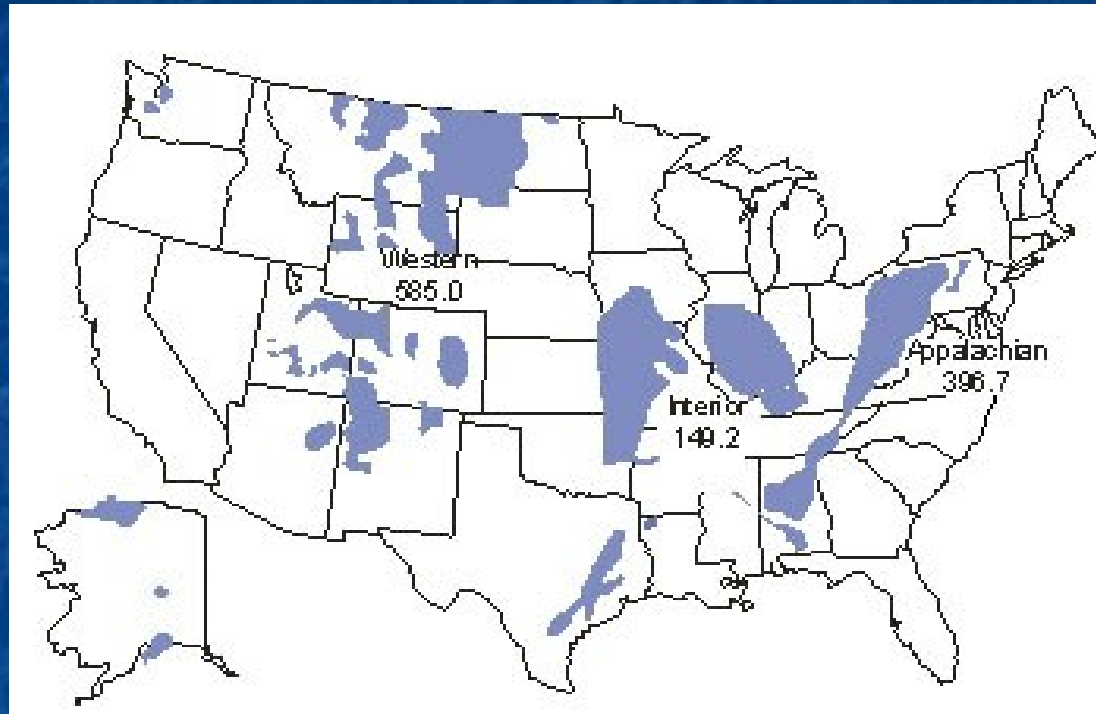
## **Advantages:**

- One of the least expensive fuels because of plentiful supplies (used primarily in power plants to generate electricity).

## **Disadvantages:**

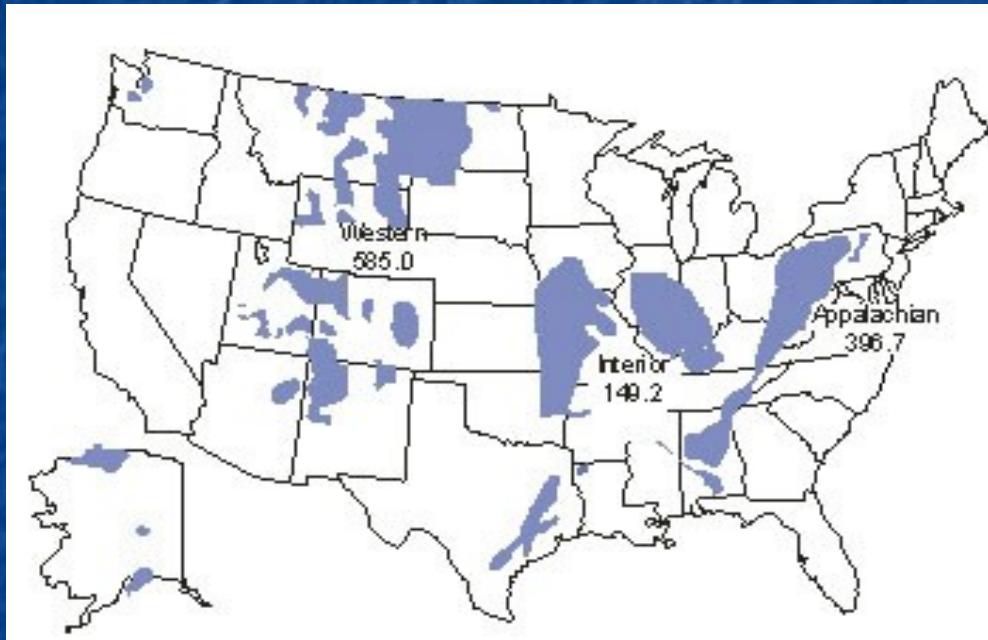
- The burning of coal is very polluting, releasing sulphur oxides, nitrous oxides, and carbon dioxide. Technology is helping to reduce these emissions. However, coal is considered a significant contributor to acid rain and global warming.
- The mining of coal is dangerous, takes up large areas of land, and can cause a lot of damage to the land (when strip mining). U.S. laws require companies to return the land to its original condition after mining.

# U.S. Coal Production



In 2006, the amount of coal produced at U.S. coal mines reached an all-time high of 1162.8 million short tons. Coal is mined in 27 states. Wyoming mines the most coal, followed by West Virginia, Kentucky, Pennsylvania, and Texas. Coal is mainly found in three large regions.

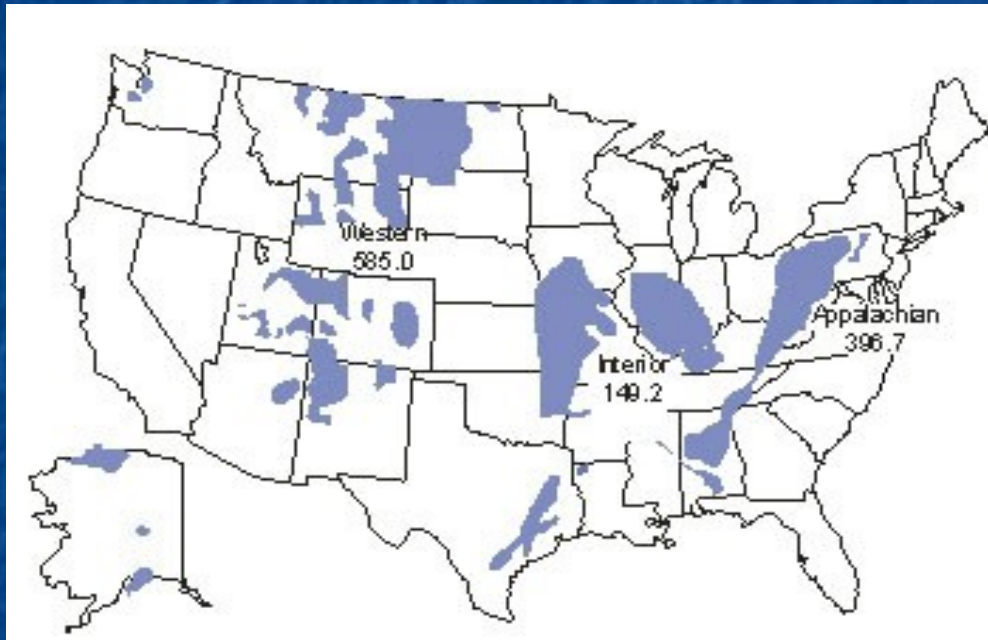
# U.S. Coal Production



- **Appalachian Region**
- More than 1/3 of all the coal produced in the U.S. comes from this region.
- West Virginia is the largest producer in this region.
- Large underground mines and small surface mines.
- Coal is primarily used for steam generation for electricity, metal production, and for export.

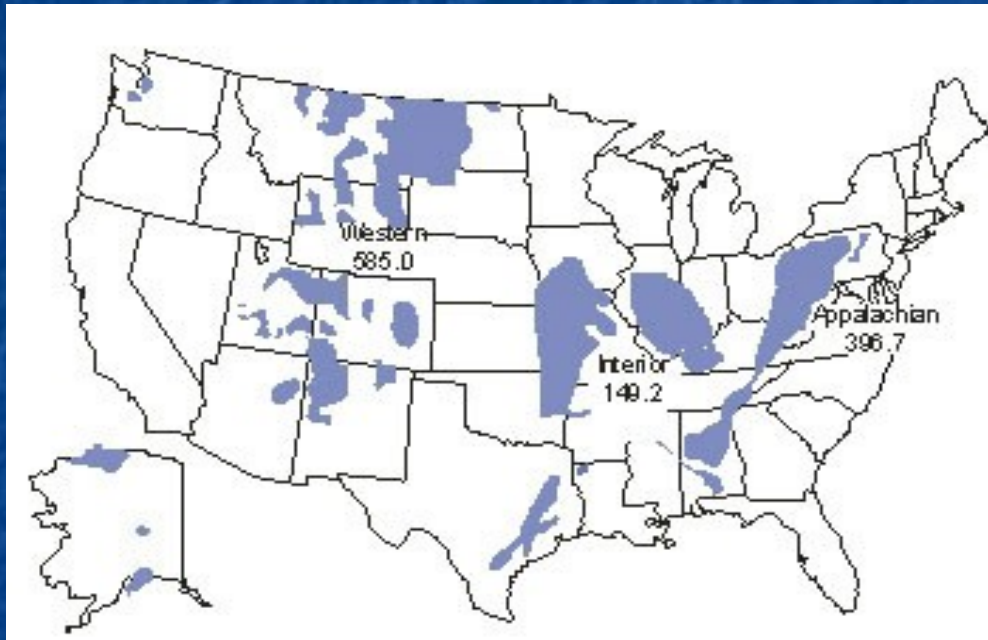


# U.S. Coal Production



- Interior Region
- Texas is the largest producer in this region, accounting for about 1/3 of the region's production.
- Mid-sized surface mines.
- Mid- to large-sized companies.

# U.S. Coal Production



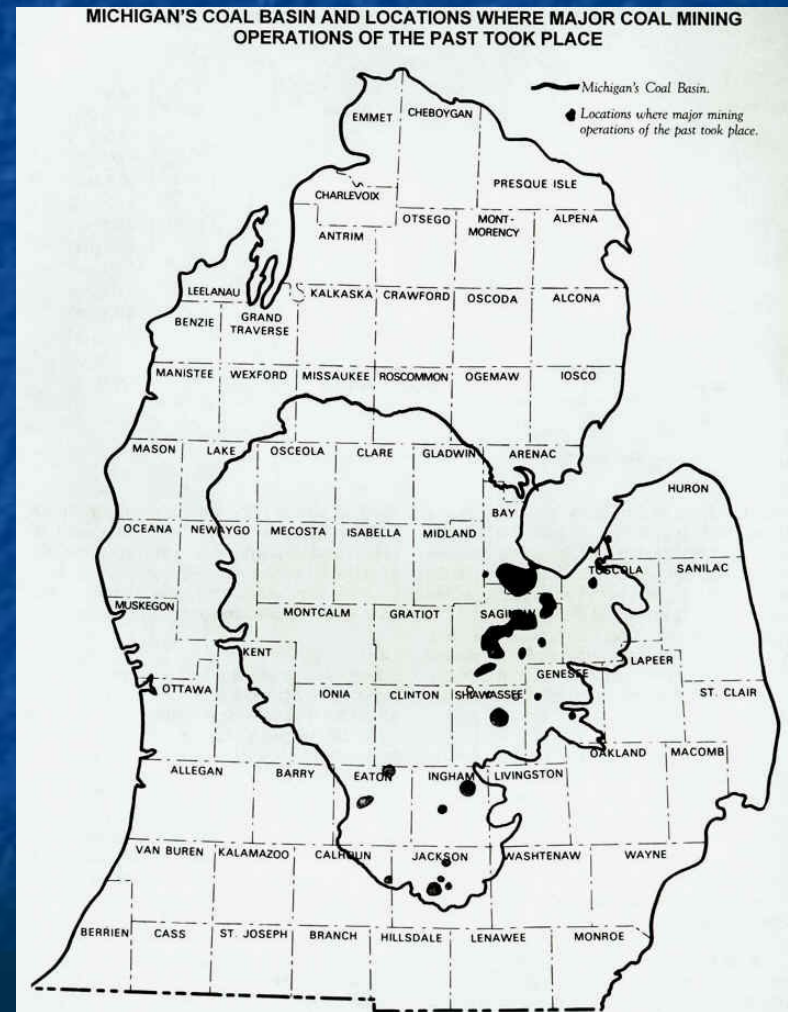
- **Western Region**
- Over ½ the coal produced in the U.S. is produced in this region.
- Wyoming is the largest regional producer.
- Large surface mines.
- Some of the largest coal mines in the world.

# Michigan Coal Reserves

The largest coal deposits in Michigan were found in the Saginaw Valley area. In 1907 around 2 million tons were removed from Michigan mines.

The last deep coal mine closed in 1952. It is estimated that Michigan has coal reserves of 220 million tons. Why are we no longer mining coal in Michigan?

Too much overburden + the coal is of low quality = not economically worth mining.



# Nonrenewable Resources\*



*Natural gas (fossil fuel) –*

## Advantages:

- Cleanest burning of the fossil fuels. Piped directly to customers, it is convenient to use (especially in homes for cooking and heating).

## Disadvantages:

- Natural gas is highly flammable and is toxic if inhaled in large amounts.
- While natural gas has relatively low emissions compared to other fossil fuels, it still produces carbon dioxide which has been linked to global warming.

# Nonrenewable Resources\*

***Crude oil (fossil fuel) –***



## **Advantages:**

- It is easier to get out of the ground than coal, and can be transported by pipeline.
- Major source of power for various modes of world-wide transportation.

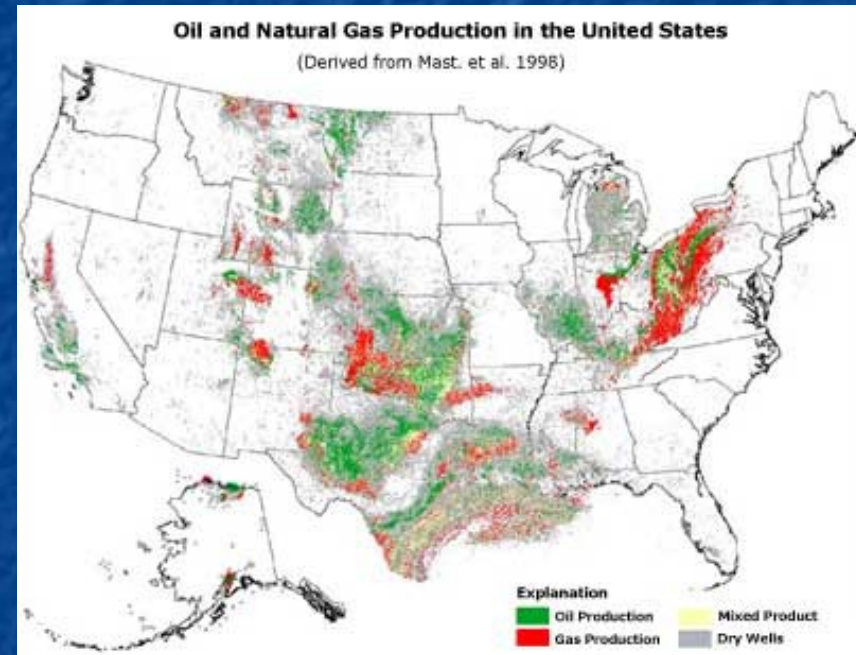
## **Disadvantages:**

- Spills may occur when transporting oil from one location to another, causing damage to the environment and life.
- Burning crude oil (and the refined products) releases carbon dioxide which has been linked to global warming.

# U.S. Oil & Natural Gas Production

As of the end of 2006, four areas in our country account for 74% of the proven U.S. oil reserves:

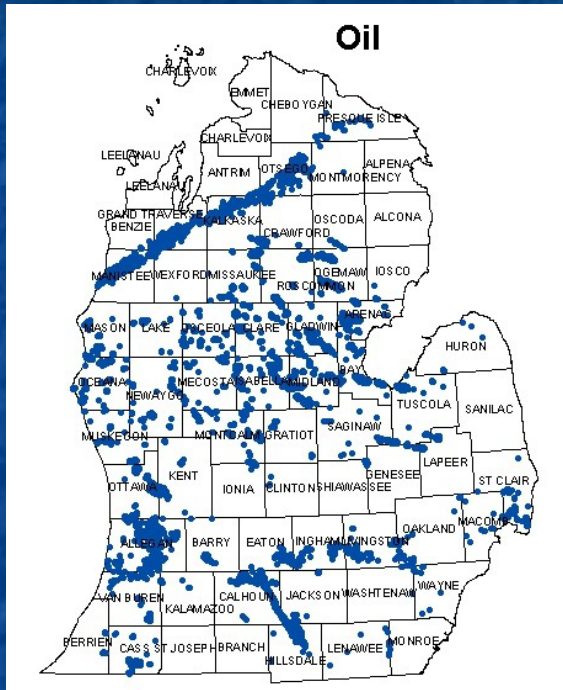
Texas	23%
Alaska	18%
Gulf of Mexico (offshore)	17%
California	16%



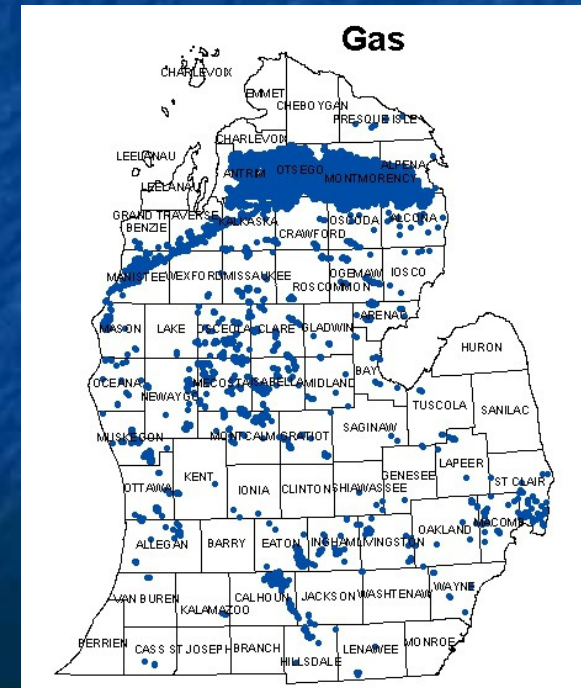
Eight areas in our country account for 81% of the proven natural gas reserves:

Texas (29%), Wyoming (11%), New Mexico/Oklahoma/Colorado (8%), Gulf of Mexico offshore (7%), Louisiana/Alaska (5%)

# U.S. Oil & Natural Gas Production



64 out of 68 counties in the Lower Peninsula have crude oil and/or natural gas production. None is found in our Upper Peninsula.



Michigan's rank among the 33 crude oil and/or natural gas producing states (2006):

Natural gas production – rank 13<sup>th</sup>

Crude oil production – rank 18<sup>th</sup>

# Nonrenewable Resources\*



## ***Nuclear Power –***

### **Advantages:**

- Nuclear fission releases great amounts of energy (much more than fossil fuels).
- No greenhouse gases are released by nuclear power plants.

### **Disadvantages:**

- Produces a radioactive waste that must be stored for many years.
- Power plants are very expensive to build.
- Nuclear radiation accidents can occur.

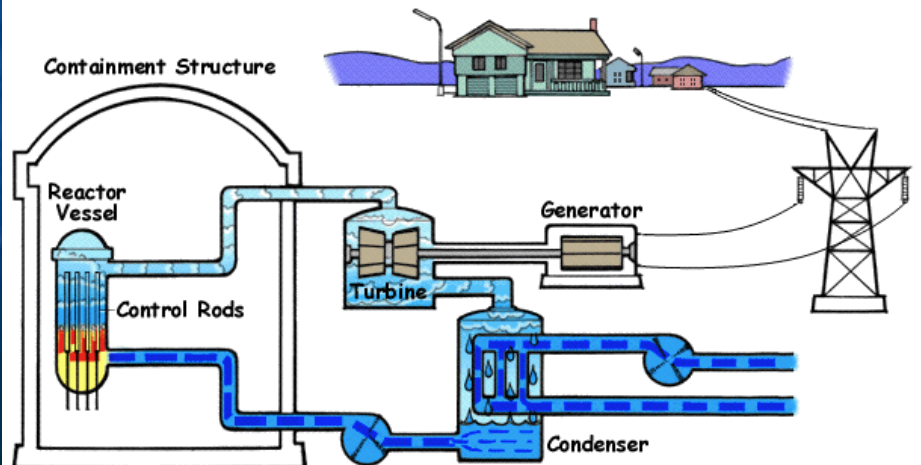
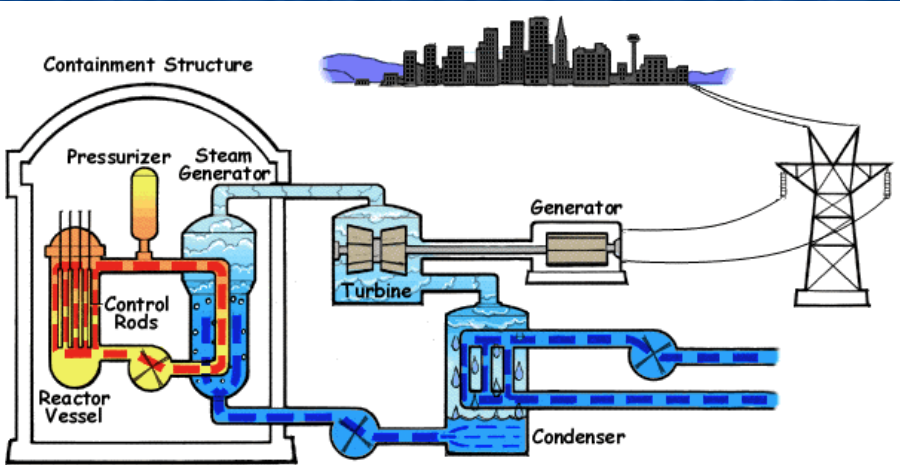
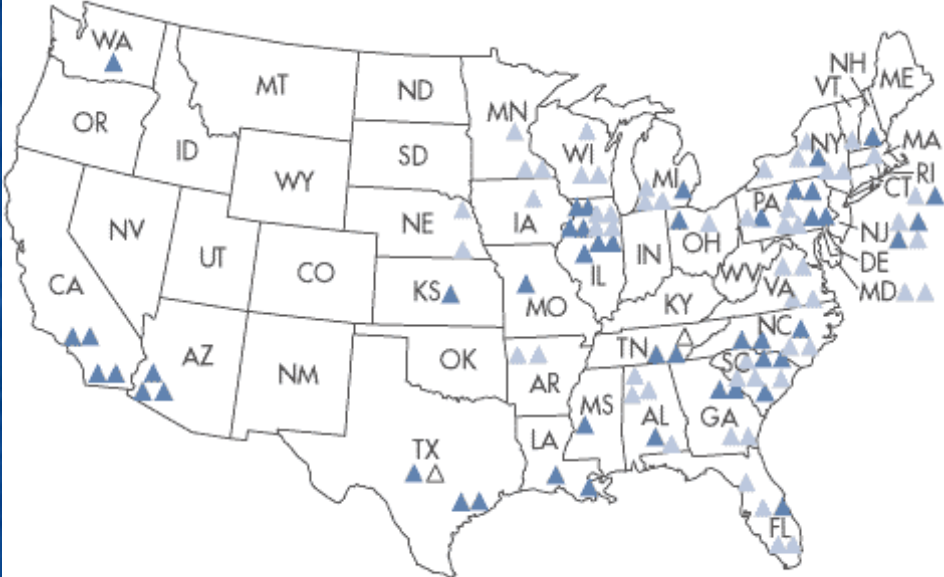


# U.S. Nuclear Power

There are currently 104 licensed nuclear power plants in the United States.

69 are pressurized water reactors (left)

35 are boiling water reactors (right)



# Michigan Nuclear Power

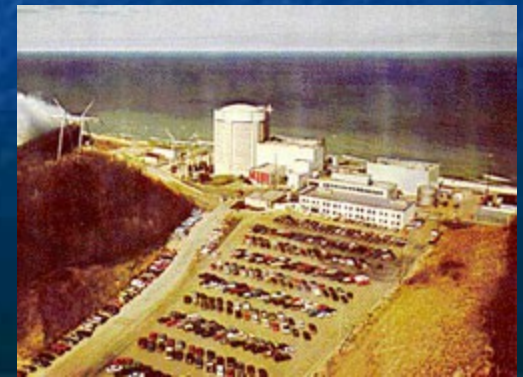
D. C. Cook 1 and 2 – Pressurized water reactors. Located near Benton Harbor.



Fermi 2 – Boiling water reactor. Located near Monroe.



Palisades – Pressurized water reactor. Located near South Haven.



# Renewable Resources\*



## ***Biomass Power –***

### **Advantages:**

- Widely available and in great quantity.
- Easy to convert to a high energy fuel (such as alcohol and gas).
- Can tap into areas currently not being used.

### **Disadvantages:**

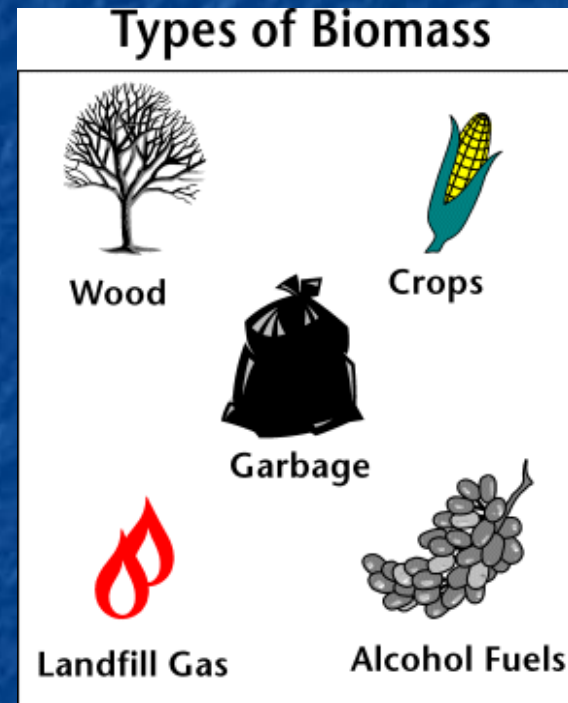
- Not economical to transport biomass over long distances (keep near power plants).
- Releases carbon dioxide gas, but no net gain in overall carbon dioxide.

# Biomass

**Biomass** (plant material and animal waste) supplies almost 15 times as much energy in the United States as wind and solar power combined.

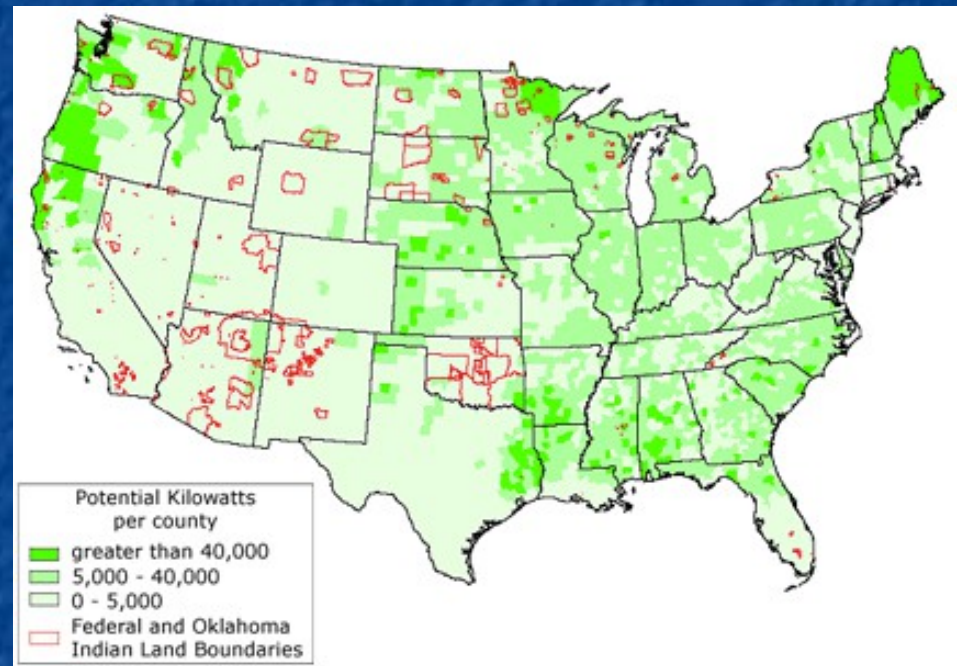
Energy crops could be grown on farms just like food crops. Trees and grasses (particularly those native to a region) are the best crops for energy.

Forestry wastes, agricultural wastes, and even city wastes are all possible sources for biomass energy.

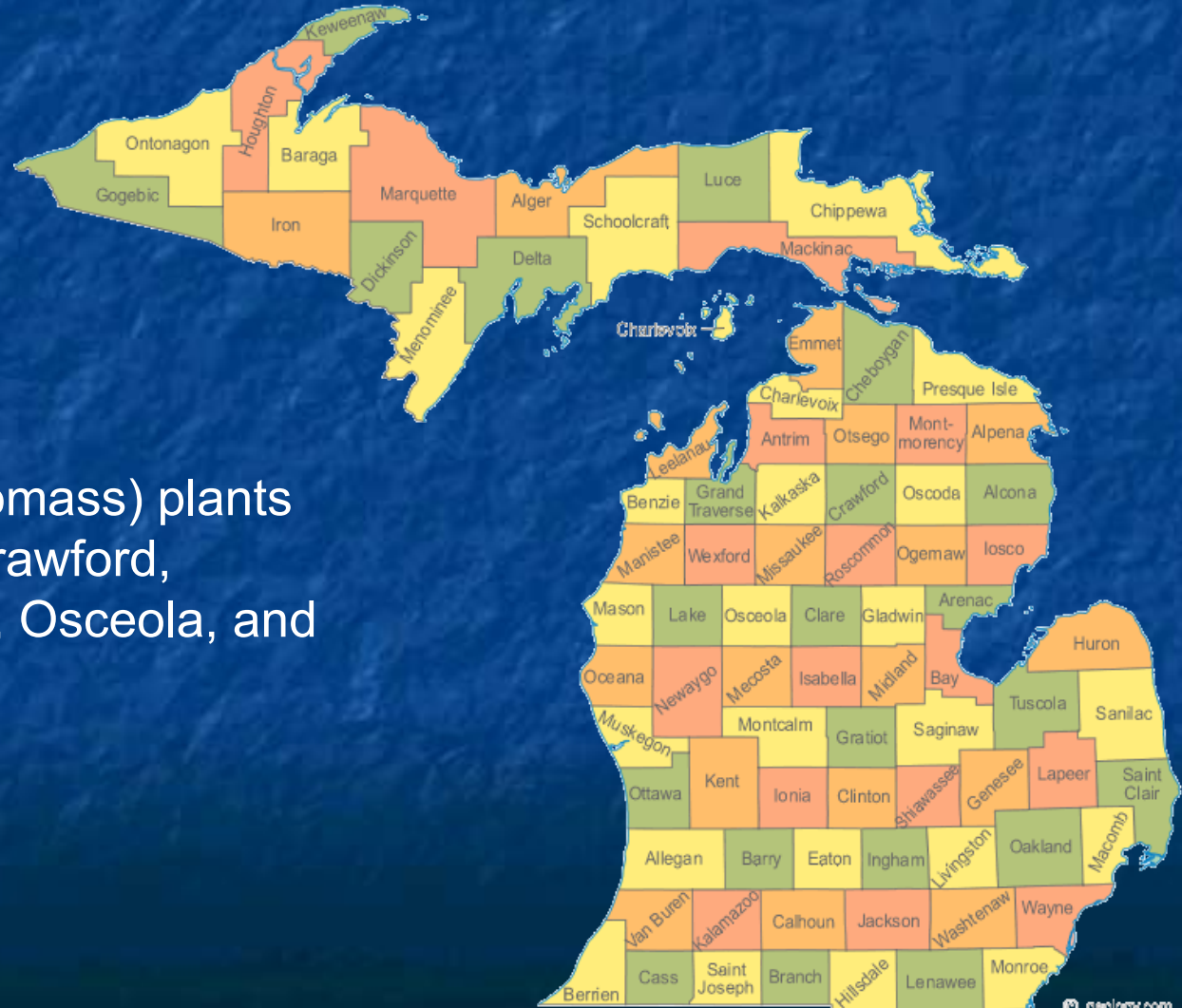


# Biomass

Producing electricity from **biomass** is most cost effective if biomass power or “biopower” plants are located near biomass feedstocks. Biomass resources are abundant across the eastern half of the United States, and thus, the majority of operating biomass power plants are located there. The future use of dedicated feedstock crops can broaden the resource availability to all regions with agricultural production activity.



# Michigan Biomass Plants

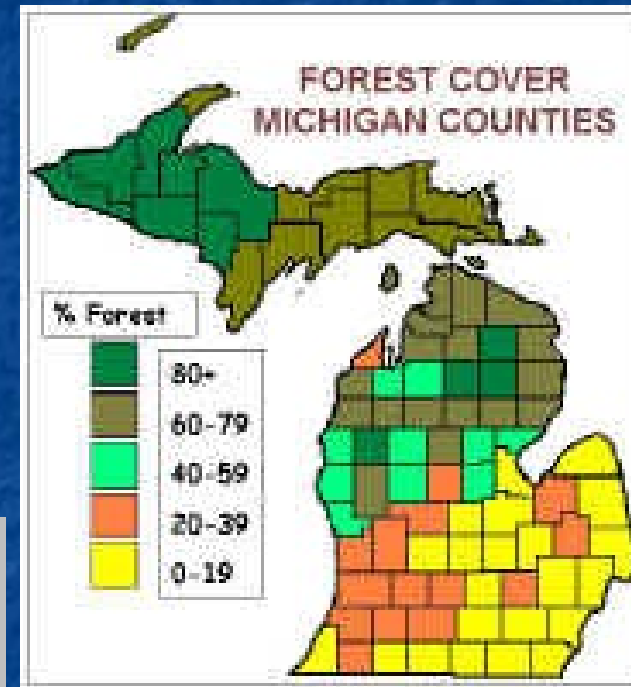


Michigan wood-fired (biomass) plants are located in Alcona, Crawford, Genesee, Montmorency, Osceola, and Wexford counties.

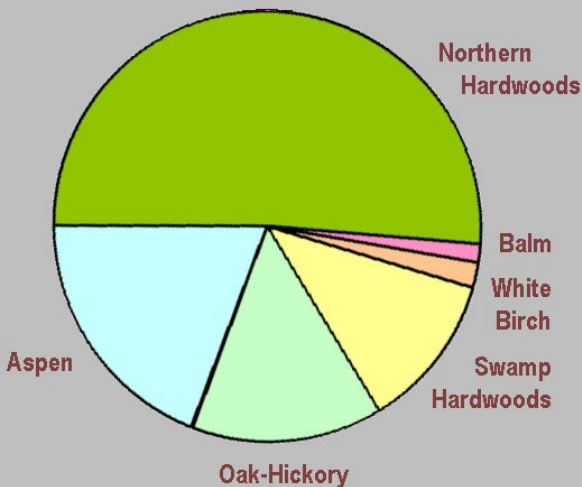
# Michigan Forests

Michigan has the fifth largest area of timberland among the 50 states. It has the second largest area of timberland that is state-owned.

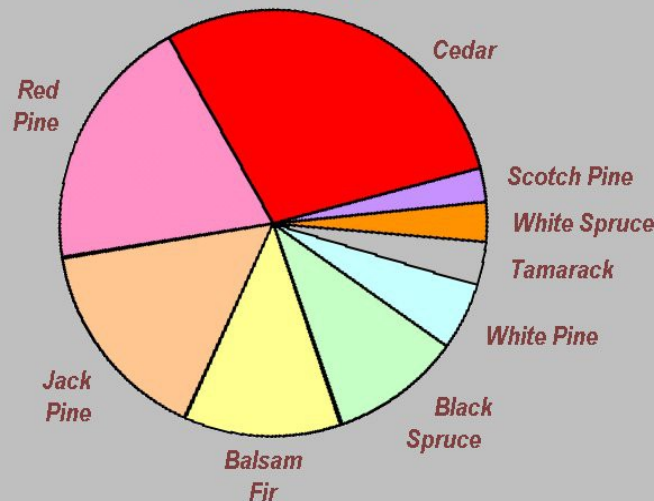
In terms of timber volume, Michigan ranks 13<sup>th</sup>. Most of our volume is in hardwood.



**MICHIGAN FOREST TYPE AREA -- HARDWOODS --**



**MICHIGAN FOREST TYPE AREA -- SOFTWOODS --**



# Renewable Resources\*

## ***Hydroelectric Power –***



### **Advantages:**

- No greenhouse gases released, no toxic wastes produced.
- Dams help to prevent flooding.

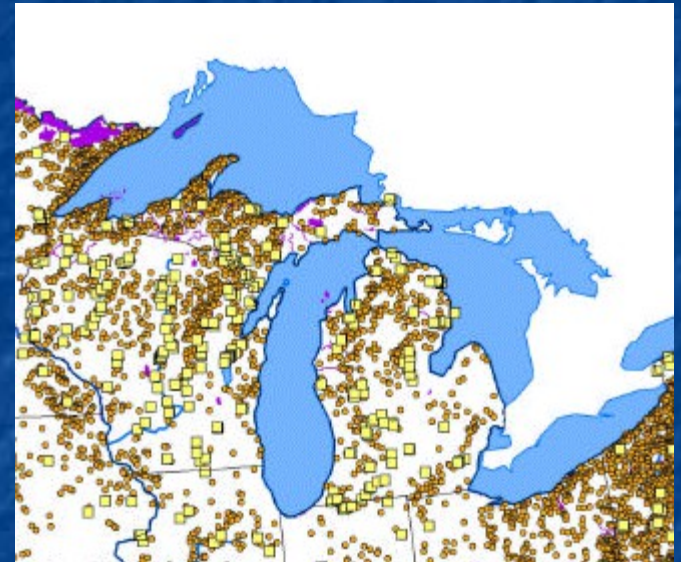
### **Disadvantages:**

- Must have fast flowing water available, can't have flat land.
- Dams can disturb the environment (fish ladders help).
- Bursting dams a small risk (constant inspections help).

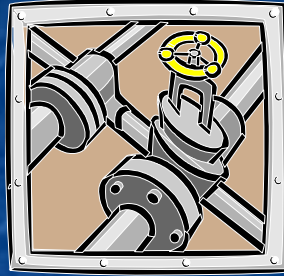


# Michigan Hydroelectric Power

The Great Lakes region has 288 hydroelectric power plants operating, with an average annual generation of 25 million megawatt hours. This ranks third in the United States, behind the Pacific Northwest and California regions.



# Renewable Resources\*



## *Geothermal Power –*

### Advantages:

- Does not contribute to greenhouse gases and has little pollution.
- Power stations are not very large.

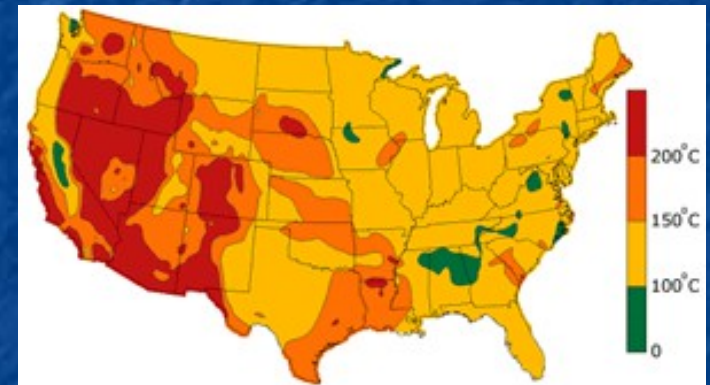
### Disadvantages:

- Need hot rocks at a depth you can reach fairly easily.
- May release hazardous gases and minerals from underground.

# Geothermal Power

Geothermal power plants convert hydrothermal fluids (hot water or steam) to electricity. Flash steam plants are the most common type of geothermal power plants in operation today. They use extremely hot water (above 300 degrees F (149 degrees C)), which is pumped under high pressure to the generation equipment at the surface. The hot water is vaporized and the vapor in turn drives turbines to generate electricity.

California, Hawaii, Nevada, and Utah currently have operating geothermal power plants.



Estimated subterranean temperatures at a depth of 6 km

# Renewable Resources\*



## ***Wind Power –***

### **Advantages:**

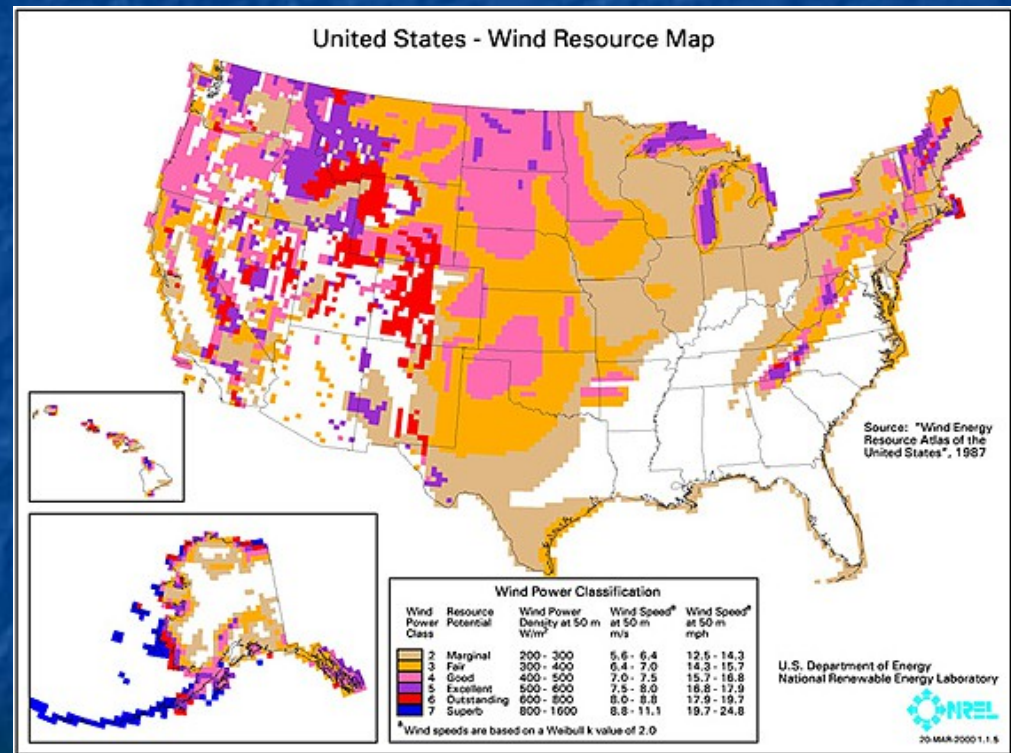
- Wind is free, and wind turbines do not release greenhouse gases or other pollutants.
- A wind turbine only takes up a small plot of land.

### **Disadvantages:**

- The strength of the wind is not constant, and at times may not produce any electricity.
- Wind turbines are large and unsightly, and somewhat noisy.
- Have to be careful of bird migration patterns.

# Wind Power

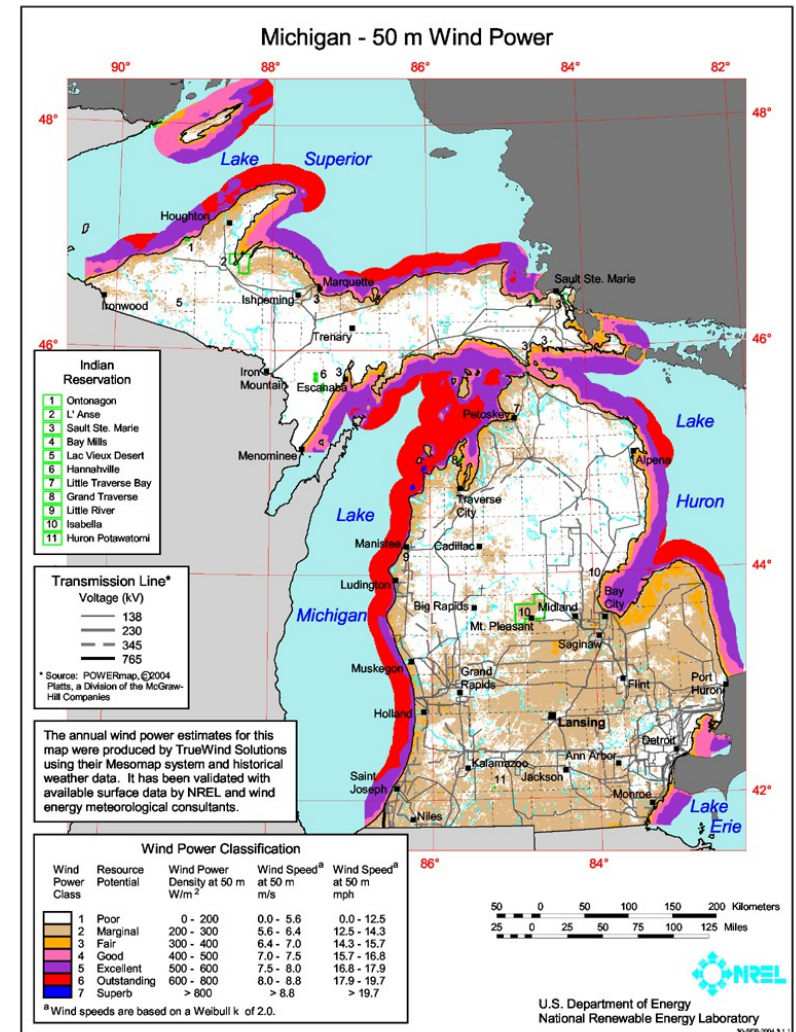
Wind power operates without emitting any greenhouse gases (GHG) and has one of the lowest GHG lifecycle emissions of any power technology. In addition, wind causes no emissions of harmful pollutants, no mining or drilling for fuel, no radioactive or hazardous wastes, and no use of water for steam or cooling. Wind farms can spread out over large areas but their footprint is light as farmers and ranchers continue to work the land up to the foot of the turbines. Most land uses remain as before when a wind farm is installed.



# Michigan Wind Power

This map gives an idea for the potential wind power around Michigan at a height of 50 meters.

Areas of interest include the “thumb”, and coastal areas that surround the state.



# Renewable Resources\*

## *Solar Power –*



### **Advantages:**

- Inexhaustible fuel supply (our sun).
- Does not release greenhouse gases or other pollutants.

### **Disadvantages:**

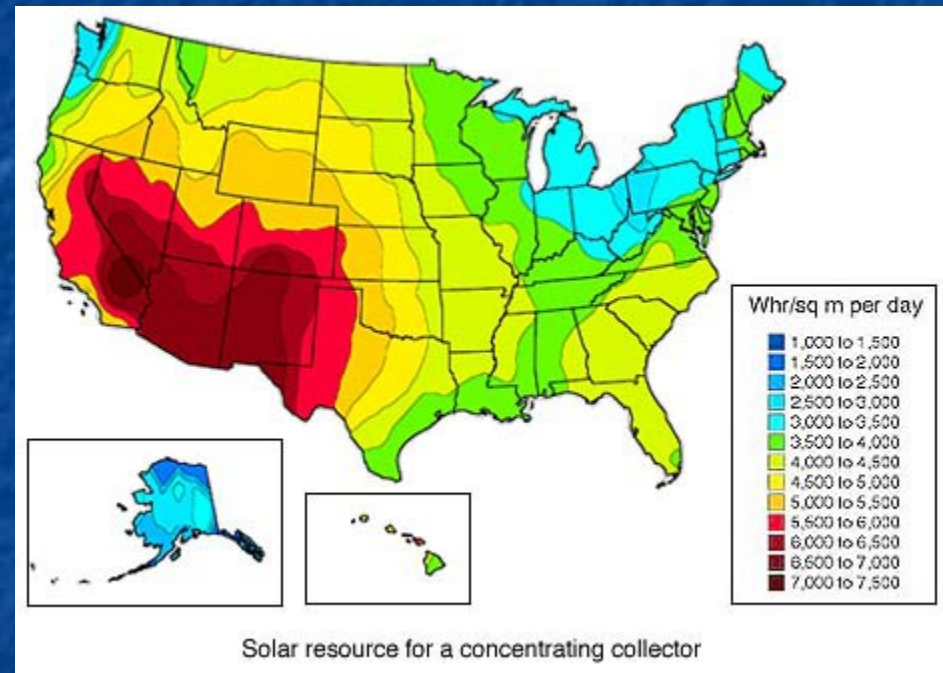
- Must have sunlight to produce electricity.
- The less sunlight an area has, the more solar panels must be installed (can cover large areas of land).
- Need to be able to store generated electricity (for nights, etc.)

# Solar Power



Concentrating solar power plants produce electric power by converting the sun's energy into high-temperature heat using various mirror configurations. The heat is then channeled through a conventional generator. The plants consist of two parts: one that collects solar energy and converts it to heat, and another that converts heat energy to electricity.

Concentrating solar power is an attractive renewable energy option in the Southwest and other sunbelt regions worldwide.





# Michigan Minerals

Washtenaw County is known for its construction sand and gravel. Natural aggregates are composed of sand, gravel, and crushed stone. These important materials are used to build and maintain urban, suburban, and rural infrastructures.

It is estimated that 229 tons of aggregate is needed for a 1,000 square foot ranch house with a full, unfinished basement and an attached garage.

