

# Environmental Impact: Nuclear Energy in Comparison with other Alternatives

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# Contents

- ✦ Introduction
- ✦ Greenhouse Gases
- ✦ Solid Waste
- ✦ Wildlife Effects
- ✦ Land Resource Use
- ✦ Other Effects
- ✦ Conclusion



# Introduction

- ✦ Environmental Issues are highly controversial topics
- ✦ Most sources are biased
- ✦ All fuel sources have pros and cons



# Greenhouse Emissions

- ✦ Greenhouse gases include  $\text{CO}_2$ , methane, ozone, CFC's,  $\text{NO}_2$
- ✦ Excess greenhouse gases are “the” cause of global warming
- ✦  $\text{CO}_2$  is estimated to be responsible for half of all global warming



# Gases from Fossil Fuels

- Depending on the particular fossil fuel and the method of burning, emissions other than  $\text{CO}_2$  are produced. Ozone, sulfur dioxide,  $\text{NO}_2$  and other gases are often released, as well as particulate matter. Sulfur and nitrogen oxides contribute to smog and acid rain. In the past, plant owners addressed this problem by building very tall flue gas stacks, so that the pollutants would be diluted in the atmosphere. While this helps reduce local contamination, it does not help at all with global issues.



# Gases from Fossil Fuels

- A 1000MW coal plant produces 6,000,000 metric tons of CO<sub>2</sub> ,44,000 metric tons of sulphur oxides and 22,000 metric tons of nitrous oxides annually



# Gases from Hydroelectric Plants

- Hydroelectric Plants release “no” harmful gases



# Gases from Renewables

- ✦ Solar power's negative impact on the environment lies in the creation of the solar cells (which are made of primarily silicon and the extraction of this silicon requires the use of fossil fuels) and the storage of the energy (which usually requires Lead-Acid batteries).
- ✦ Burning biomass produces many of the same emissions as burning fossil fuels. However, growing biomass captures carbon dioxide out of the air, so that the net contribution to global atmospheric carbon dioxide levels is lessened.



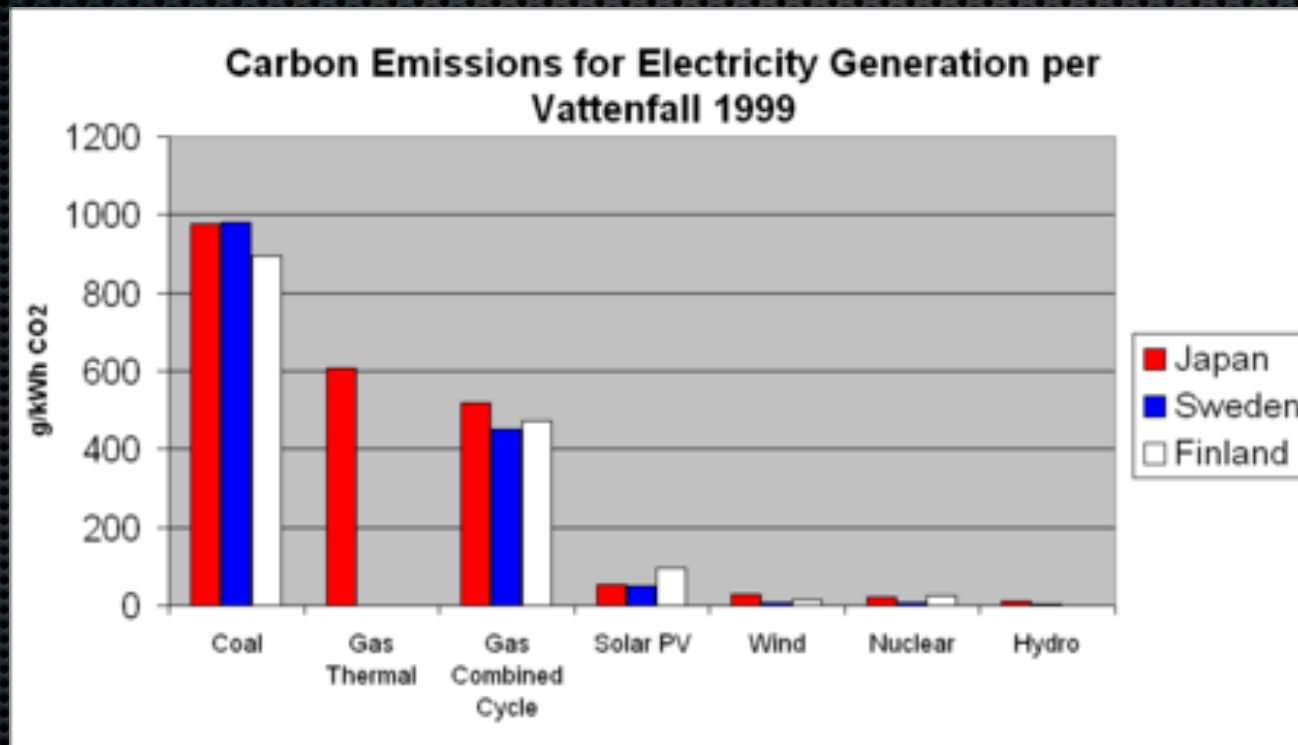


# Gases from Nuclear Plants

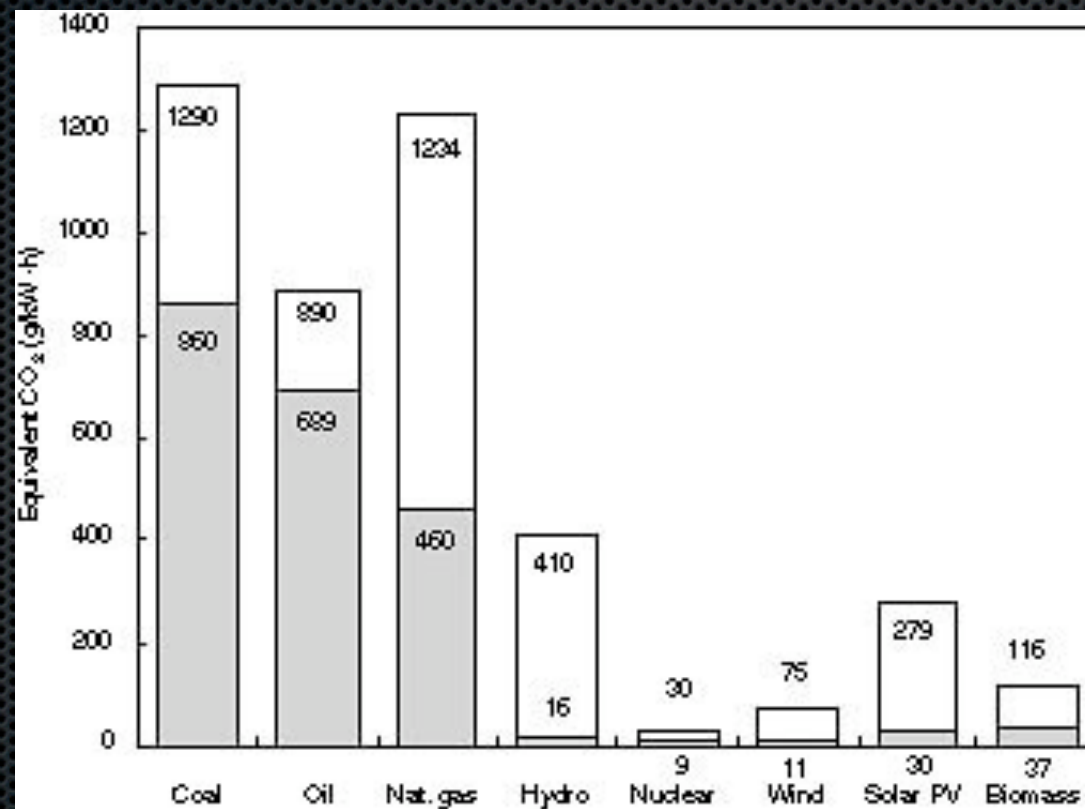
- Nuclear Plants release “no” harmful gases



# CO<sub>2</sub> gas emissions by source



# CO<sub>2</sub> gas emissions per mass



# CO<sub>2</sub> gas emissions by source

The Environmental Protection Agency (EPA) identifies the following average emission levels in the production of 1 MWh of electricity  
Pounds of Emissions per MWh

	Coal	Oil	Natural Gas	Nuclear
Carbon Dioxide	2249	1672	1135	0
Sulfur Dioxide	13	12	0.1	0
Nitrogen Oxides	6	4	1.7	0

Source: [www.epa.gov/clean energy/impacts](http://www.epa.gov/clean_energy/impacts)



# Solid Waste

- ✦ Solid Waste is anything and everything solid from the plant
- ✦ Most solid waste is benign however some dangerous solid waste products include mercury, arsenic, and radioactive substances, among others
- ✦ The different types of waste are treated differently



# Waste from Fossil Fuels

- ✦ The burning of fossil fuels creates by far the most solid waste
- ✦ a 1000MW coal plant creates 320,000 metric tons of ash containing 400 metric tons of heavy metals annually



# Waste from Hydroelectric Plants

- Hydroelectric Plants release “no” solid waste



# Waste from Renewables

- ✦ Burning biomass produces most of the same waste as fossil fuels



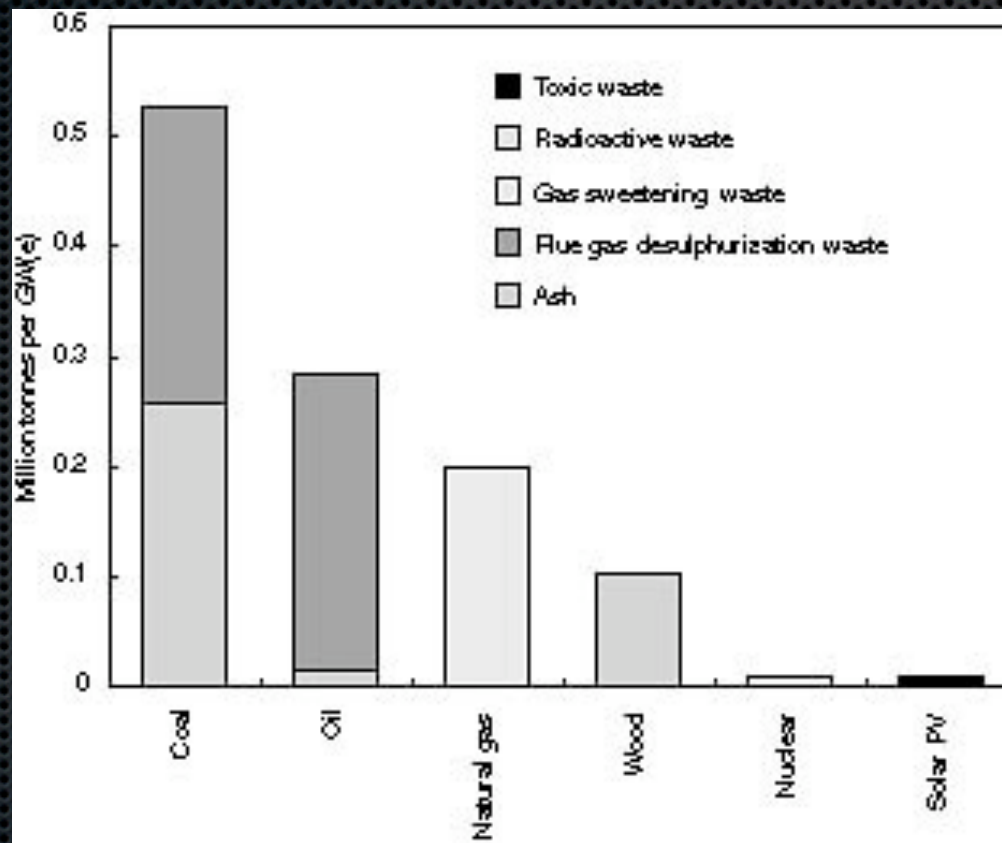


# Waste from Nuclear Plants

- ✦ A 1000MW reactor produces 800 metric tons of low and intermediate wastes and 30 metric tones of highly radioactive spent fuel
- ✦ Because nothing is burned, little fuel mass is lost during power generation



# Waste Generated Annually



# Local Wildlife Effects

- ✦ Each type of power production has an effect on the surrounding wildlife



# Fossil Fuels' Effects



- Strip mining has led to some rivers in coal producing areas to run red with sulfuric acid killing all life in the river
- Transportation of oil leads to occasional spills



# Hydroelectric Plants' Effects

- ✦ The building of dams have stymied fish travel (i.e. salmon runs)
- ✦ Areas can flood because of a dammed river
- ✦ Some rivers have actually run dry from to many dams



# Renewables' Effects



- Wind turbines can affect birds
- Tidal power plants reduce or increase the tidal swing
- Geothermal Plants heat up nearby water sources



# Nuclear Plants' Effects



- A large nuclear power plant can release enough heat into a natural body of water to affect the local aquatic life
- There is the risk of a severe radiation leak
- Mining of uranium is not much better than coal mining



# Land Resource Use

- Electricity generation generally requires the use of land (either for mining or the actual power plant sites)
- The use of this land normally has a negative effect on the environment





# Fossil Fuels' Land Use

- Large pieces of land must be utilized for mining/drilling
- Both mining and drilling can cause erosion, loss of soil productivity, and landslides
- Soil at the power plant site can become polluted destroying animal habitats



# Hydroelectric Plants' Land Use



- ✦ The construction of a dam and the creation of lakes can destroy animal habitats, farmland or scenic retreats.
- ✦ Dams can also cause erosion along the riverbed which can alter fish behavior



# Renewables' Land Use

- Solar power does not damage the land it is on but it does require large pieces of land that could be used in other ways
- Geothermal plants can cause sinkholes if water underground water pressure is held fixed
- Wind power uses land very efficiently
- Biomass uses large tracks of land which could be used to grow food products



# Nuclear Plants' Land Use



- ✦ The construction of a nuclear power plant can destroy habitats
- ✦ The stored waste may ruin the land above “forever”



# Energy densities

One kilogram (kg) of firewood can generate 1 kilowatt-hour (kW·h) of electricity. The values for the other solid fossil fuels and for nuclear power are:

1 kg coal:	3 kW·h
1 kg oil:	4 kW·h
1 kg uranium:	50 000 kW·h (3 500 000 kW·h with reprocessing)

Consequently, a 1000 MW(e) plant requires the following number of tonnes (t) of fuel annually:

2 600 000 t coal:	2000 train cars (1300 t each)
2 000 000 t oil:	10 supertankers
30 t uranium:	reactor core (10 cubic metres)

The energy density of fossil and of nuclear fuel allows relatively small power plant areas of some several square kilometers (km<sup>2</sup>). The low energy density of renewables, measured by land requirements per unit of energy produced, is demonstrated by the large land areas required for a 1000 MW(e) system with values determined by local requirements and climate conditions (solar and wind availability factors ranging from 20 to 40%):

Fossil and nuclear sites:	1–4 km <sup>2</sup>
Solar thermal or photovoltaic (PV) parks:	20–50 km <sup>2</sup> (a small city)
Wind <i>fields</i> :	50–150 km <sup>2</sup>
Biomass <i>plantations</i> :	4000–6000 km <sup>2</sup> (a province)



# Other Effects of Fossil Fuels

- ✦ The burning of fossil fuels releases more radioactivity than a nuclear reactor
- ✦ The solid waste from burning fossil fuels is a very large volume but relatively safe
- ✦ Many believe the burning of fossil fuels is causing global warming



# Other Effects of Hydroelectric Plants

- Hydroelectric power is cheap after the dam is built
- Dam collapses usually lead to loss of life
- The production of hydropower releases no pollution



# Other Effects of Renewables

- ✦ Wind power uses the less land per kW-h than any other energy.
- ✦ There are some power plants that burn residential waste
- ✦ The tip of a wind turbine blade can travel as fast as 170mph





# Other Effects of Nuclear Reactors

- ✦ From 1973 to 1997 nuclear power prevented the emission of 119,000,000 tons of nitrous oxide and 260,000,000 tons of sulfuric oxide
- ✦ People living closest to a nuclear power plant receive one extra day of radiation per year



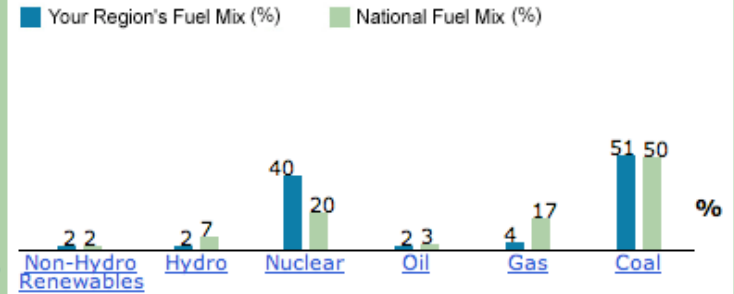
# Our Electricity

## FUEL MIX COMPARISON

### 1

#### What Is My Fuel Mix?

This chart compares fuel mix (%) of sources used to generate electricity in your region to the fuel mix (%) for the entire United States.

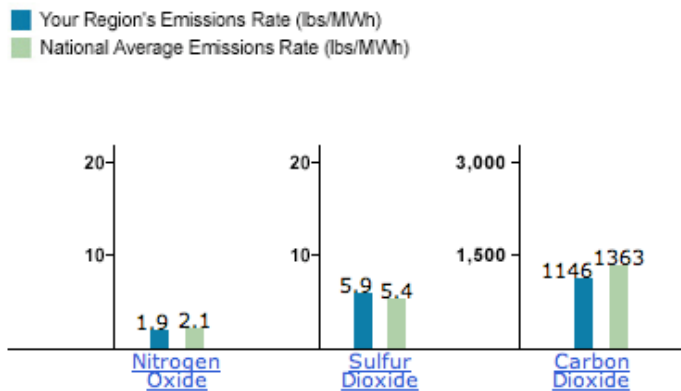


## EMISSIONS RATE COMPARISON

### 2

#### What Are the Emissions in My Area?

This chart compares the average emissions rates (lbs/MWh) in [your geographical region](#) to the national average emissions rates (lbs/MWh) for nitrogen oxide, sulfur dioxide, and carbon dioxide.



# Conclusion

- Which type of energy is best is a matter of taste
- Each type of electricity generation has pros and cons
- A mixture of all types of production is needed in order to spread the faults of each out so that each fault is minimized

