

# Nuclear Power



Karen Street  
Berkeley MM

## In a Warming World

Berkeley MM  
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# Two Big Fears

Big Fear 1: Perceived Risks of NOT using more nuclear energy

Big Fear 2: Perceived Risks of using nuclear energy



# Big Fear 1: Climate change

- Temperature increase over pre-industrial times may exceed 2 C, or even 3 C, or much, much more, primarily due to the use of fossil fuels.
- As a result, the Earth's ability to supply food and clean water, and to support today's species, will plummet.



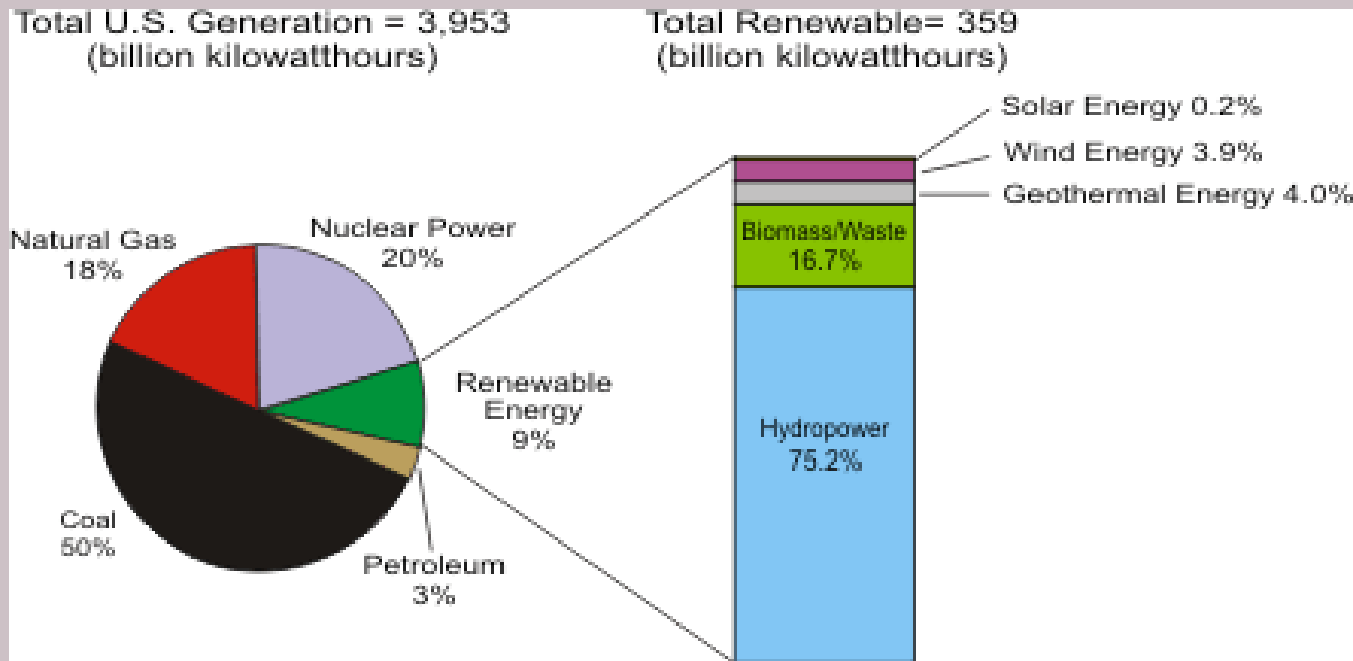
# Points of Agreement?

If there is an energy source that is good at meeting demand without adding GHG, would you seriously want to consider it?

We need to find energy sources to replace old fossil fuel plants, meet increased demand, and slow the warming trend.



# Current Power Mix



US,  
electricity  
only

- Fossil fuels 71%
- Majority of remainder is nuclear power.
- Of 9% we call renewable, almost none belongs to the groups we traditionally think of as high potential sources for the future.
- Hydro limited, especially in US, may actually decline.

# Big Fear 2: Perceived risks of expanding nuclear power

- radioactivity
- accidents: Three Mile Island, but especially Chernobyl
- the bomb

# Risks of radioactivity

Nuclear waste is highly radioactive for tens of years, radioactive for tens of thousands of years, but

Will anyone die????

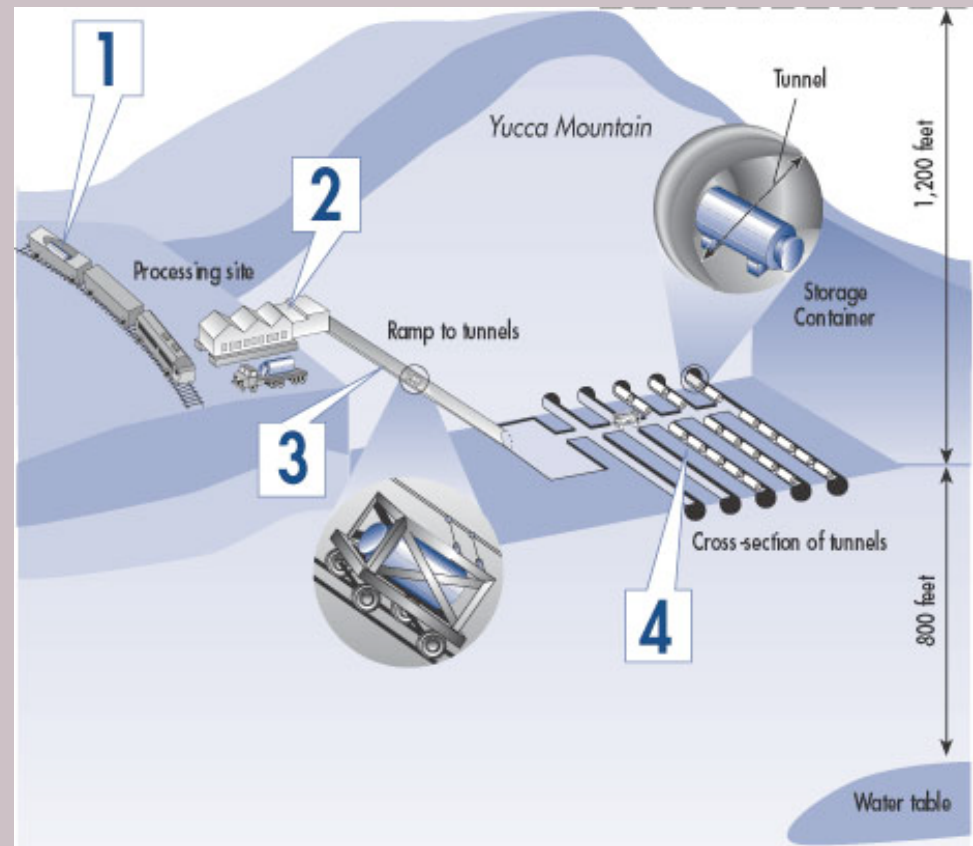
Does it harm the environment???



# Nuclear Waste

Assuming that the alternative to nuclear power is fossil fuels, nuclear is much, much safer for both the health and the environment (and agriculture and buildings) than are fossil fuels.

In normal operation, including waste, no one is expected to die from nuclear power.



# Nuclear Waste

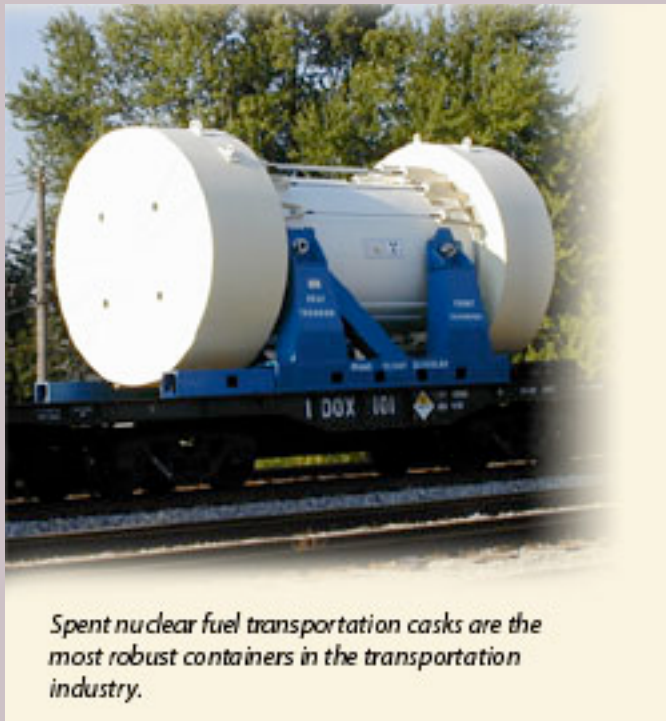
Assuming current Yucca Mountain plan (which includes monitoring for 100 - 300 years):

- First 10,000 years, essentially no human exposure to radioactivity.
- After, maximum exposure to any one individual: 260 mrem/year
  - average American exposure today: 300 mrem/year
  - higher average doses in US and around world without increased cancer rate, from areas in Iran (26,000 mrem/year) to Brazil and India (3,500 mrem/year) to Norway (1,050 mrem/year). “To date, no radiation related health effects have been found.”

United Nations Scientific Committee on the Effects of Atomic Radiation

# All energy sources produce waste

Fossil fuels require 100,000 - 1 million times as much fuel, and produce 100,000 - 1 million times as much waste, and it's gaseous, not solid.



*Spent nuclear fuel transportation casks are the most robust containers in the transportation industry.*

There are *no good ideas* as to what to do with fossil fuel waste. We can reduce it by using carbon capture and storage, but we can't eliminate it.

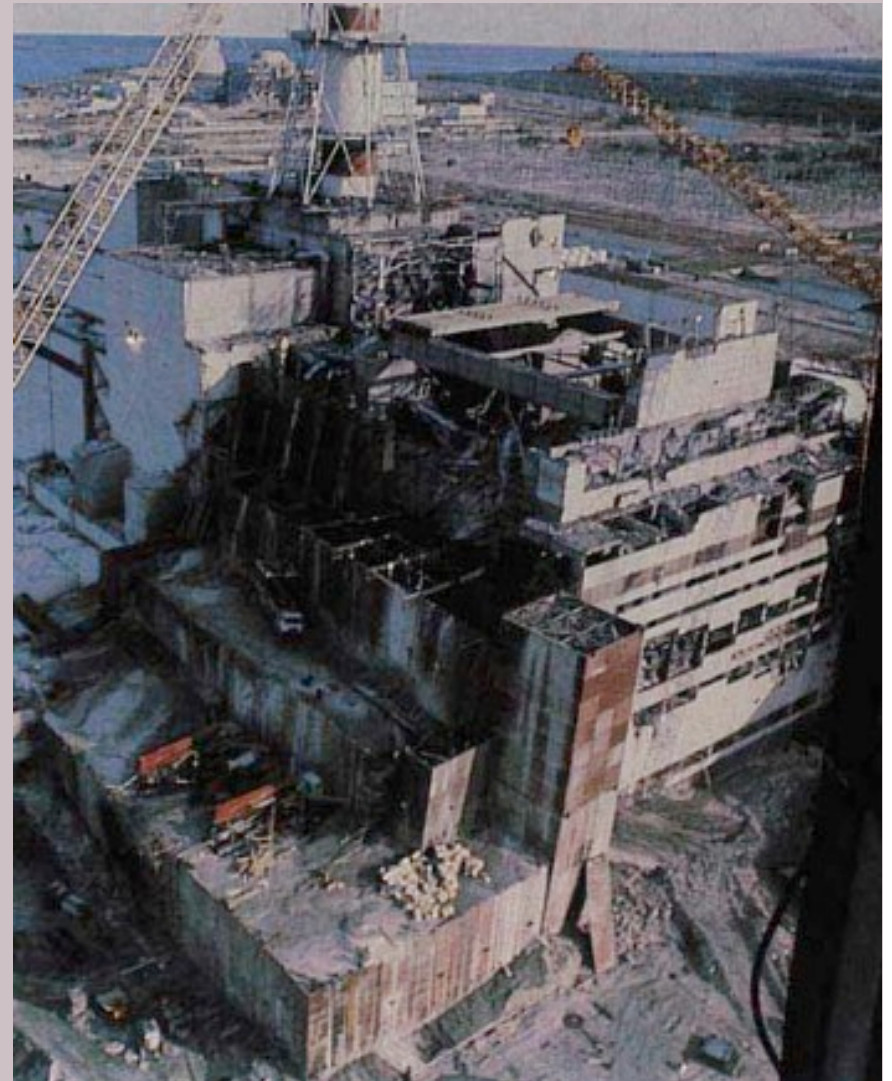


# Nuclear Accidents

Accidents in 1<sup>st</sup> world: presumably between 0 (Three Mile Island) and Chernobyl.

Scientists report for Chernobyl:

- 50 - 60 from explosion and initial radioactive exposure, including 31 firemen, and 9 childhood thyroid cancers.
- No increase in leukemia observed, though it was expected.
- Up to 4,000 people over the next 60 years due to cancers from that initial exposure.



# Nuclear Accidents

- Chernobyl was badly designed.
- Five decades experience beginning with early designs for nuclear power plants, and an early regulatory system
- New plants are thought to be 10 x safer.
  - gravity, not valves
  - assume operator malicious



# Birth defects from Chernobyl?

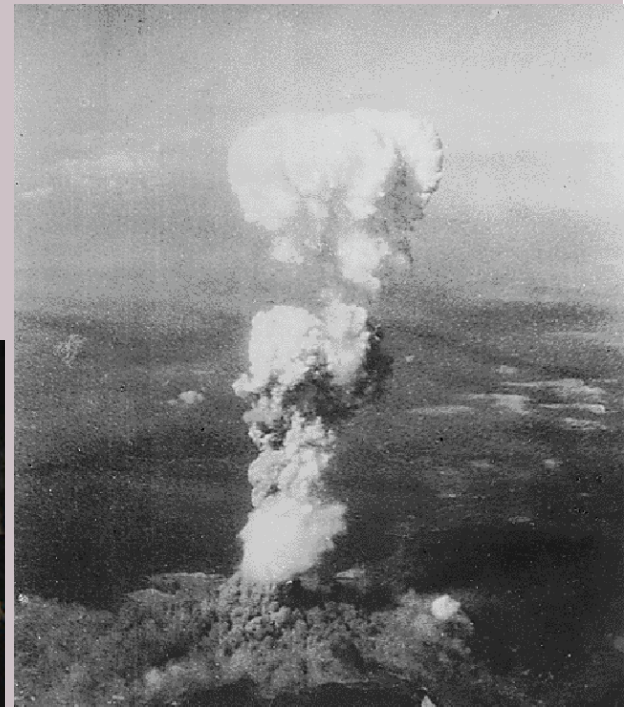
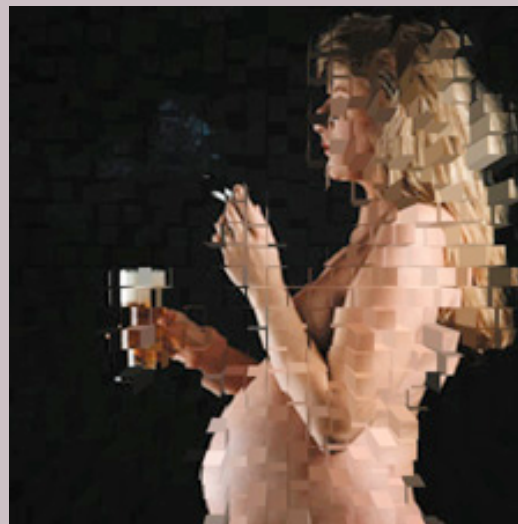
Fear: birth defects resulting from Chernobyl

What is the evidence?

# Birth defects from Chernobyl?

Data show:

- no increase in birth defects occurred
- no relationship has been found between incidence of birth defects and greater exposure. (Greater exposure *does* lead to more childhood thyroid cancers, so the connection is clear.)
- no increase in birth defects resulted from Hiroshima-Nagasaki.



# Big Fear 2: Speaking of bombs

Will expanded use of nuclear power increase the risk of:

- greater access to nuclear weapons material by terrorists?
- more states acquiring nuclear weapons?

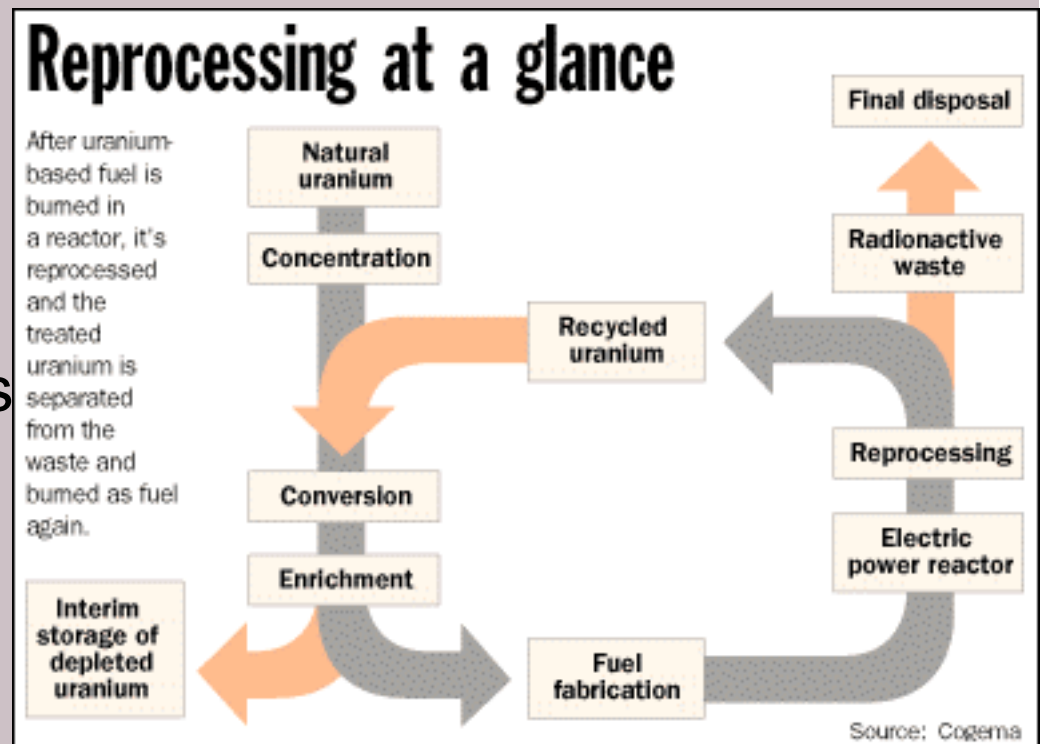
# Problems with reprocessing

Without reprocessing, nuclear waste is theft-proof.

Concern: Terrorist groups could obtain weapons usable Pu. This would make a not very good bomb – but it would be a bomb.

We have choices about how to expand nuclear power.

The US does not reprocess and does not share power plant technology with countries that want to reprocess (India).

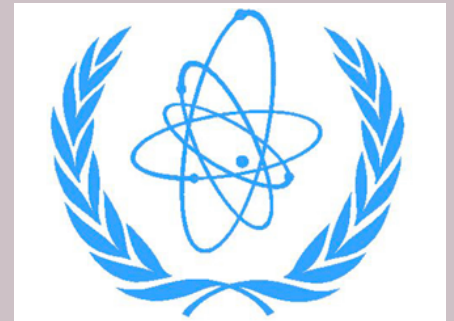


# Nuclear weapons proliferation is a peace issue

To address nuclear weapons proliferation, address nuclear weapons, nuclear power.

Focus on these:

- strengthen and fund the International Atomic Energy Agency
- nuclear weapons states give up their nuclear weapons (quickly is better)



Other issues: finding ways to make nuclear power more proliferation-resistant. US input to this process is important.

No matter what we in the US do, nuclear power will expand rapidly worldwide.

# Big Fears

Big Fear 1: Perceived Risks of NOT using more nuclear energy



Big Fear 2: Perceived Risks of using nuclear energy.



# Why Nuclear Power?

How does nuclear power compare to other alternatives in terms of:

- effects on human health and the environment
- taking away the occasion that leads to war.
- economics and practicality

# Why Nuclear Power?

- Solutions that include nuclear power are better for human health and the environment than solutions that do not.

# Coal and other fossil fuels

Normal operation coal power --  
cardio-respiratory diseases from  
particulates  
ozone  
miners

- US: equivalent of 8 Chernobyls/year
- China: equivalent of >100 Chernobyls/year



*“Chinese coal mine: death toll explosion reaches 169; separate mine flood traps 42”*  
November 2005

Healthy lung, coal miner’s lung

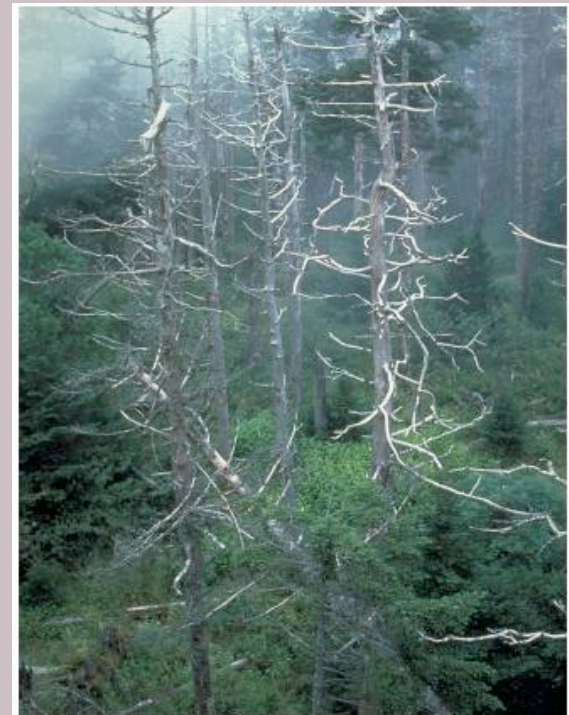
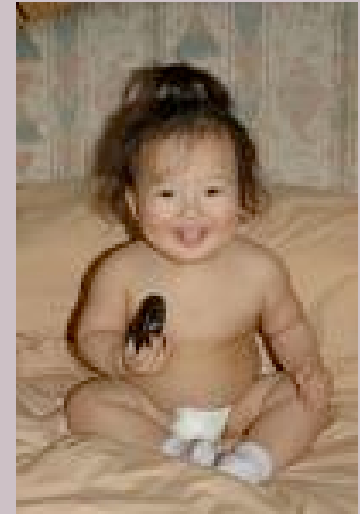


# Air Pollution

China estimates 50,000 newborns die each year from air pollution.

Air pollution -- great costs to crops and ecosystems.

Natural gas also polluting, just not *as* polluting.



# Why Nuclear Power?

- Solutions that include nuclear power are better for human health and the environment than solutions that do not.
- Nuclear power helps take away the occasion that leads to war by reducing the use of fossil fuels and the terrifying prospects of further and accelerating climate change.

# Climate change is a peace issue

Likely:

- lack of clean water
- sea level rise

*Not welcome* signs are already up.

Estimates for the cost of climate change do not include the cost of war.

Ganges River, a  
holy site



# Why Nuclear Power?

- Solutions that include nuclear power are better for human health and the environment than solutions that do not.
- Nuclear power helps take away the occasion that leads to war.
- Nuclear power is relatively low-priced, and available now.

# Is there enough uranium?

Some information seems to come '*two guys and a web site*'.

- not-yet-submitted to peer review claim no more high quality uranium this year (rewritten in 2005 when the prediction for 2002 failed).

*or*

- information used by tens of governments, hundreds of site managers and thousands of academics.



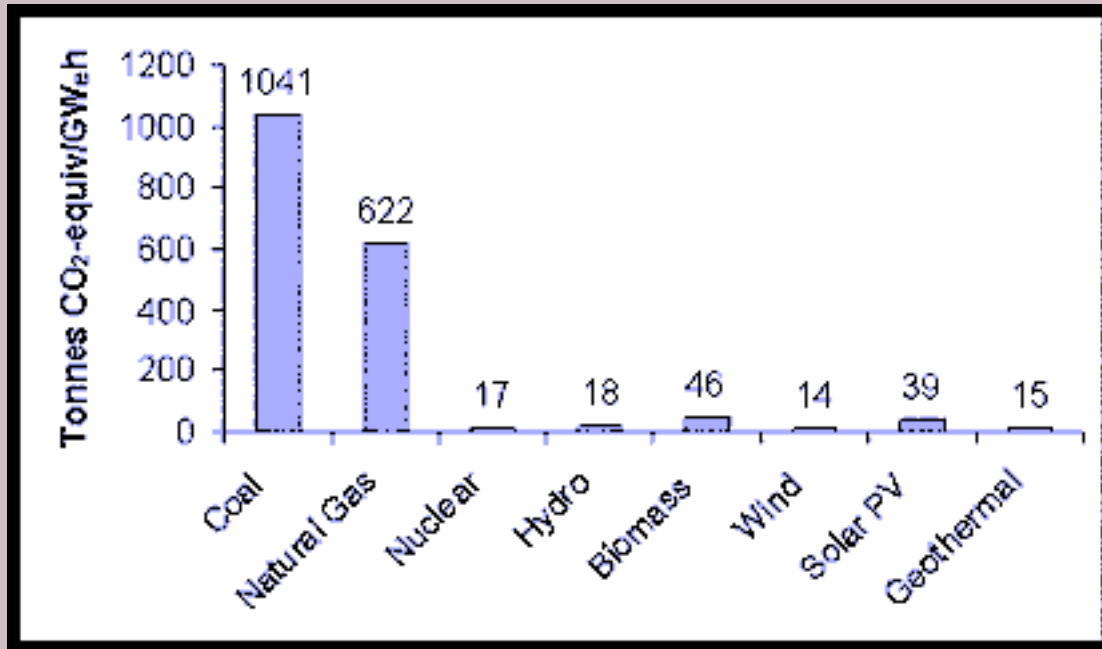
# How much GHG from nuclear power?

Not-yet-submitted to peer review:

Nuclear power over its entire fuel cycle (from mining to decommissioning to decay) emits as much GHG as natural gas does over its fuel cycle.

The unit of GHG is CO<sub>2</sub>e, carbon dioxide equivalent.

# All energy use results in GHG emissions



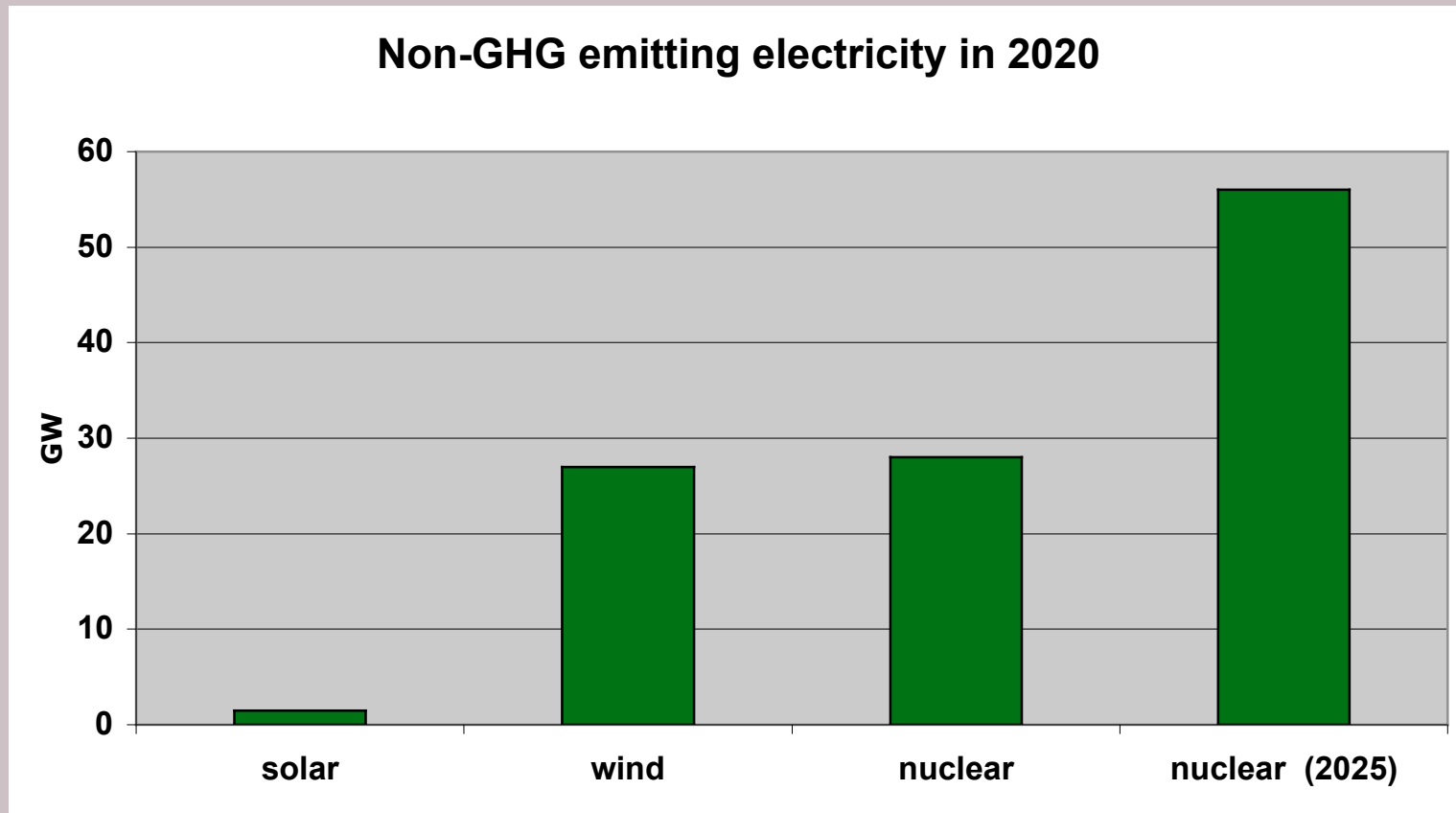
Indirect emissions include building the plant/windmill, obtaining fuel, etc. American analysis

# Relative costs of electricity sources

We need to use (almost) all solutions. Today:

- Nuclear is cheaper in most countries. Coal cheaper than nuclear in countries with large reserves (US, China, Australia).
- With carbon capture and storage, nuclear cheaper everywhere.
- Hydro limited in most countries.
- Wind more expensive than nuclear in most or all countries, certainly Europe, is expected to remain so, especially in Europe (US has way more wind).
- Solar more expensive everywhere, will always be expensive in Europe (US has way more sun).

# Can we do it without nuclear power?



Increase in US electricity demand by 2020 is equivalent to production of 130 GW in nuclear power plants. How much of this can come from non-fossil fuels?

# Can we do it without nuclear power?

Efficiency and nuclear are the fastest way to reduce GHG today.

All of these are not enough.

# Can we do it even *with* nuclear power?

# Other factors

- The cost of climate change is very high -- perhaps 5 - 20% of our GDP or more, plus the cost of war.
- Countries with old electricity infrastructure (US) will see high capital costs.
- While climate change is more expensive than wind or nuclear power, we don't want to go broke preventing it.

# More factors

- Nuclear is on at night and on windless days.
- Coal with carbon capture and storage more expensive than nuclear, higher GHG emissions, but makes sense from energy security view.

# Summary

Modern western nuclear plants have caused very few deaths (construction, eg), and do not contribute to climate change.

Coal kills, directly and indirectly.

Natural gas kills, directly and indirectly.

Hydro limited, likely to become more limited in many countries.

Windmills and solar panels can be built faster, but nuclear plants can be built in 4 - 5 years, and they are big.

# Big Fears

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## Blog and Other Sources

A Musing Environment

<http://pathsoflight.us/musing>

David Bodansky

Nuclear Energy 2nd edition

Relative Dangers of Energy Sources

<http://www.quaker.org/fep/reldangersquestions.html>

Talks at UC, Berkeley

<http://events.berkeley.edu>