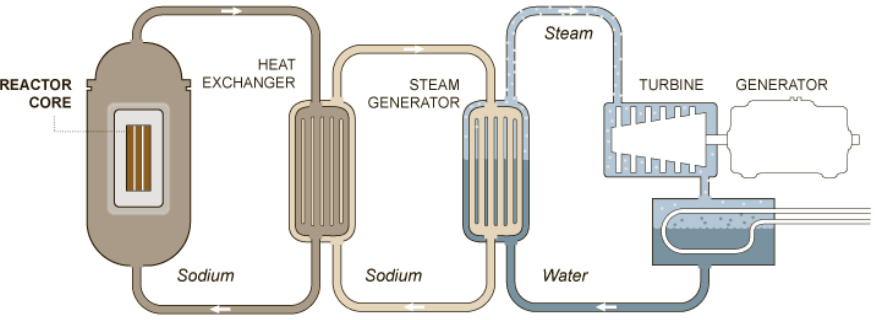
Nuclear Breeder Reactor Technology
Fact Sheet - EGRS 352
Becca McIver

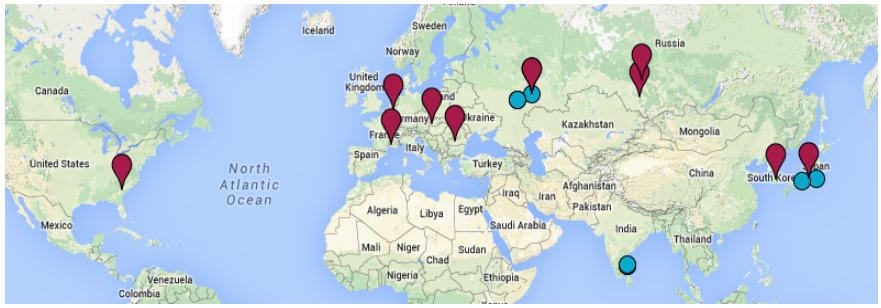


Pros:

- can make more fuel than it uses
- can use current nuclear waste as fuel
- increase nuclear resource lifetime
  - from 30 years to 4,200 or even possibly 50,000 years, depending on use and technology.
- no CO2 emissions - help with climate change
- higher efficiency (60%)
  - rather than 2% for LWR or 5% for HTGR

Cons:

- reprocessed fuel can be used in nuclear weapons
- reprocessing creates radioactive waste and exposure issues
- safety of coolant (sodium) - fire possibility
- higher capital costs



Where are breeder reactors located?

Currently

- Russia-3 (expansion likely-4)
- China-1 (expansion likely-2)
- India-2
- Japan-2 (expansion likely)

Future?

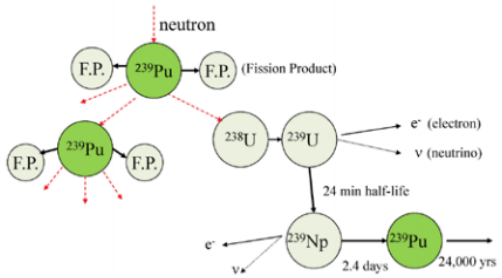
- US-1
- France-2
- Belgium-1
- Romania-1
- South Korea-1

History:

- First breeder reactor 1946
- long history in R&D
  - never really took off because large Uranium source.
- large amount of money invested over past 75 years
  - over $50 billion in total
  - see figure to right
  - US Breeder budget
    - 1947 - $0.9 M
    - 1965 - $34.1 M
    - 1976 - $912.8 M
    - decline since

How does it works?

1) fission: an atomic nucleus splits into two smaller nuclei
2) small amount of mass is converted to energy
3) neutrons produced by fission have high energies and move extremely quickly
4) fast neutrons are readily captured by an isotope of uranium (U_{238}), which then becomes plutonium (Pu_{239})
5) plutonium can be reprocessed



Generation IV reactor types:

- Gas-cooled
- Lead-cooled
- Liquid sodium-cooled (most common)
- Supercritical water-cooled
- Molten salt reactor

Research and Development:

- work on making more economically competitive with standard (LWR) reactors
- work on safety after disaster / malfunction
  - 2011 Fukushima (not breeder but heightened awareness for all nuclear)
- work on "proliferation resistance"
  - 90kg of weapon-ready plutonium per year, but it only takes 5kg for bomb.
- currently R&D has very mixed support worldwide
- many different ideas/technologies for the future
  - divides funding

Funding in OECD countries with substantial breeder programs (1974 to 2007)

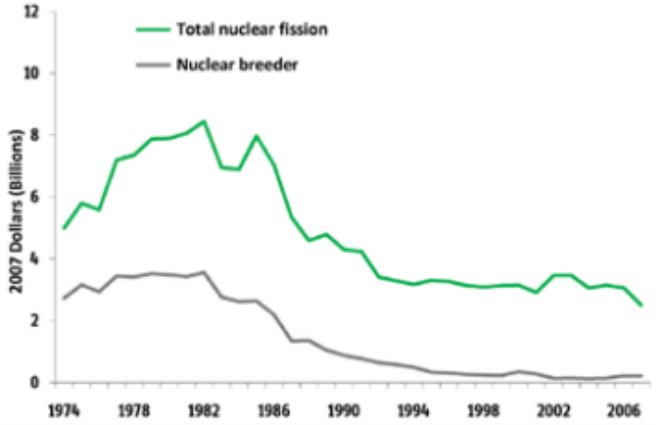


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Figure 1 Source:

"How a Breeder Reactor Works." *The New York Times*.

Pros Source:

Fast Neutron Reactors. World Nuclear Association

Chow, Brian G. "The Economic Issues of the Fast Breeder Reactor Program."

Hannum et al. "Smarter Use of Nuclear Waste."

Cons Source:

Cochran et al. "It's Time to Give up on Breeder Reactors."

Chow, Brian G. "The Economic Issues of the Fast Breeder Reactor Program."

Figure 2 (map) Source:

self made figure with information from
Fast Neutron Reactors. World Nuclear Association

Where are these breeder reactor located? Source:

Fast Neutron Reactors. World Nuclear Association

History Source:

"It's Time to Give up on Breeder Reactors."

Chow, Brian G. "The Economic Issues of the Fast Breeder Reactor Program."

How does it work? Source:

Karam, P. Andrew. "How Do Fast Breeder Reactors Differ from Regular Nuclear Power Plants?"

Figure 3 Source:

Cochran et al. "Fast Breeder Reactor Programs: History and Status." p.3

Generation IV reactor types Source:

Fast Neutron Reactors. World Nuclear Association

R&D Source:

"It's Time to Give up on Breeder Reactors."

Cochran et al. "Fast Breeder Reactor Programs: History and Status."

Figure 4 Source:

Cochran et al. "Fast Breeder Reactor Programs: History and Status." p.7