

FAST BREEDER REACTORS: AN EXAMPLE OF TECHNOLOGICAL REBIRTH AND REBIRTH AND REBIRTH...

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OECD/NEA, THE NUCLEAR AND SOCIAL SCIENCE NEXUS: CHALLENGES AND OPPORTUNITIES FOR SPEAKING ACROSS
THE DISCIPLINARY DIVIDE

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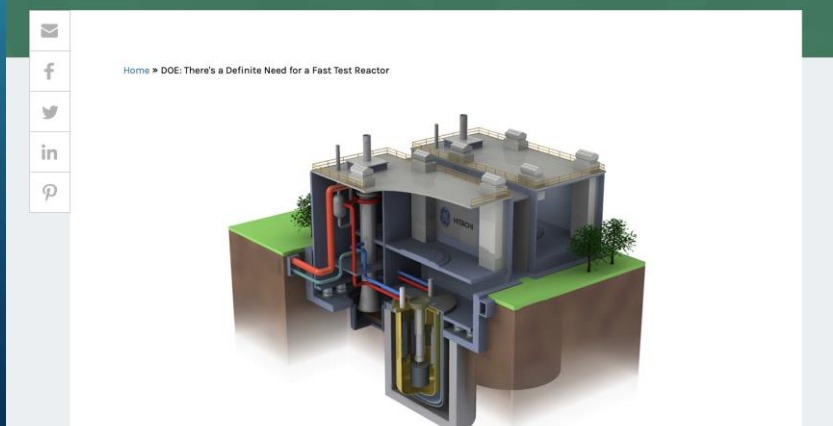
PARIS, FRANCE

RECENT EVENTS



DOE: There's a Definite Need for a Fast Test Reactor

MARCH 1, 2019



startup

(BRIGHT IDEA)
THE NEXT WAVE
 TerraPower is on the forefront of innovation in nuclear power generation and waste recycling.

FISSION: NEW & IMPROVED!

- Uses widely available byproduct of uranium enrichment process.
- Fuel is burned more completely than in conventional nuclear reactors.
- Creates one-fifth the spent fuel volume produced by conventional reactors.

HOW THE TRAVELING WAVE REACTOR WORKS

- 1 Fueled mainly by depleted uranium, a byproduct of uranium enrichment. A small amount of enriched uranium is used to start the reaction.
- 2 Depleted uranium fissions, releasing energy. Active neutrons continue cycle of reactor, "traveling" through the reactor core.
- 3 Reactor can be sealed for up to 60 years. Plutonium created during process is used up, reducing risk of nuclear weapons proliferation.
- 4 "Traveling reaction" uses up most fuel, creating far less waste than conventional reactors.

ILLUSTRATION BY CELIA JOHNSON

MAY 2010 58 | 13



S1G: FIRST SODIUM-COOLED REACTOR IN US, 1954



FAST BREEDER EXPERIENCE

- 8 countries (US, UK, China, Russia/Soviet Union, France, India, Japan, Germany) built 26 sodium-cooled fast reactors over 70+ years
 - Most had operating problems, many serious
 - Invested over US\$100 billion

- US
 - S1G, 1955-57 leaking steam generators, **shutdown**
 - EBR-I, partial core meltdown, **shutdown**
 - Fermi-1, steam generator leaks, partial core meltdown, **shutdown**
- UK
 - PFR, 1974-1994, steam generator leaks, Na leaks, **shutdown**
- Japan
 - Monju – sodium fire, fuel rod problem, **shutdown**
- France
 - Phenix – technical problems, **shutdown**
 - Superphenix - technical problems, **shutdown**
- Russia
 - BN-350, BN-600 – many sodium fires
- India
 - FBTR – sodium leaks

RESEARCH QUESTION

- How a technology that has not achieved success on the usual measures
 - Economics, technological progress, safety, security
- Continues to receives funding and political support after 70 years experience in multiple countries?



SCIENCE AND TECHNOLOGY STUDIES INSIGHTS

- Technologies not divorced from the society in which they are embedded
 - Langdon Winner, Ruth Cowan
- Technologies do not “progress”
- Political forces shape which technologies succeed and fail
 - Donald MacKenzie
- Technologies can enact political goals
 - Gabrielle Hecht

RAISON D'ÊTRE FOR FAST REACTORS: A CHANGING STORY

- Initial period: 1946-mid 1970s
- Justification
 - Fast reactors essential for energy production: depletion of fossil fuels and increase in energy needs
 - Fast breeders needed because of uranium scarcity
- Dominance of powerful men
 - Walter Zinn, Milton Shaw, Glenn Seaborg
- Reconfiguration, mid-1970s-2000
 - External Events have high impact
 - International Security important
 - Connection to nuclear weapons
 - Environmental movement questioned safety, security, effectiveness
 - Cost of programs in US

RAISON D'ETRE FOR FAST REACTORS: A CHANGING STORY

- Renaissance, 2000-present

- Uranium abundant
- New set of justifications
 - Safety, reliability, economical
 - Waste minimization
 - Proliferation resistance
 - (Climate change)
- Gen IV International Forum, IAEA's INPRO, US GNEP

- Startup Culture, mid-2000s-present

- Private industry
- Dependent on venture capital
 - Has its limits
- Climate change, waste management central
- Modular designs


SECRETS OF “SUCCESS”

- No predetermined path forwards
 - Experience of US Navy
- Imaginary of containment – Atoms for Peace
 - Jasanoff and Kim, 2013
- Powerful symbol of modernity, progress, control over nature, global superiority
- Technological fantasy, fulfilling a vision in society
 - Sovacool and Ramana, 2014
- Imaginary technologies – idealized technology
 - Fjaestad, 2015
- Reaction to Seawolf:
- Fast reactors are “expensive to build, complex to operate, susceptible to prolonged shutdown as a result of even minor malfunctions, and difficult and time-consuming to repair.”



Admiral Hyman Rickover

FAST REACTORS EMBODY THE CREATION MYTH



Our children will enjoy in their homes electrical energy too cheap to meter.

(Lewis L. Strauss)

izquotes.com

Lewis Strauss, 1954 Speech

CONCLUSIONS

- Creation myth
 - Fast reactors are energy source that create their fuel
 - Perpetuated in nuclear engineering programs, other institutions
- Political power of fast reactors based on
 - Holy grail aspect
 - Connection to nuclear weapons
 - Solve nuclear waste, climate change, etc
- Now, goal of “advanced” reactors allow nuclear energy to retain a place in energy production, even as the existing fleet of light water reactors begins to fade away
- Resilience of fast breeder technology based on its creation myth, not its success in producing electricity



