

Nuclear Energy post Fukushima Daiichi

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Energy Production and Infrastructure Center

Outline

- ▶ Introduction
- ▶ Nuclear Consensus
- ▶ Fukushima Daiichi
- ▶ Perception vs. Reality
- ▶ New Nuclear
- ▶ Summary



EPIC's Mission

- ▶ Education for Engineers in Energy
- ▶ Research and Development
- ▶ Economic Development



Albert and Freeman
Energy Production and Infrastructure Center

2020 External Partnerships

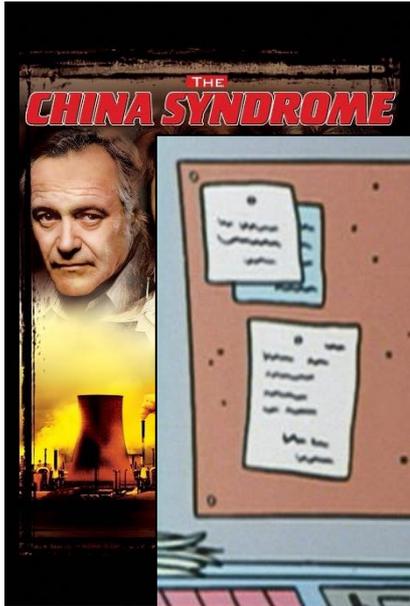


GODZILLA!

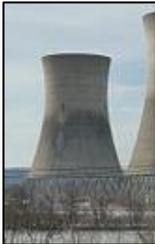
The fallout from the Castle Bravo Thermonuclear Explosion in 1954 is said to have led to the longest running horror movie franchise in history...



Hollywood LOVES Nuclear Energy, right?



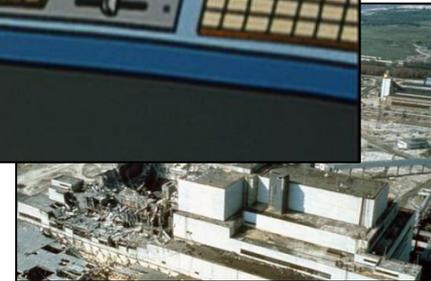
Three Mile Island (Level 5)



Fukushima Daiichi (Level 7)



Cimarron Nuclear Fuels Facility



Chernobyl (Level 7)

← → ↻ youtube.com/watch?v=m1GEPsSVpZY

☰ YouTube Search 🔍



Chernobyl Doctor Fact Checks the HBO Series | Vanity Fair

6,121,216 views • Sep 19, 2019

👍 140K 💬 1.9K ➦ SHARE 📌 SAVE ⋮

Ukrainian medical responder and radiation expert Alla Shapiro reviews the validity of the HBO series "Chernobyl." Alla shares some real-life on-site experiences to explain whether clips from the series are true to what actually happened on April 26th, 1986 and the days that followed.

Consensus on Nuclear Energy?

It depends on where you live...



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In the United States...



A carbon-free future is a nuclear future

by Rep Michael Burgess & Bud Albright

“Contrary to what Hollywood might have you believe, nuclear power is one of the safest and most reliable sources of energy in the world, producing approximately 20% of our nation's electrical power, and more than half of our nation's carbon-free energy. Despite these benefits, America's nuclear industry is at a crossroads: evolve into the 21st century or fade away for good. On this troubling issue, there is bipartisan agreement.”

- The environmental emergency of the second decade is now climate change.
- Zero emission energy sources that work 24 hours a day are suddenly important again.

Nuclear Power in Germany

(Updated December 2019)

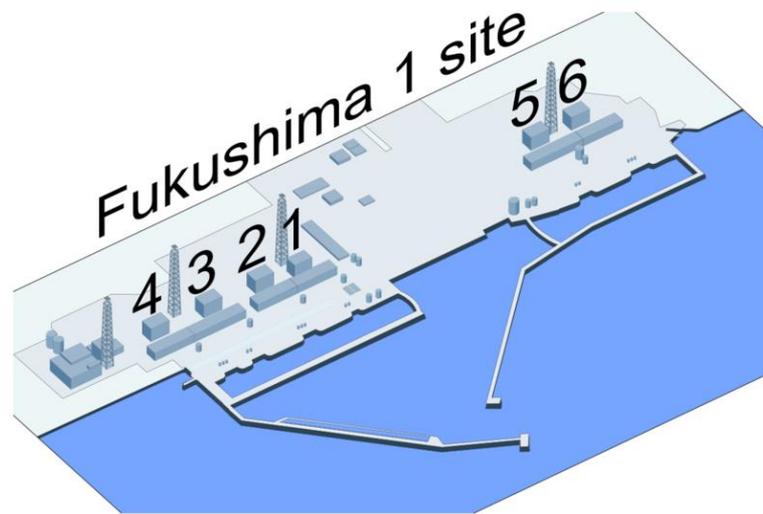
- Germany until March 2011 obtained one-quarter of its electricity from nuclear energy, using 17 reactors. The figure is now about 12% from seven reactors, while over 40% of electricity comes from coal, the majority of that from lignite.
- A coalition government formed after the 1998 federal elections had the phasing out of nuclear energy as a feature of its policy. With a new government in 2009, the phase-out was cancelled, but then reintroduced in 2011, with eight reactors shut down immediately.
- Public opinion in Germany remains broadly opposed to nuclear power with virtually no support for building new nuclear plants.
- Germany has some of the lowest wholesale electricity prices in Europe and some of the highest retail prices, due to its energy policies. Taxes and surcharges account for more than half the domestic electricity price.



German nuclear power units

Plant	Type	MWe (net)	Commercial operation	Operator	Provisionally scheduled shutdown 2001	2010 agreed shutdown	March 2011 shutdown & May 2011 closure plan
Gundremmingen C	BWR	1288	1/1985	RWE	2016	2030	2021
Grohnde	PWR	1360	2/1985	E.ON	2017	2031	2021
Brokdorf	PWR	1370	12/1986	E.ON	2019	2033	2021
Isar 2	PWR	1400	4/1988	E.ON	2020	2034	2022
Emsland	PWR	1329	6/1988	RWE	2021	2035	2022
Neckarwestheim 2	PWR	1305	4/1989	EnBW	2022	2036	2022
Total operating (6)		8052					

Direct
consequence of
Fukushima Daiichi
accident



Fukushima Daiichi

1. March 11, 2011 the most powerful earthquake in modern Japanese history occurred off shore: **The Great Tōhoku Earthquake.**
2. This caused a deadly tsunami to sweep the mainland: **15,899 deaths (none of these due to the nuclear accident).**
3. At Fukushima Daiichi (“number 1”) nuclear station, the earthquake strength was less than the “design basis” meaning: **the reactors shut down automatically and no damage rated above a Level 0 accident occurred.**
4. But the largest tsunami wave was 13-14 m at this location, and it swept over the seawall to flood rooms below reactors 1-4: **emergency generators to power cooling pumps could not operate.**
5. Reactor cores and spent a fuel pool overheated, three core melted down and **radioactive materials were released into the air and water equivalent to a Level 7 accident.**
6. No immediate deaths due to radiation exposure occurred, although there were deaths during the evacuations: **The principal loss was economic and land use, not human life.**

The principal “fall out” was political

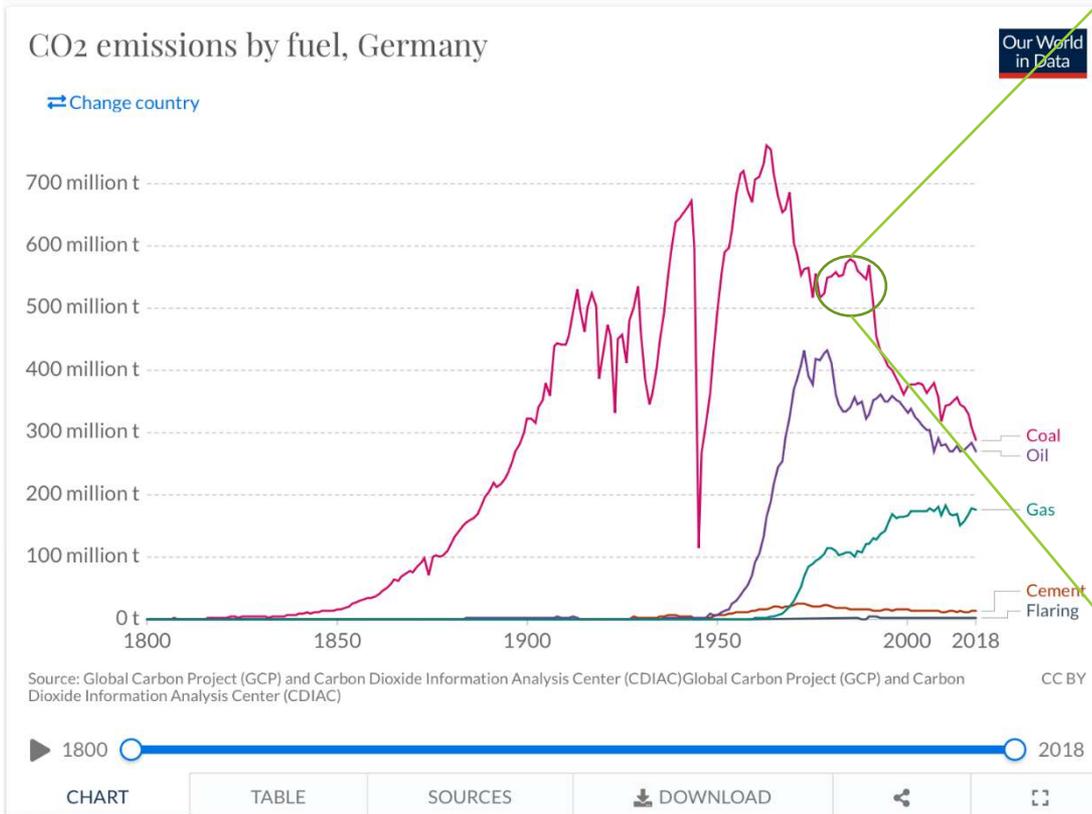


Protest against nuclear power in Cologne, Germany on 26 March 2011

And increased carbon dioxide emissions

Germany: How are CO₂ emissions from different fuels changing?

At least 2.7 Reichstag Buildings worth of solid carbon emitted into the atmosphere



Perception versus Reality



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Do you think about nuclear energy like this?



Or like this?



Aurora power station, Oklo Power LLC

Do you think about wind energy like this?



Or like this?



Demonstrators march through Dublin in opposition to energy plans

Do you think about solar energy
like this?



Or like this?



<https://www.ozy.com/news-and-politics/what-could-take-the-shine-off-of-solar-a-waste-problem/90308/>

New Nuclear



“

Nuclear plants across the country remain at risk of closing as they continue to face economic challenges. State policymakers in New Jersey, along with Connecticut, Illinois and New York, have acted to recognize the carbon-free attribute of nuclear energy.

- Maria Korsnick, President and CEO, NEI

”

- Existing nuclear plants economically threatened by wholesale markets
- Carbon free nuclear energy is essential for meeting most state government mandated low or zero-carbon goals by 2035
- Nuclear is increasingly being included in clean energy policy



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Future Nuclear Plant Construction

Challenge

In the U.S., construction costs are too high and timelines are unreliable.

- Approximate capital costs for NPP:

U.S.	\$12,000/kW
France/Finland	\$10,000/kW
UK	\$7,000/kW (rising)
UAE/Japan	\$4,000/kW
Korea	\$3,000/kW
China	<\$2,000/kW

Presented at the Oct. 2018 meeting of the Piedmont Chapter of the American Nuclear Society by Armond Cohen, Chair of EPRI's Advisory Council

Vision: "Advanced Construction"

Apply advanced manufacturing strategies to the overall NPP construction, fabrication, assembly process.

- "More than 50% of costs are civil works"
(Tim Schmitt, Engineering Supervisor for Civil Analysis, and Carl Fisher, VP for Products and Engineering, Framatome, meeting at EPIC, Nov. 1, 2018)

Approach

Build the airplane, not the airport.

Why?

New nuclear generation will operate in a new grid environment.

- Smaller reactors = many more of them
- Integration of renewables demands variable output and cost competitiveness



Build the airplane, not the airport.

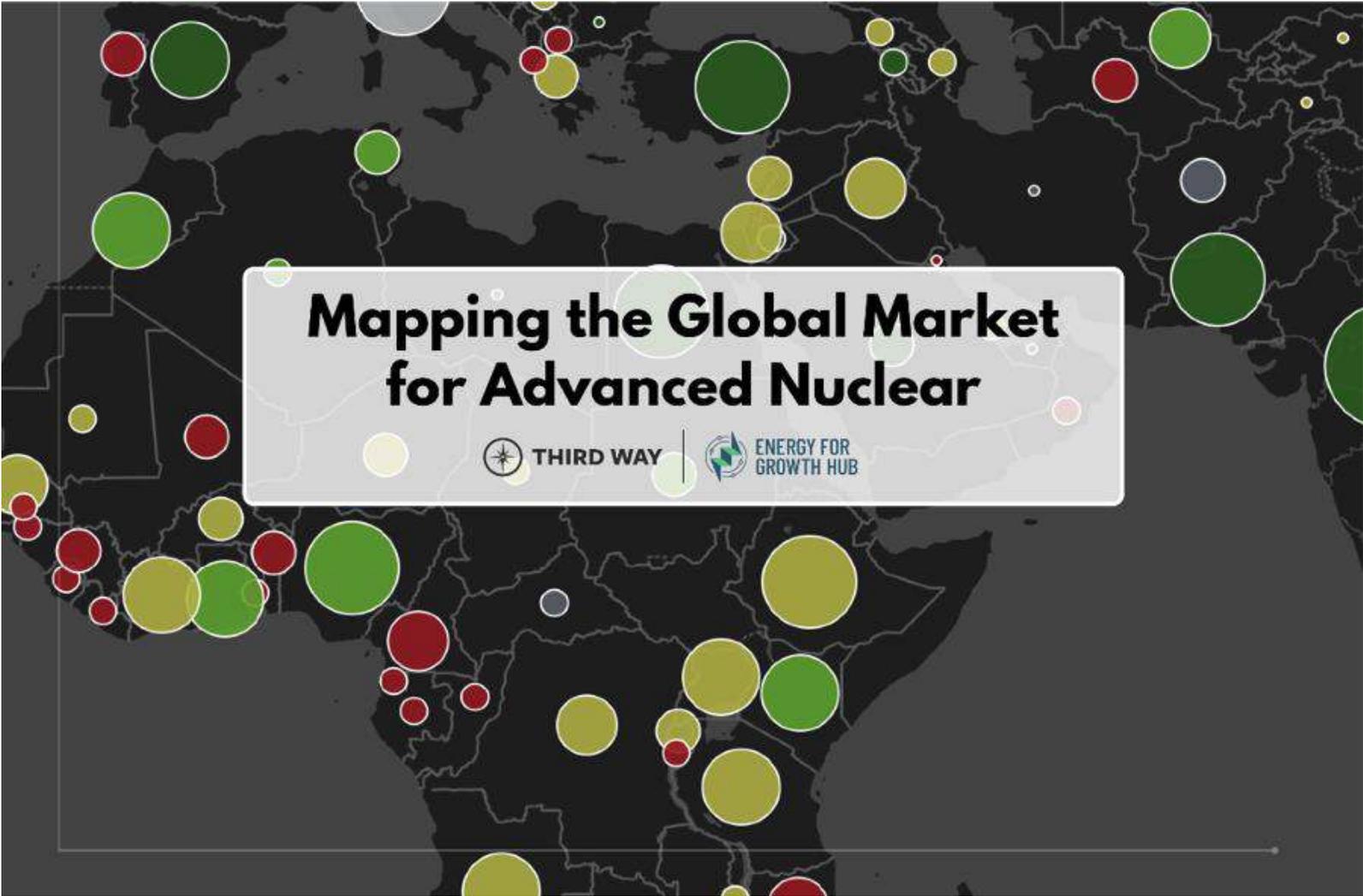
Characterized by:

- All digital design
- Automated component production by supply chain
- Repeatable component dimensions
- Reliable assembly by OEM
- Cost competitive
- High production rates
- Achieved in a regulated environment designed for safety

Characterized by:

- Single design (no two airports alike)
- Local fabrication
- No complete digital design
- Diminishing supply chain





Mapping the Global Market for Advanced Nuclear



THIRD WAY



ENERGY FOR
GROWTH HUB



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Summary

- Fukushima Daiichi nuclear accident complicated support for civilian nuclear energy
- Climate change consensus is the force pushing back on old-style antinuclear alliances
- Advanced nuclear reactors will be safer, cheaper, and is an industry American entrepreneurship is building

