EXPLOSIVE GROWTH IN THE URANIUM PRICE: IS NUCLEAR BACK?

Nucleus Wealth

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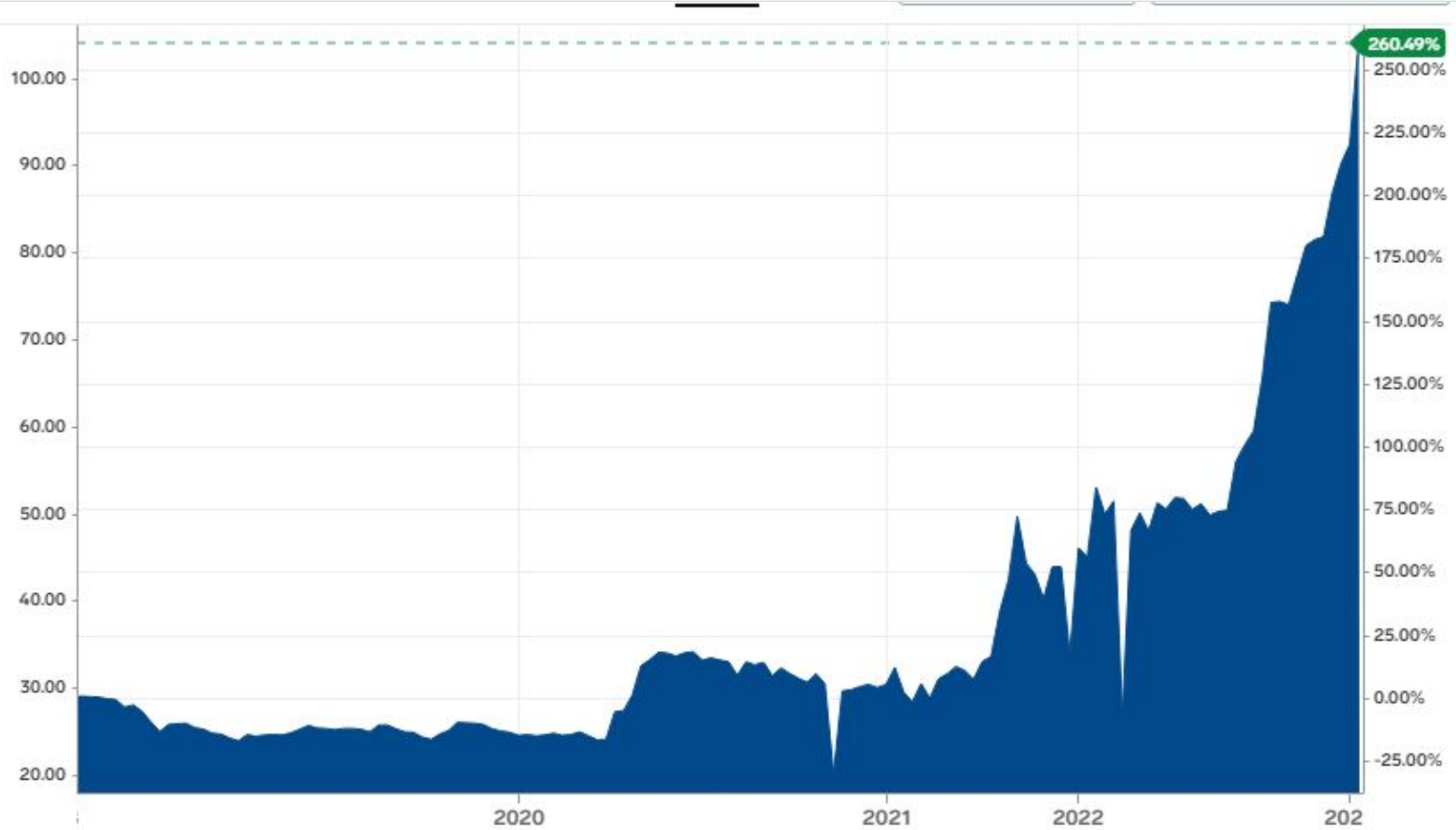
Agenda:

- What is going on with the uranium price
- The case for/against Nuclear
- Uranium mining cost structure
- Demand/Supply
- Investment implications

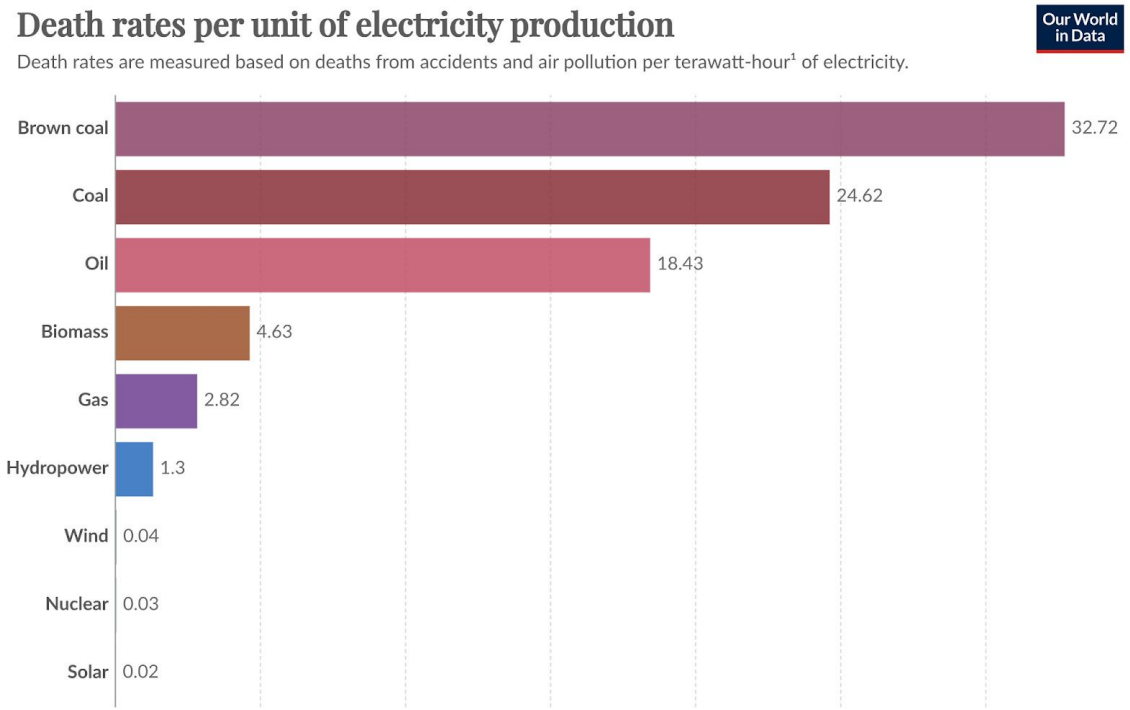
Uranium cracks $100:



The case for:

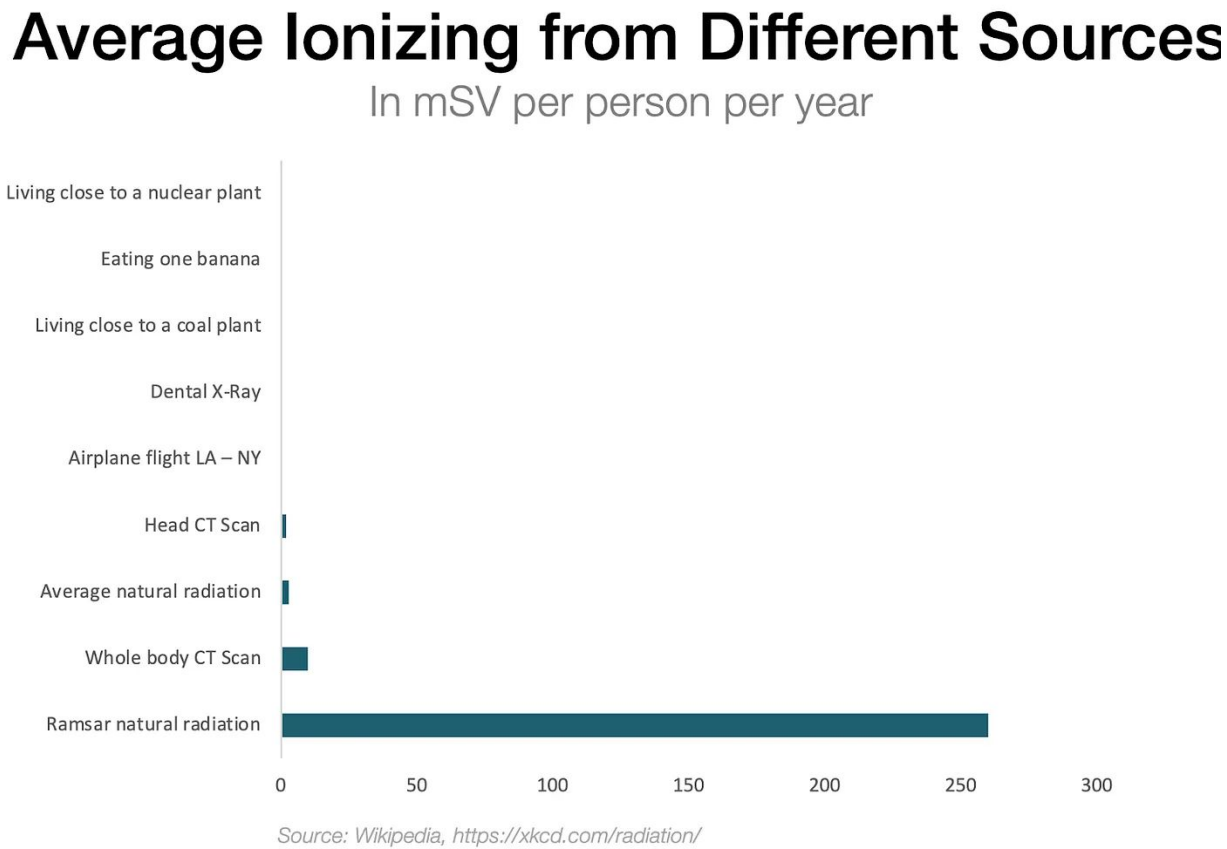
- Taken from Thomas Pueyo https://unchartedterritories.tomaspueyo.com/p/why-nuclear-is-the-best-energy
-

The case for: Safety

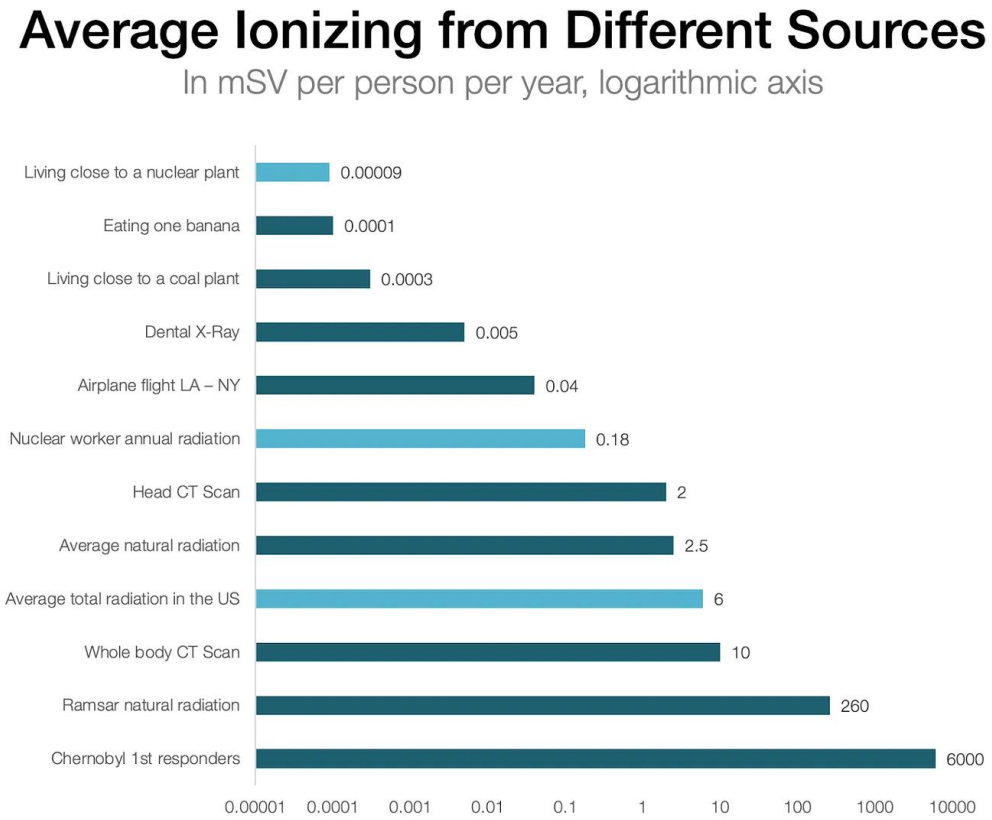


1. Watt-hour: A watt-hour is the energy delivered by one watt of power for one hour. Since one watt is equivalent to one Joule per second, a watt-hour is equivalent to 3600 Joules of energy. Metric prefixes are used for multiples of the unit, usually: - kilowatt-hours (kWh), or a thousand watt-hours. - Megawatt-hours (MWh), or a million watt-hours. - Gigawatt-hours (GWh), or a billion watt-hours. - Terawatt-hours (TWh), or a trillion watt-hours.

The case for: Safety

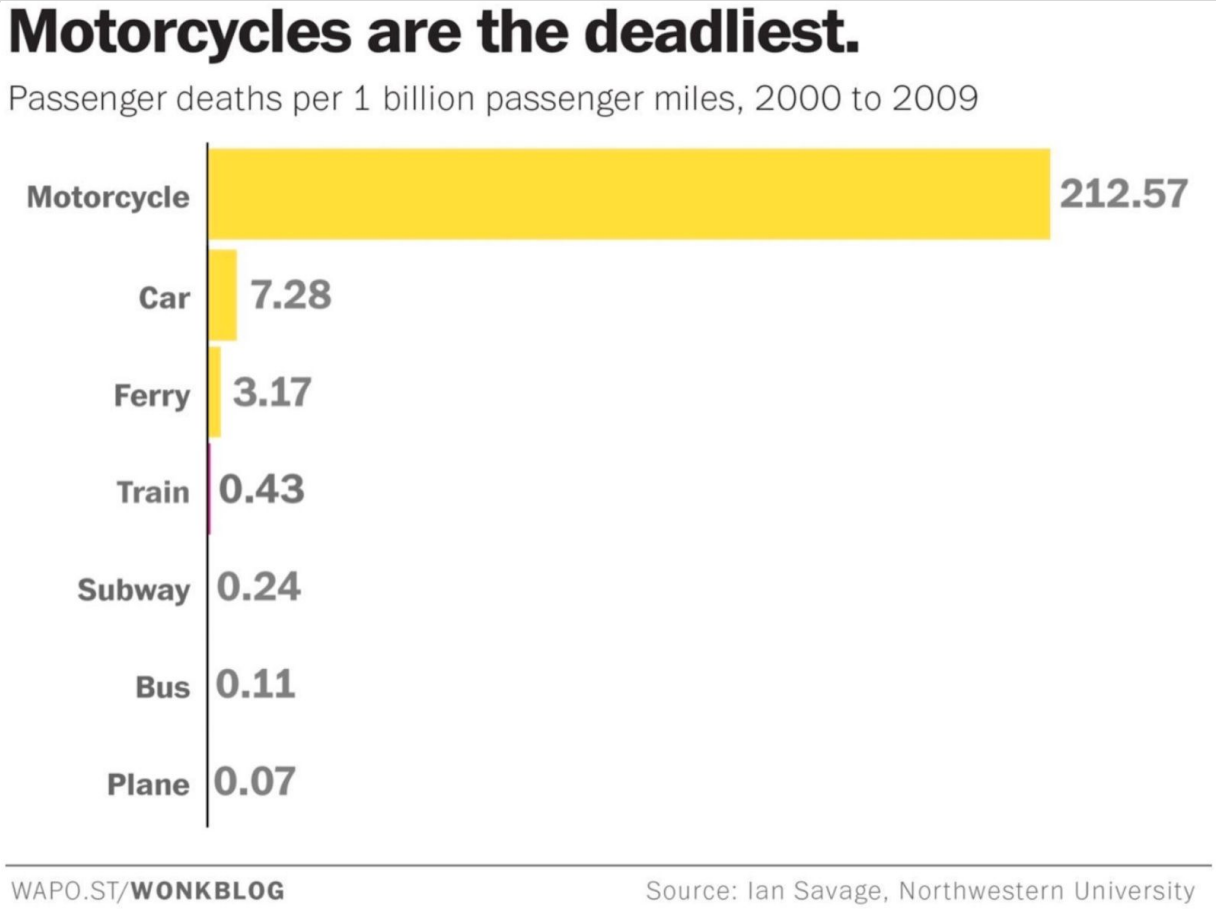


The case for: Safety

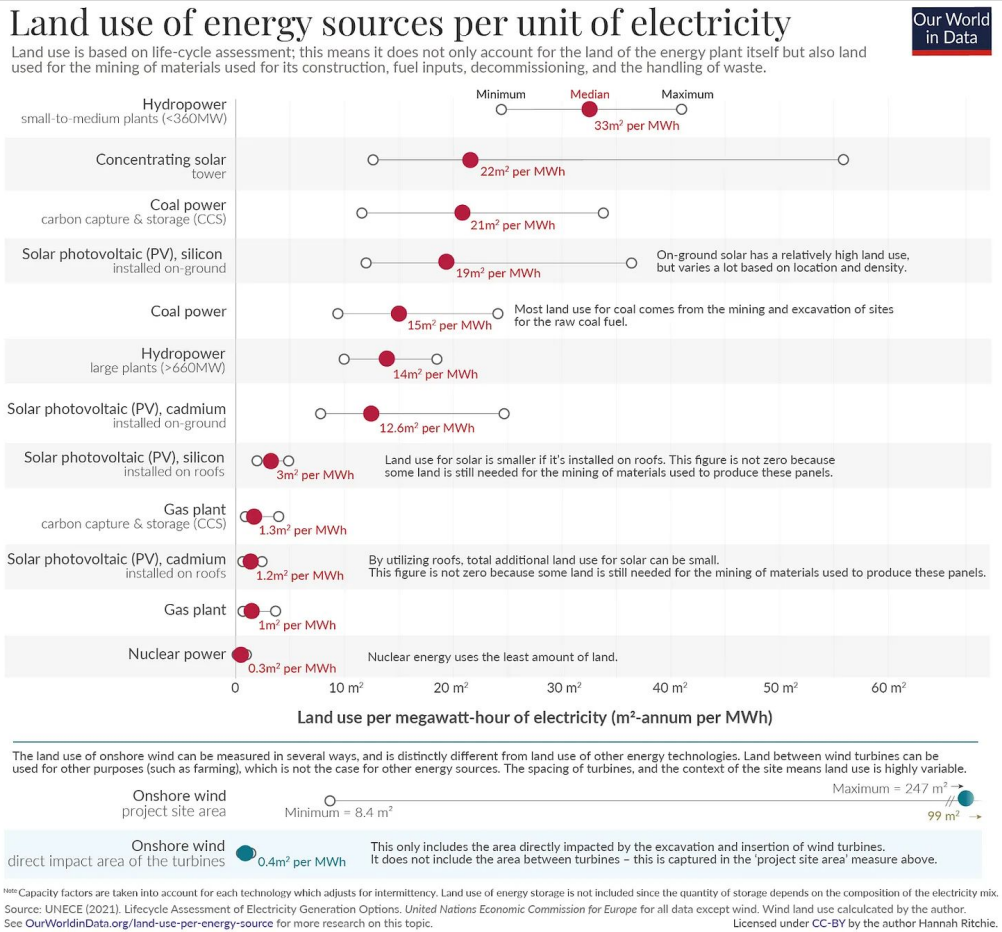


Note: All data is per year, except for Chernobyl, which was in a few hours.
Source: Wikipedia, https://xkcd.com/radiation/

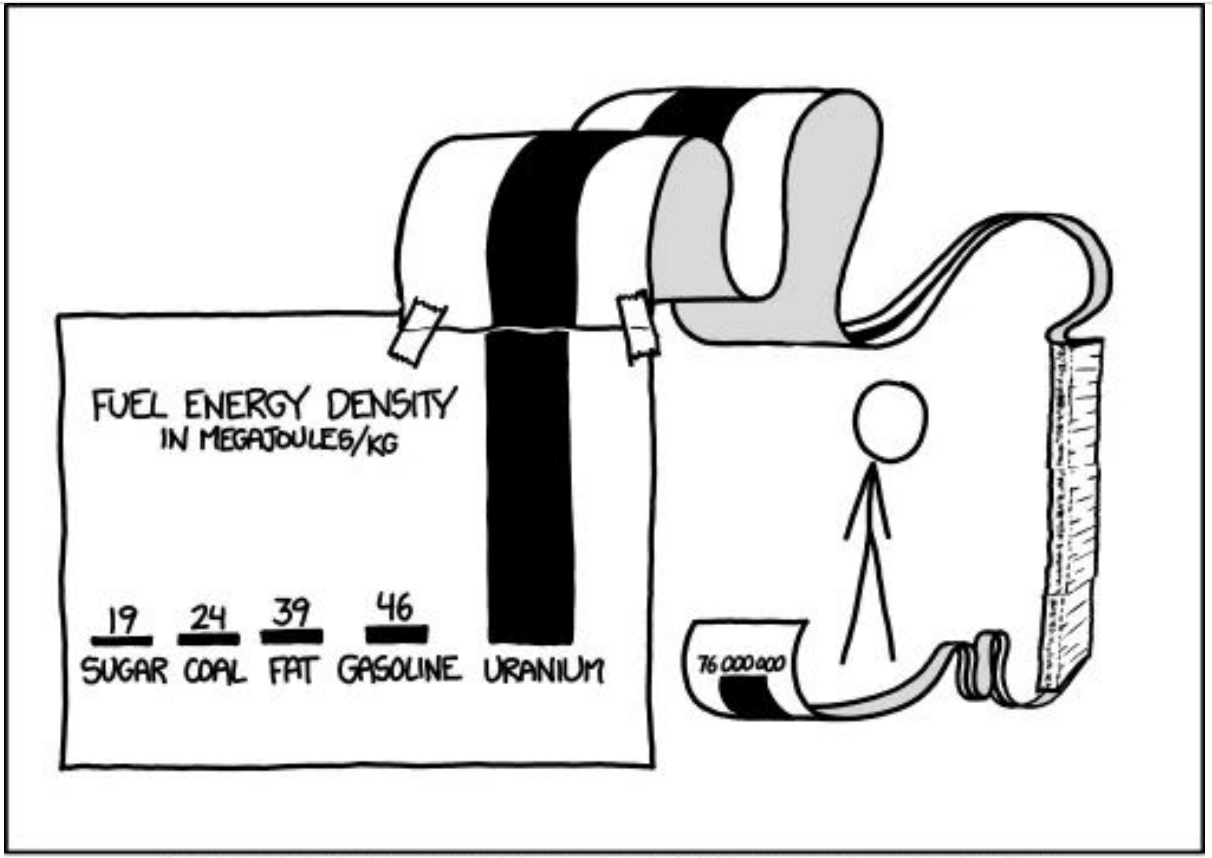
The case for/against: Safety



The case for: Environmental

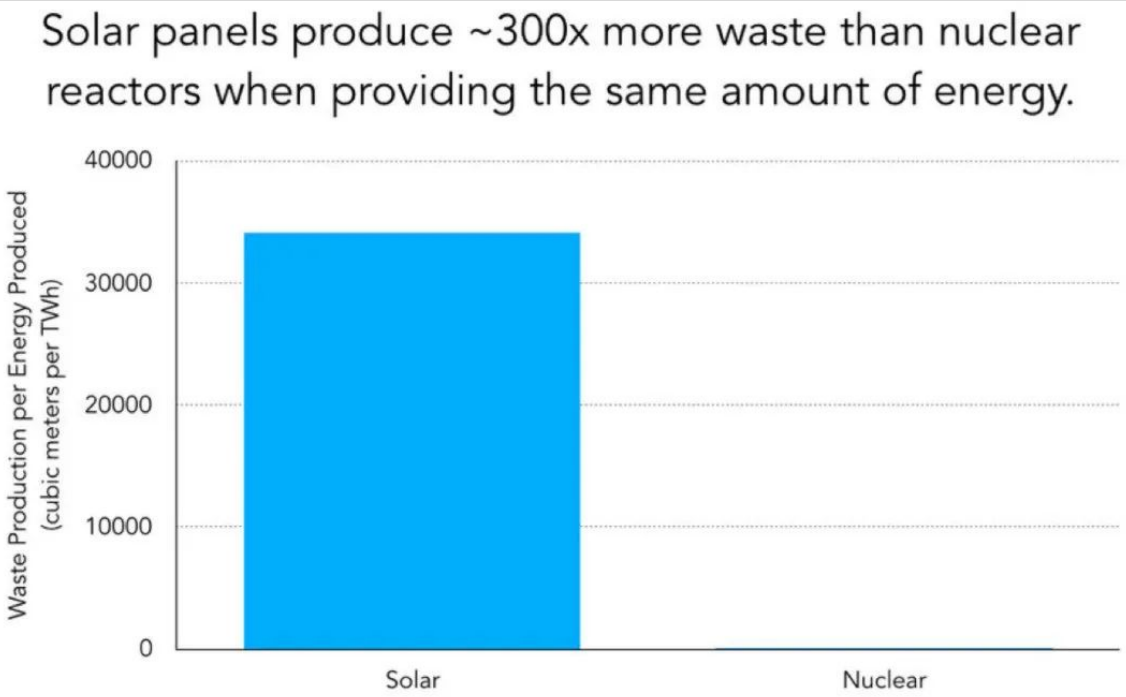


The case for: Environmental



SCIENCE TIP: LOG SCALES ARE FOR QUITTERS WHO CAN'T FIND ENOUGH PAPER TO MAKE THEIR POINT *PROPERLY.*

The case for: Environmental

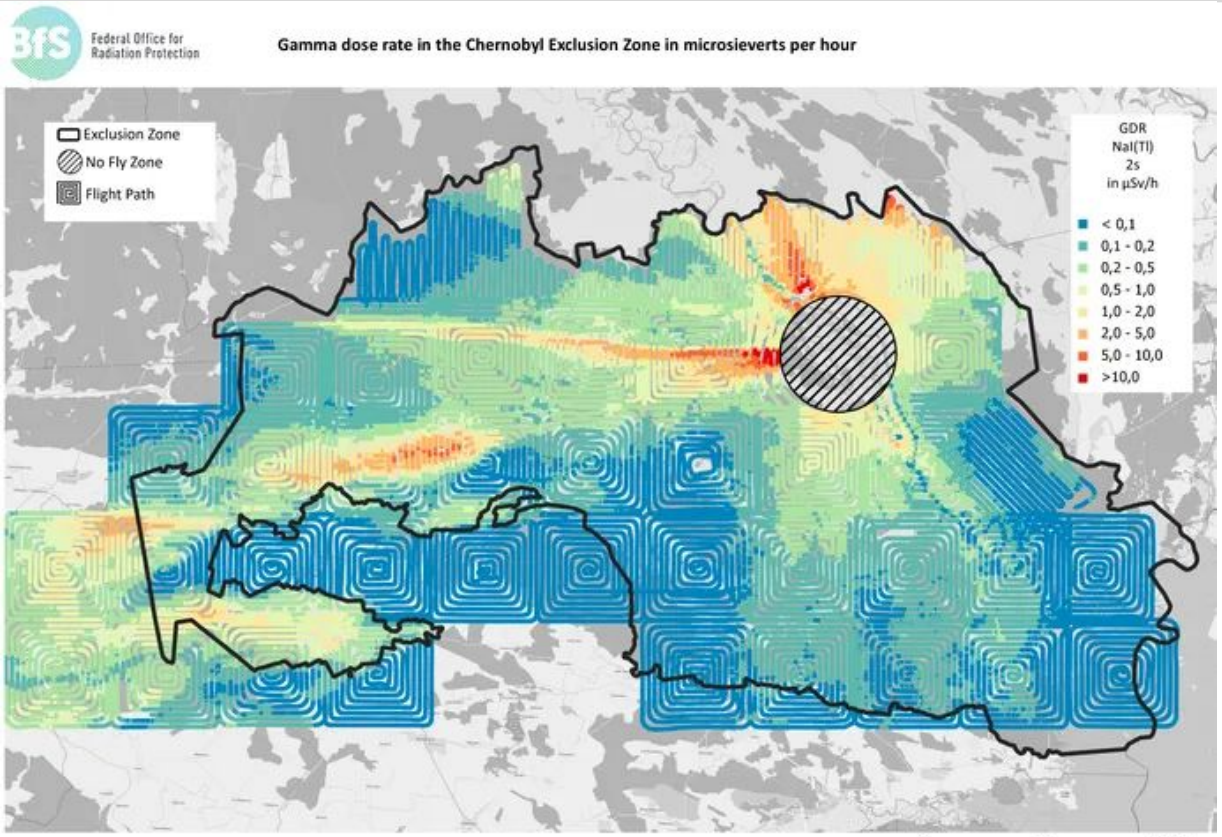


Sources and Notes:
US GAO, http://www.gao.gov/key_issues/disposal_of_highlevel_nuclear_waste/issue_summary
World Nuclear Association, http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/radioactive-waste-management.aspx
http://www.world-nuclear.org/information-library/facts-and-figures/world-nuclear-power-reactors-archive/reactor-archive-december-2015.aspx
IAEA, https://www.iaea.org/PRIS/home.aspx
BP, http://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

Solar panels specifications vary. Panel specifications were standardized according to TrinaSolar's Duomax Dual Glass 60-Cell Module:
http://static.trinasolar.com/sites/default/files/PS-M-0474%20A%20Datasheet_Duomax_PEG5.XX_US_Feb_2017_A.pdf

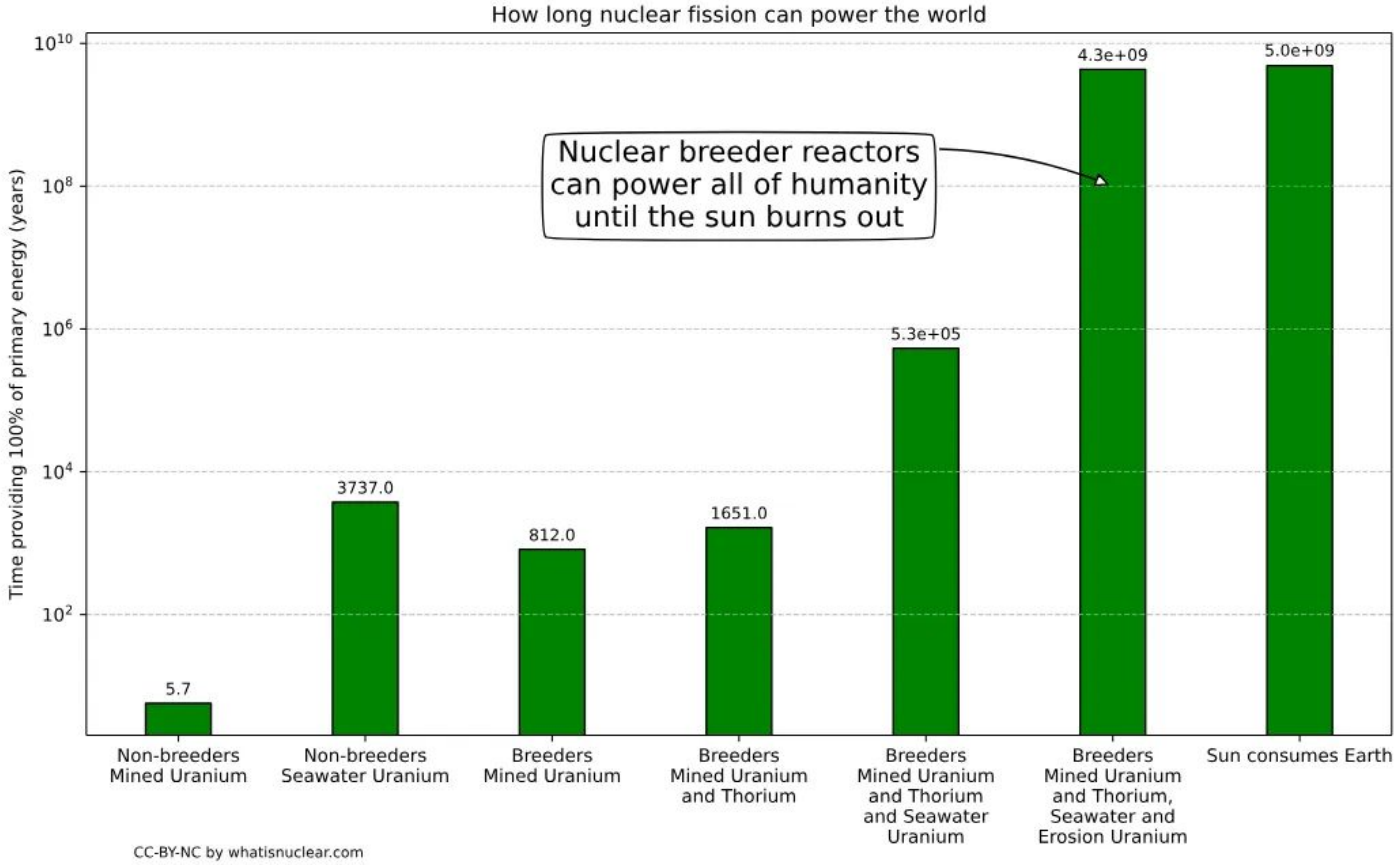
ENVIRONMENTAL PROGRESS

The case for/against: Environmental

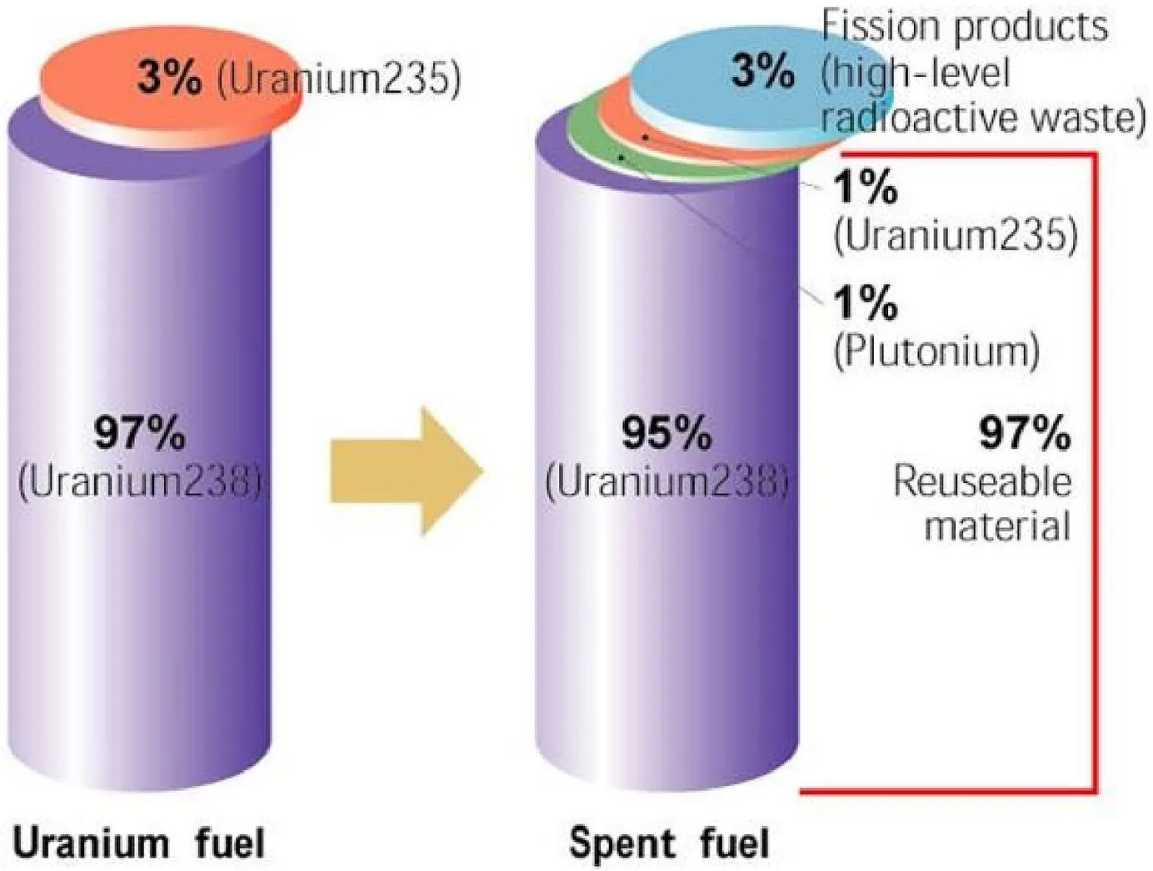


© BfS | Measurements as of September 2021 **Local gamma dose rate in the Ukrainian part of the Chernobyl exclusion zone in microsieverts per hour. The two-second measurement spectra recorded with sodium iodide scintillation detectors (NaI(Tl)) were evaluated.**

The case for: Sustainability



The case for: Sustainability



The case for: Reliability

Figure 1.1. **Global distribution of identified recoverable conventional uranium resources**

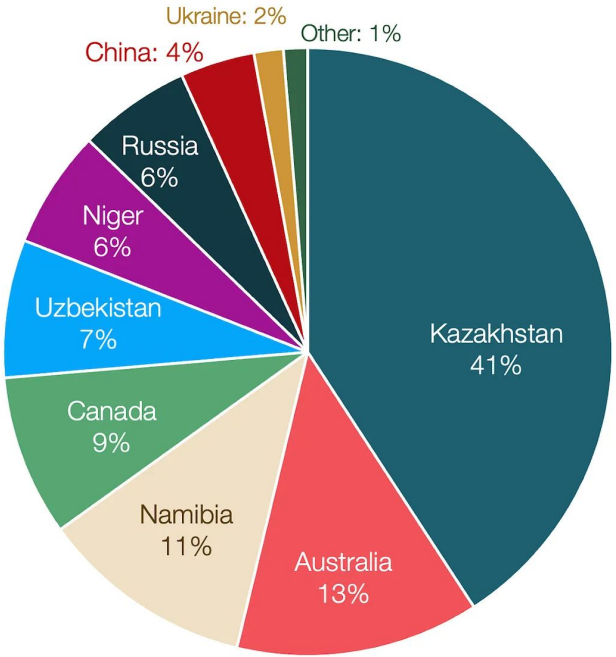
(<USD 130/kgU as of 1 January 2021)

* Secretariat estimate or partial estimate.

The global distribution of identified recoverable conventional uranium resources in the <USD 130/kgU cost category among 15 countries, which are either major uranium producers or have significant plans for growth of nuclear generating capacity, illustrates the widespread distribution of these resources. Together, these 15 countries are endowed with 95% of the global resource base as specified above (the remaining 5% are distributed among another 24 countries). The widespread distribution of uranium resources is an important geographic aspect of nuclear energy in light of security of energy supply.

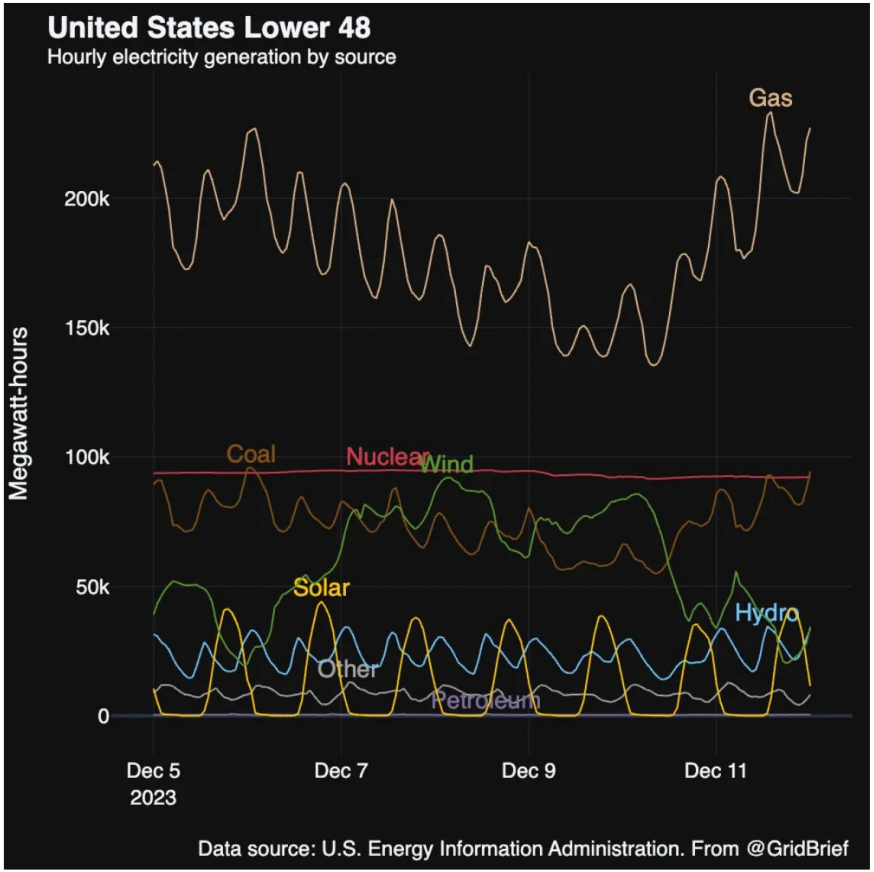
The case for: Reliability

Uranium Production by Country

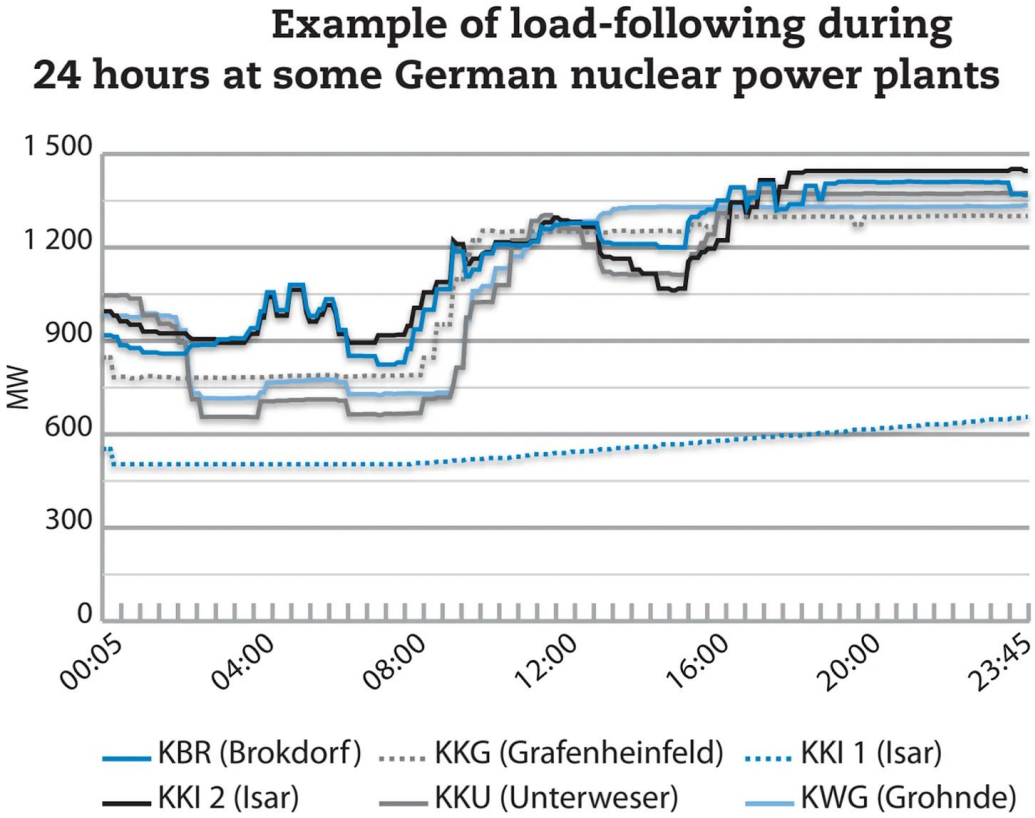


Source: World Mining Data,
via https://wisevoter.com/country-rankings/uranium-production-by-country/

The case for: Reliability

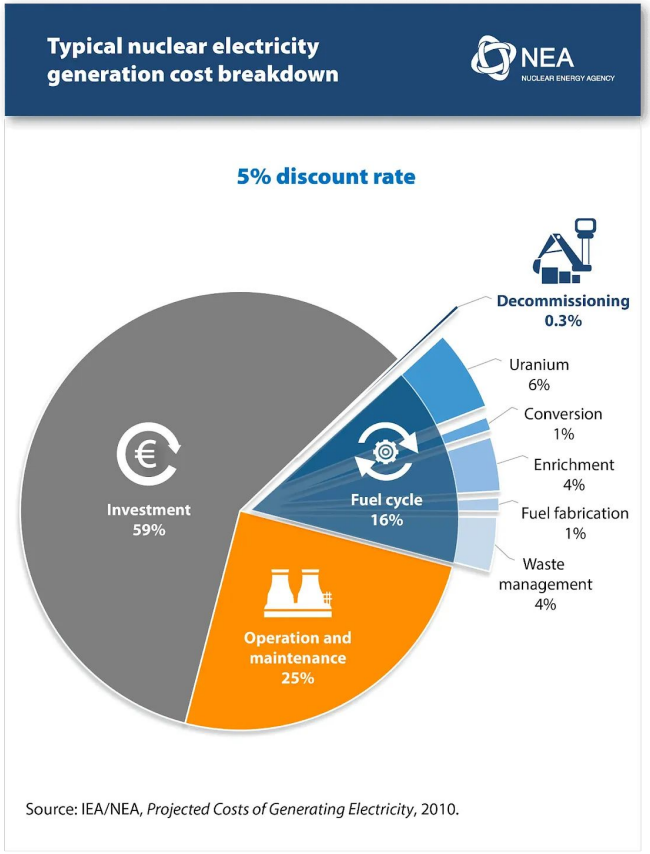


The case for: Reliability

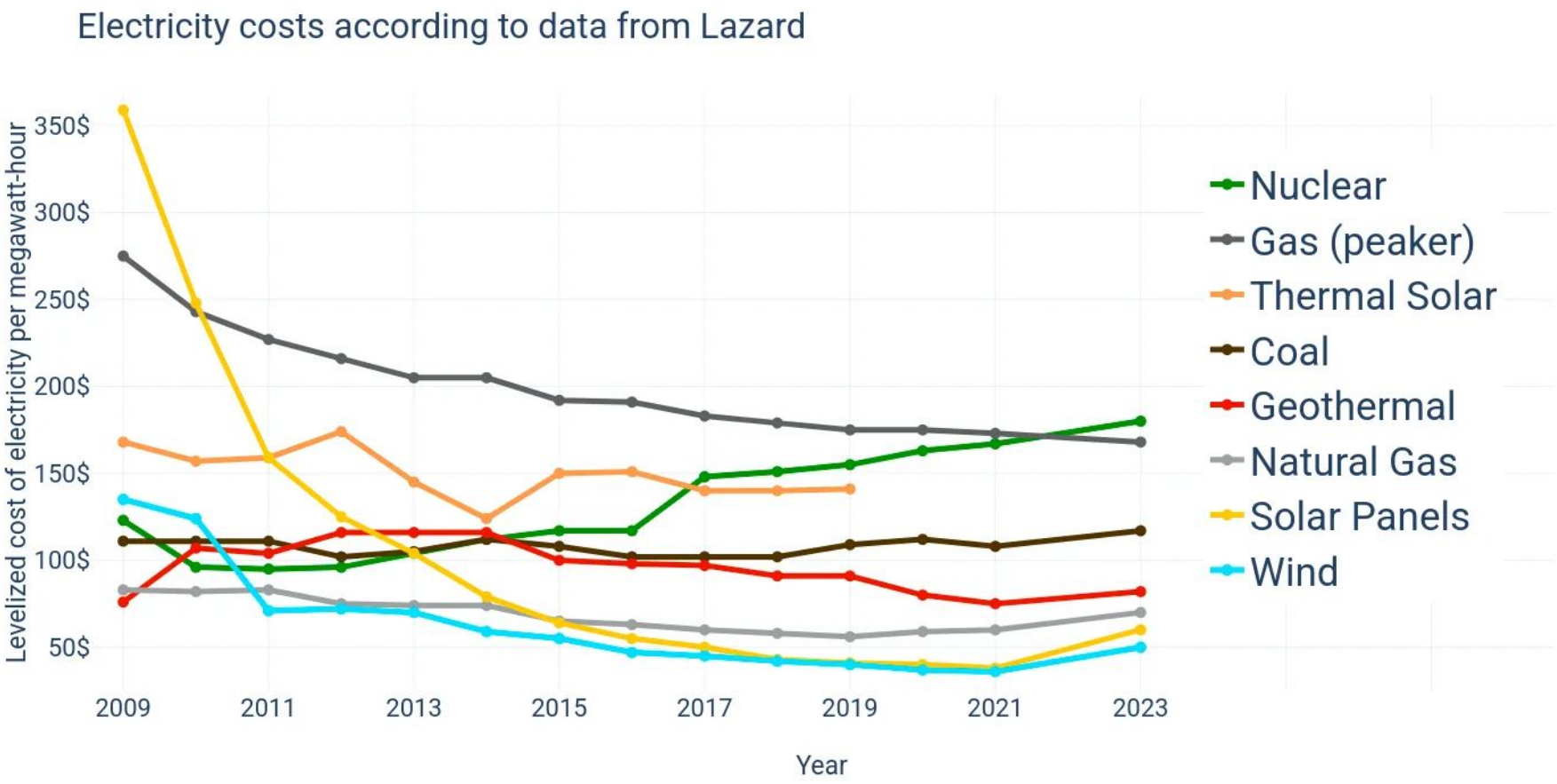


Courtesy of E.ON Kernkraft.

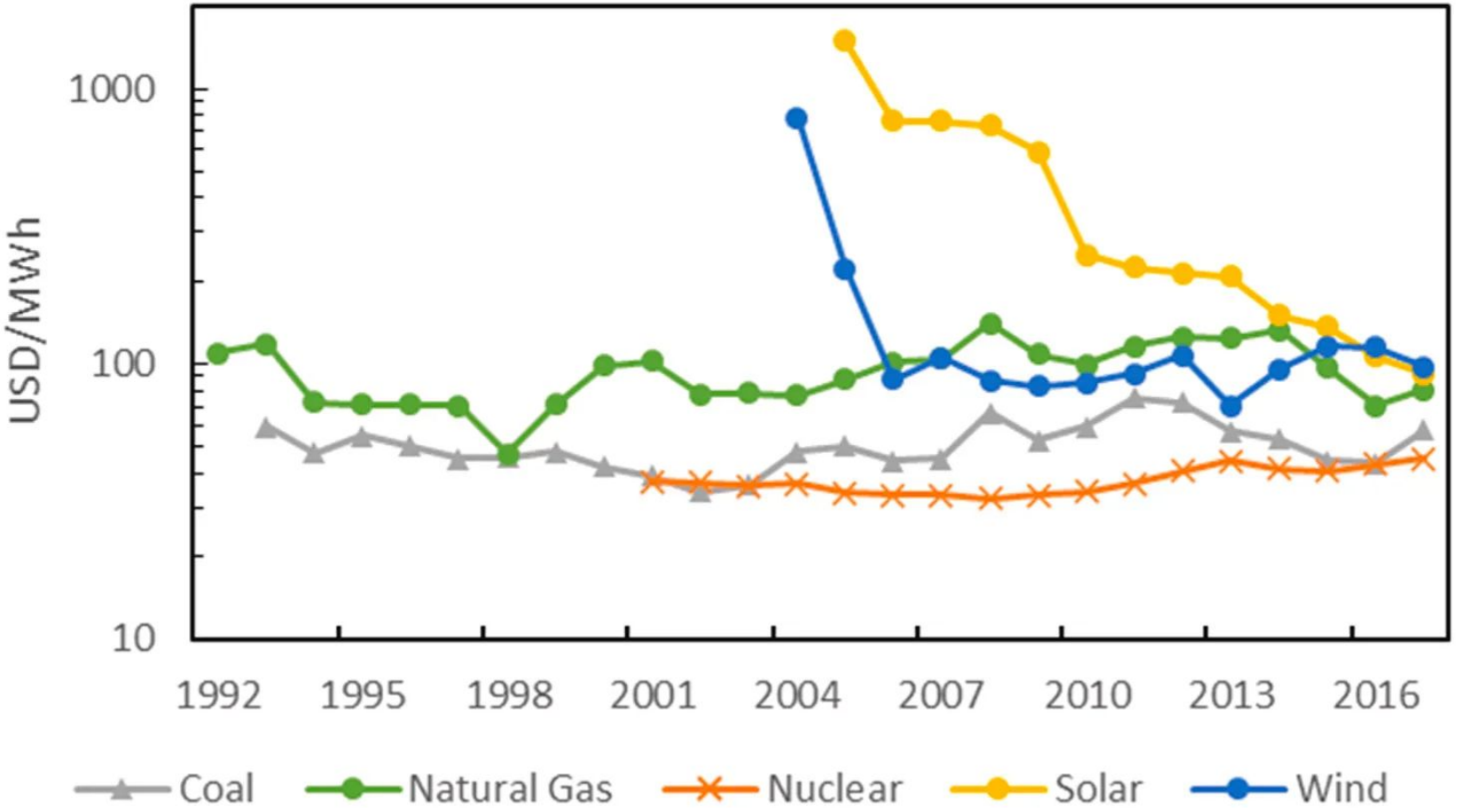
The case for: Stability



The case for/against: Economics



The case for: Economics



The case for: Economics

India's new nuclear reactors are cheaper than solar

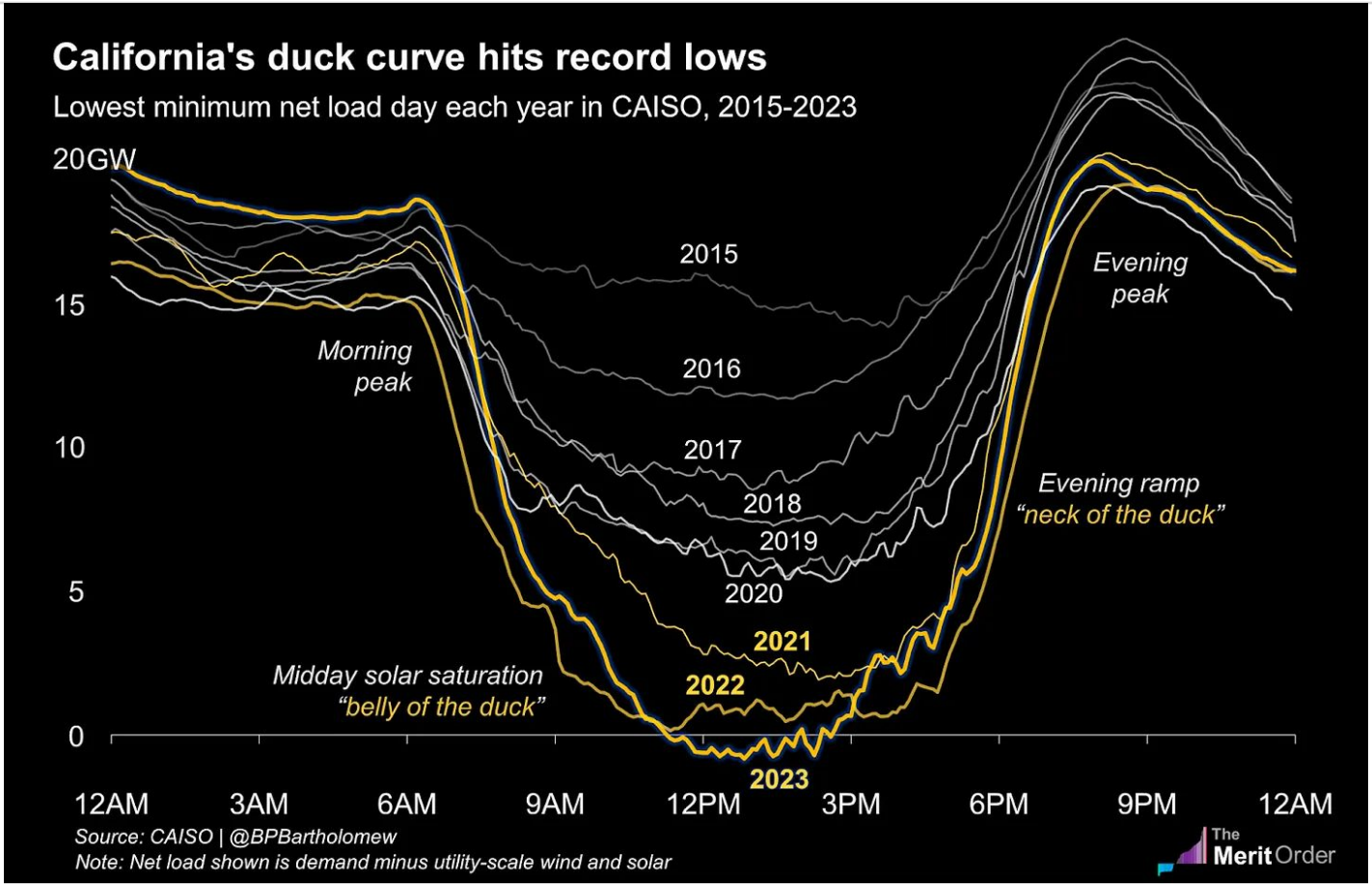
	Build Cost* (billions)	Capacity in MW	Capacity Factor (Est.)	Annual Electricity (Capacity×CF×365×24)	Build Cost per kWh
Kakrapar 3 & 4 nuclear reactors GUJARAT	$2.44 B	1,400	90%	11,038 GWh	**$0.22**
Bhadla Solar Park RAJASTHAN	$1.40 B	2,250	25%	4,928 GWh	**$0.28**
Pavagada Solar Park KARNATAKA	$2.20 B	2,050	25%	4,490 GWh	**$0.49**
Kurnool Ultra Mega Solar Park ANDHRA PRADESH	$0.88 B	1,000	25%	2,190 GWh	**$0.40**

*Sources

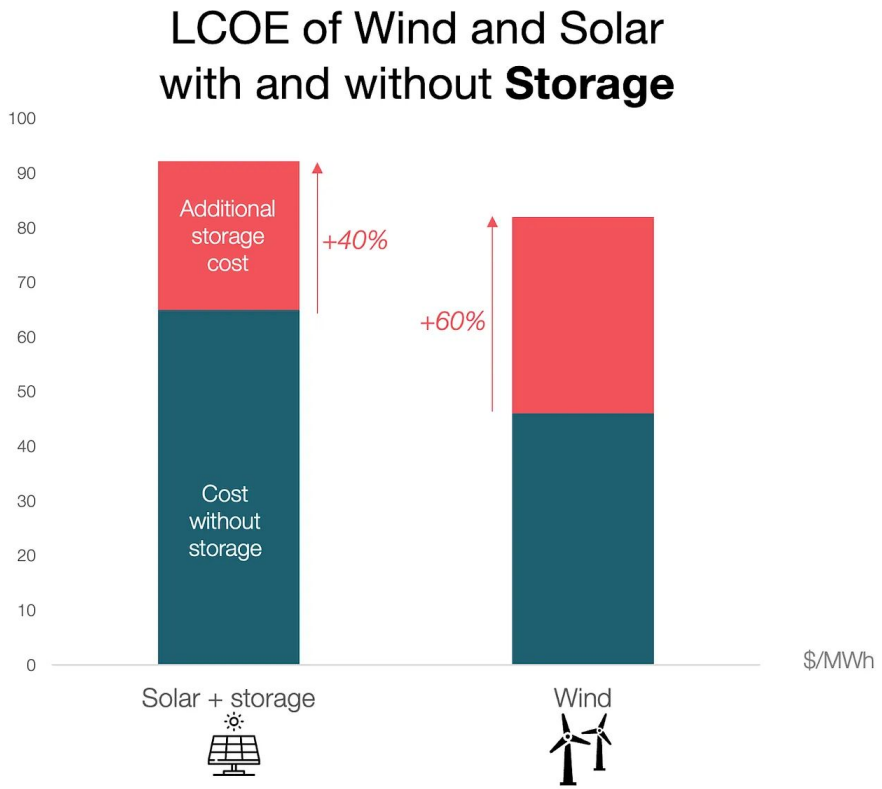
1. Ministry of Statistics and Programme Implementation, Govt. of India http://www.cspm.gov.in/ocmstemp/PROJ_SUMMARY?prcd=N02000010&stat=O
2. NS Energy https://www.nsenergybusiness.com/projects/bhadla-solar-park-rajasthan/
3. Tumkur district, Govt. of Karnataka https://tumkur.nic.in/en/solar-park/
4. *The Hindu*, "With Kurnool solar park, State takes a giant leap"

AUTHOR Aravindh C.
@arvv

The case for: Economics



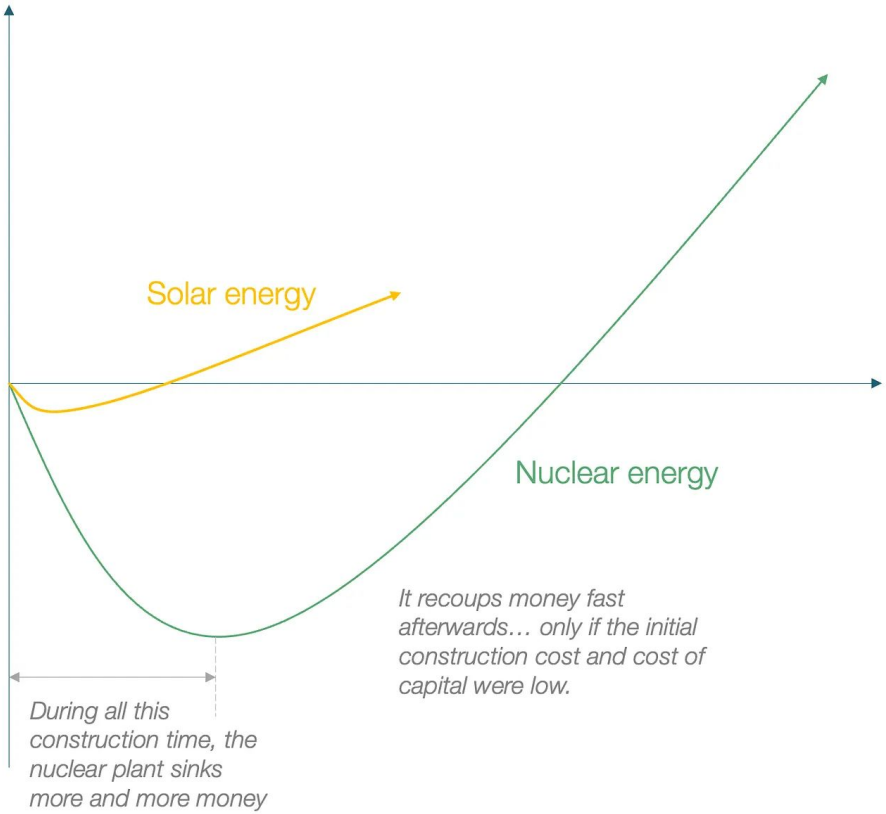
The case for: Economics



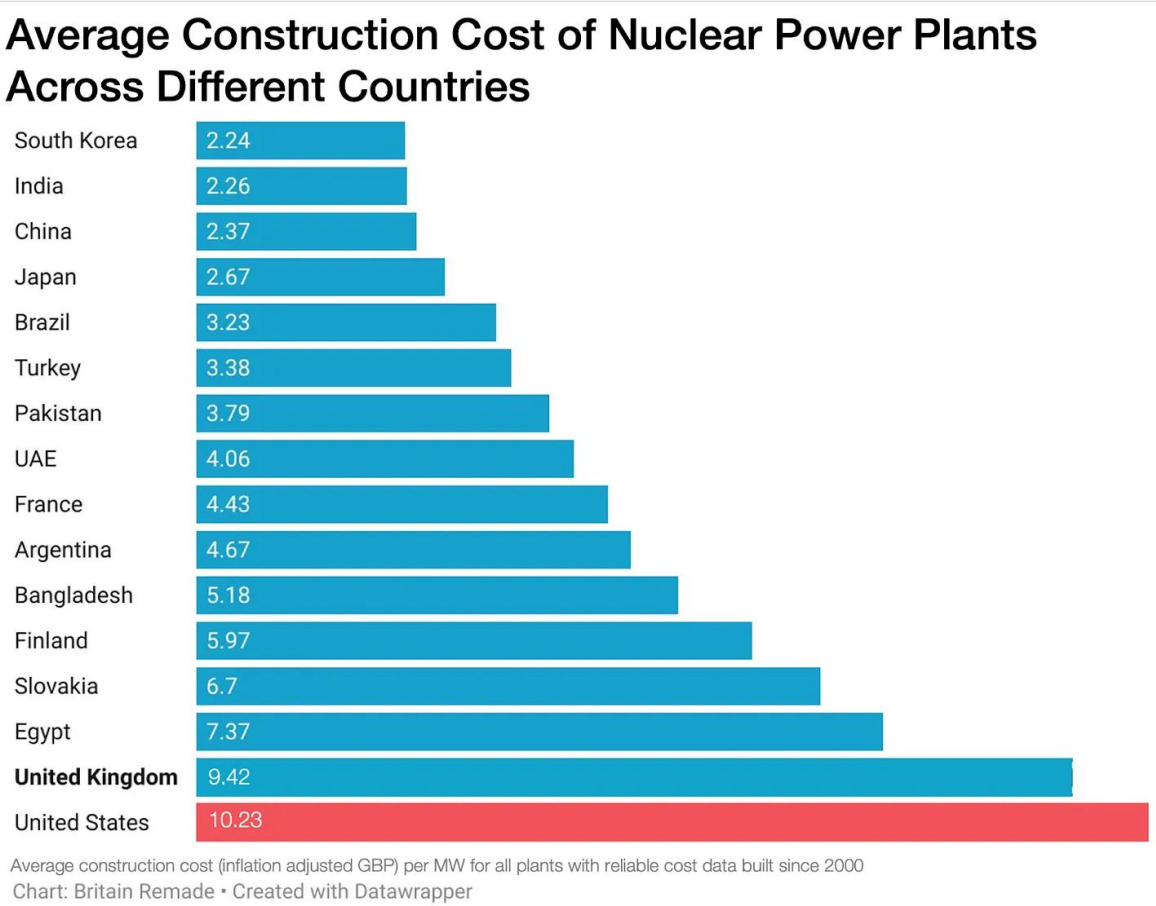
Note: Wind is onshore; solar is photovoltaic. Amounts are averages across different regional players, provided by Lazard. The teal baseline represents the unsubsidized costs here to control for subsidies.
Source: Lazard, https://www.lazard.com/media/2ozoovyg/lazards-lcoeplus-april-2023.pdf, https://twitter.com/energybants/status/1650331895492751360

The case for: Economics

Cash Flow Profile of Nuclear vs Solar Power Plants

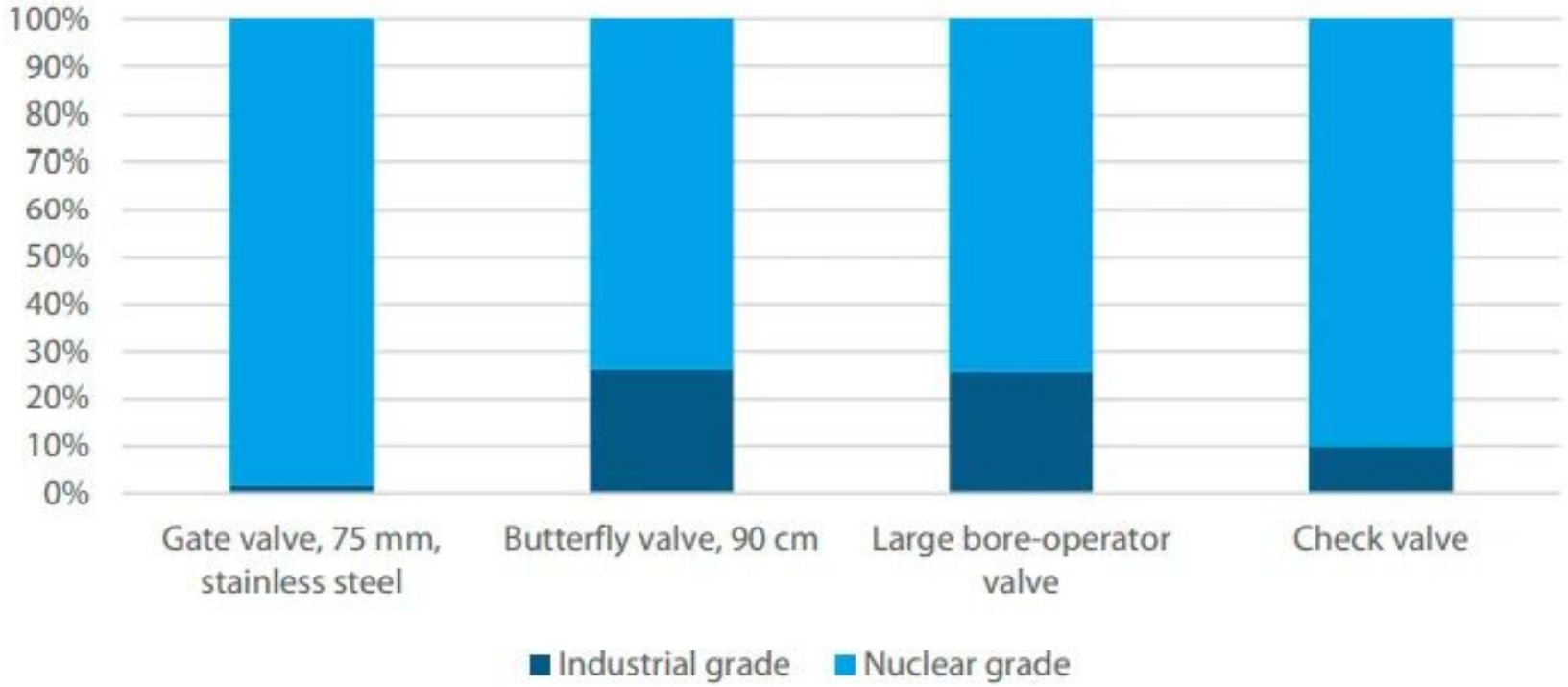


The case for: Economics

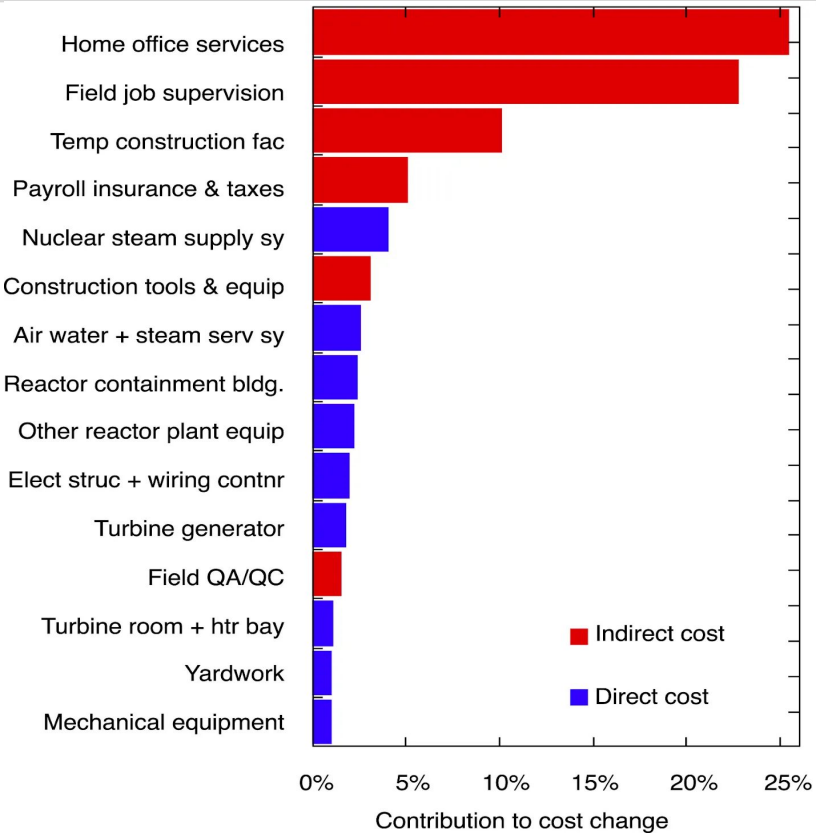


The case for: Economics

Figure 28: **Cost gap between nuclear- and industrial-grade valves**

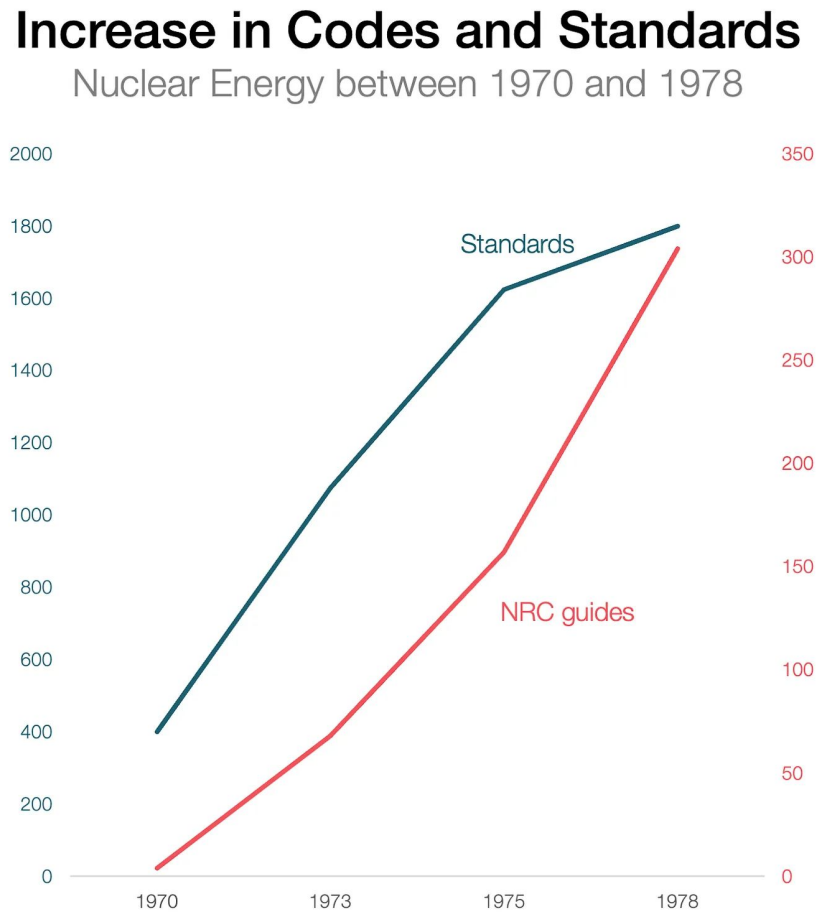


The case for: Economics

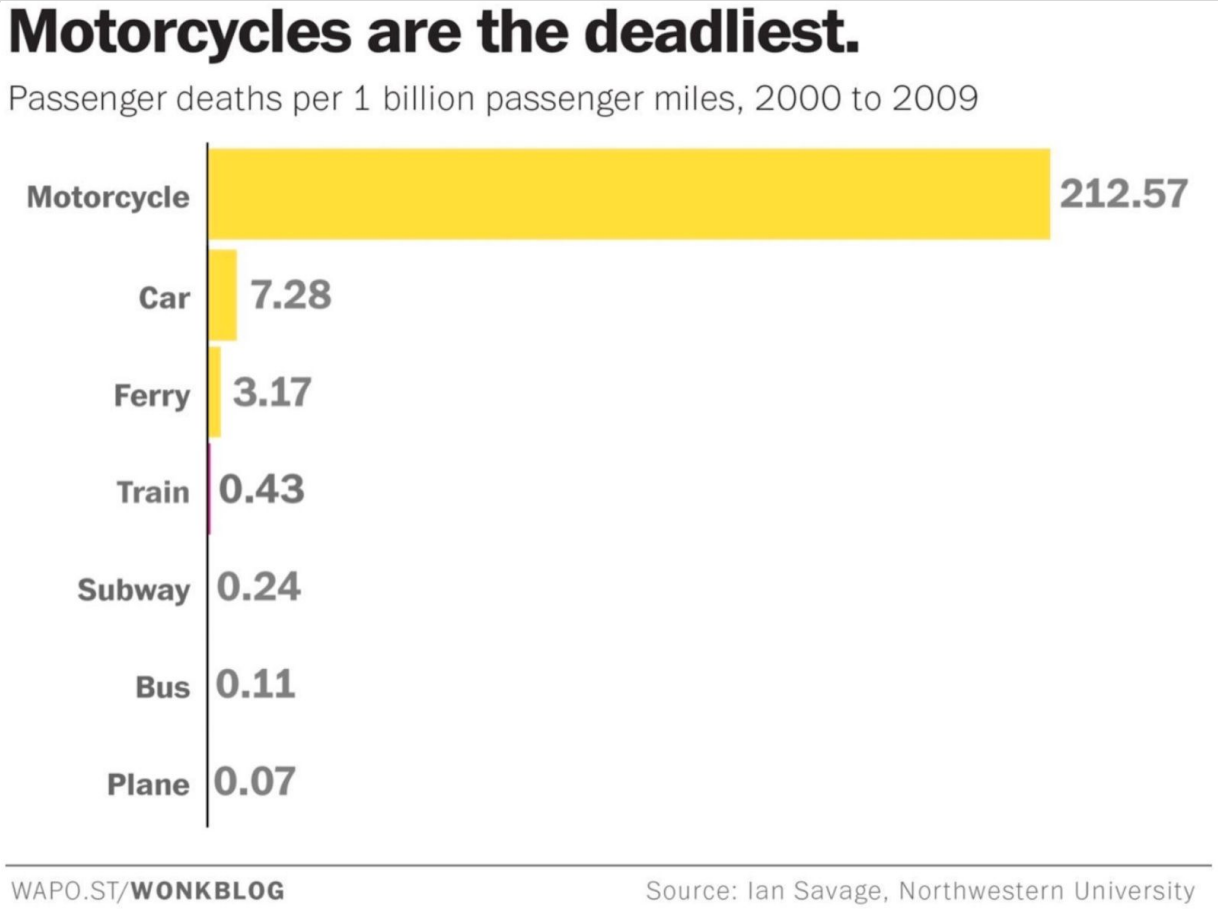


Change in cost for plants between 1976 and 1988. Source.

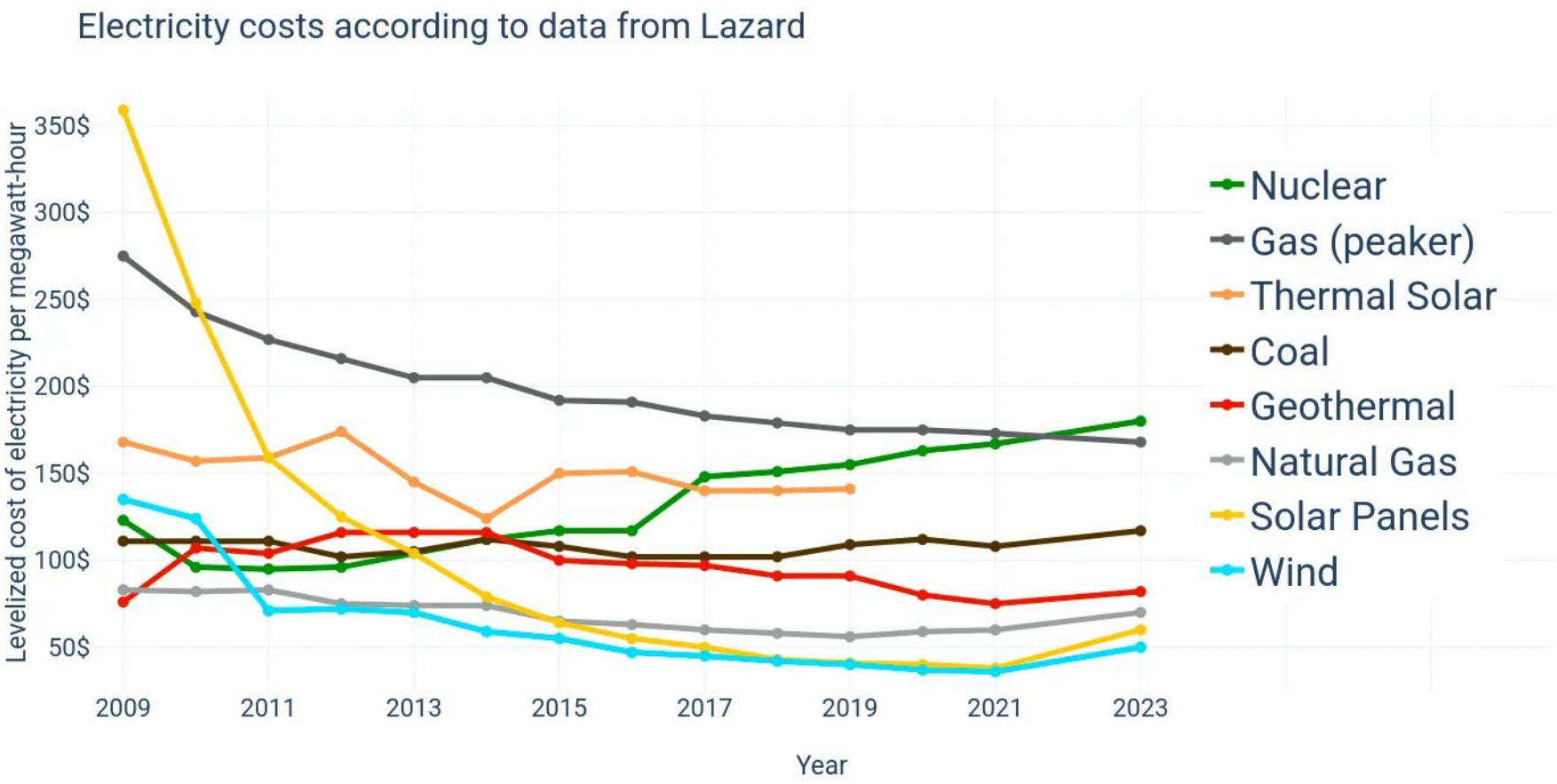
The case for: Economics



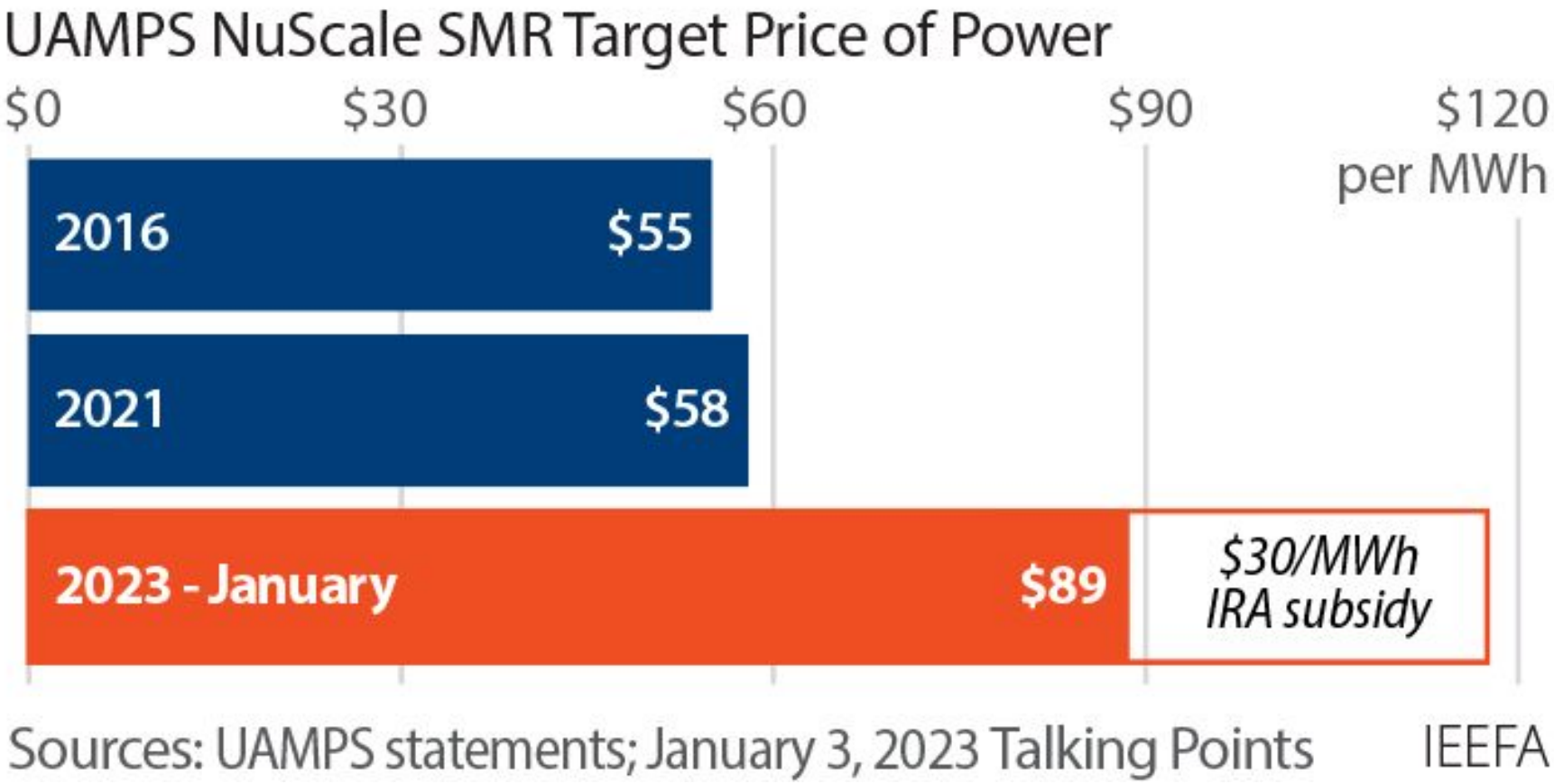
The case for/against: Economics of regulation



The case for/against: Economics



The case for/against: Economics



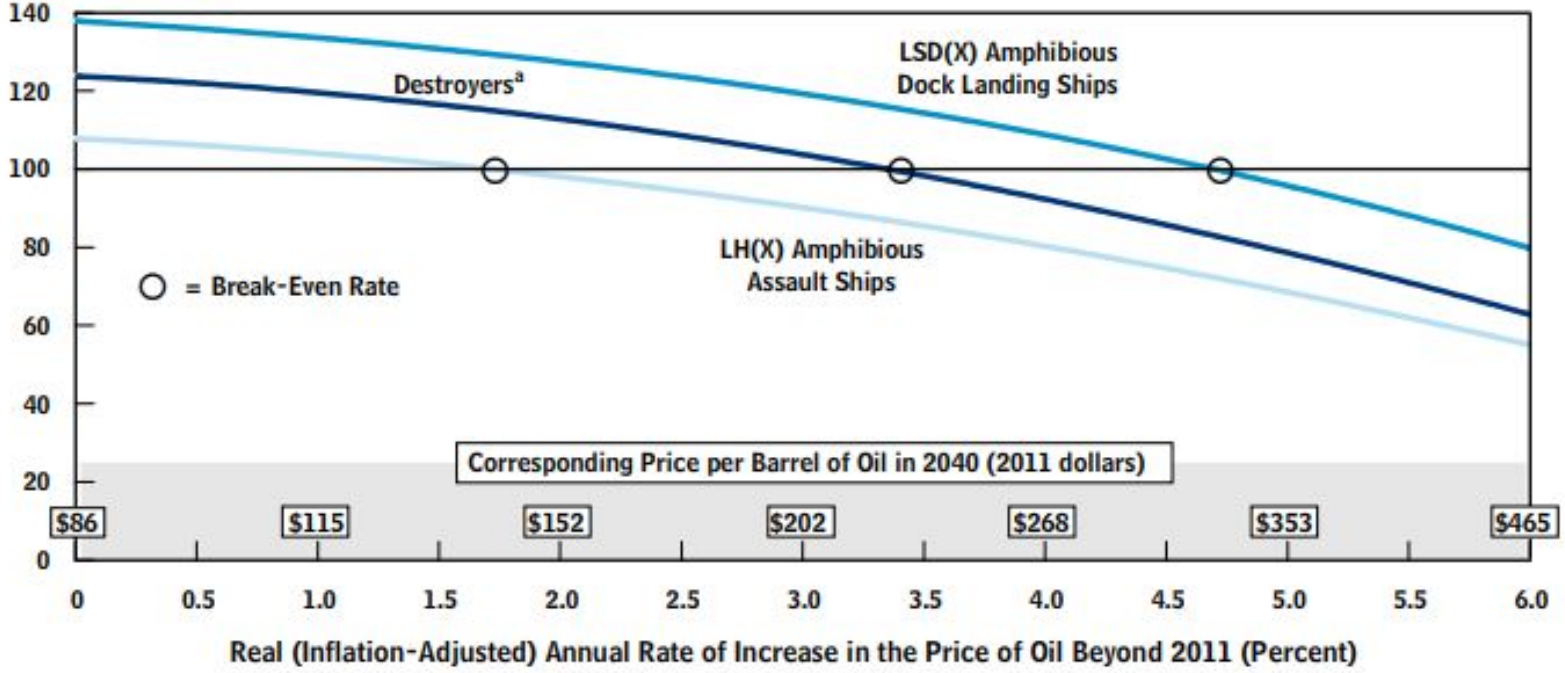
The case for/against: Economics

- SMR Rolls Royce. $2.3b, $50-$75 per MWh, 60 years
- Up front vs ongoing. Payback period.

The case for/against: Economics

Break-Even Rates for Oil Prices at Which Life-Cycle Costs, Discounted Using Risk-Adjusted Rates, Are Equal for a Nuclear and a Conventionally Powered Fleet

(Relative discounted cost, nuclear power to conventional power, as a percentage)

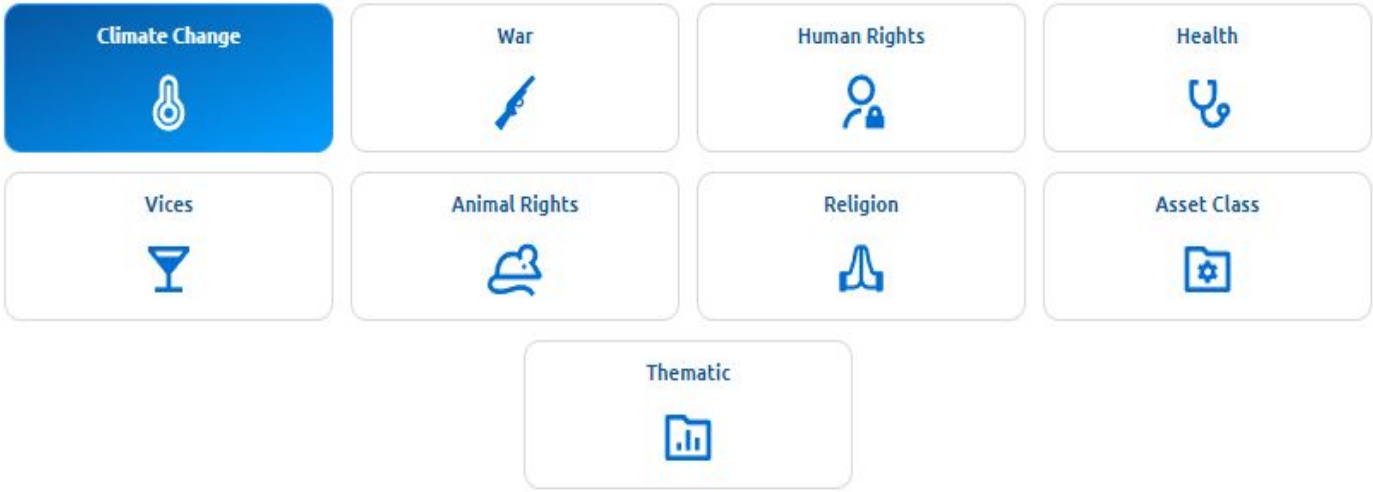


Source: Congressional Budget Office.

The case for/against: Economics

- Scalability. Batteries and solar are amazing!
- Distribution. If old system is right, Nuclear looks better
- 200 ships using Nuclear now.
- Thorium. Way less dangerous, far less radiation, electricity output better, no plutonium produced. Problems: not widely used, it ain’t the safety!!

Choose themes to screen from your portfolio away from (i.e. remove stocks)



Climate Change

- [ ] No Fossil Fuels (Worst Offenders)
- [ ] No Fossil Fuels (Any)
- [ ] No Coal Seam Gas or Fracking
- [ ] No Nuclear Power
- [ ] No Old Growth Forest Logging

Uranium: Demand/Supply

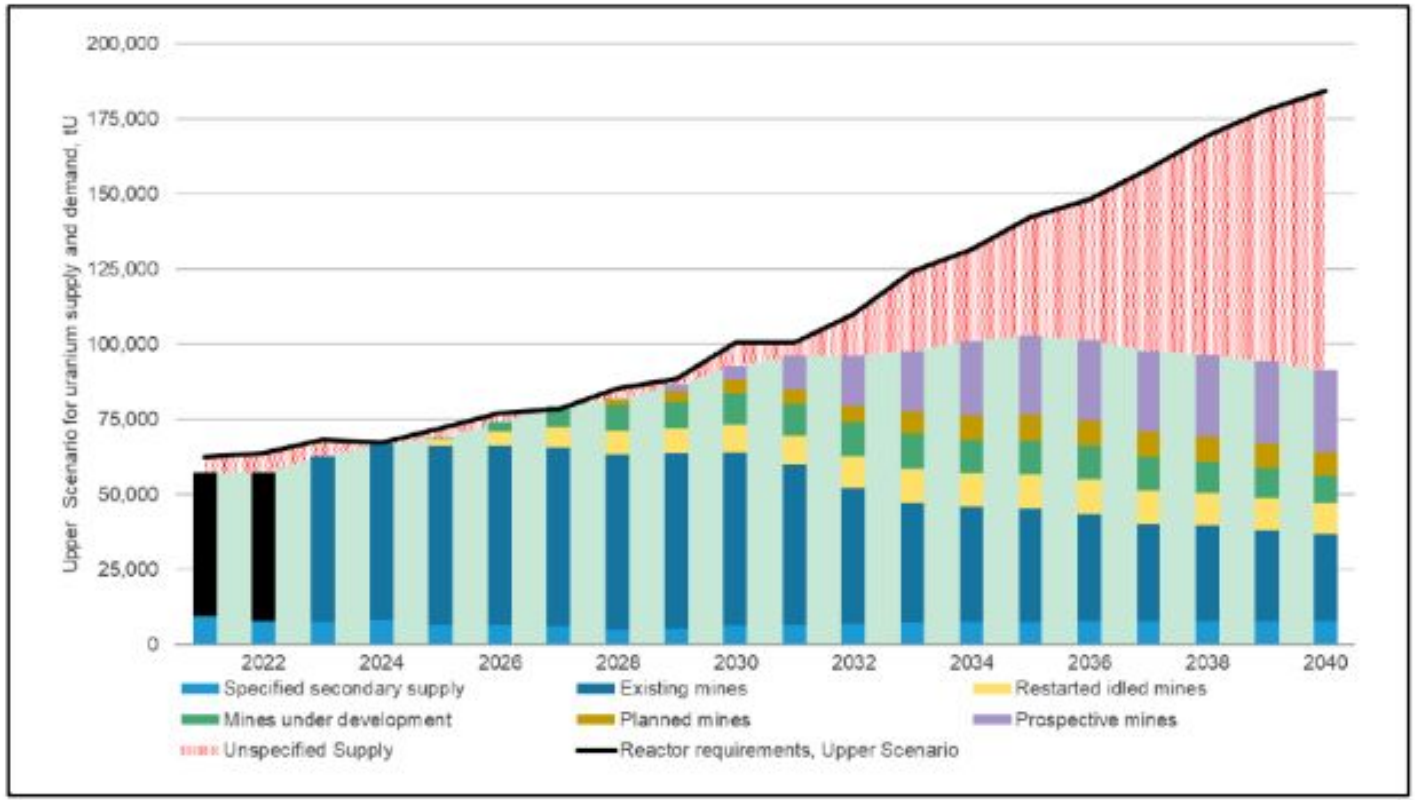


Figure 1: Upper Scenario Supply (metric tons Uranium).
(Source: World Nuclear Association – The Nuclear Fuel Report 2023).

Uranium: Supply

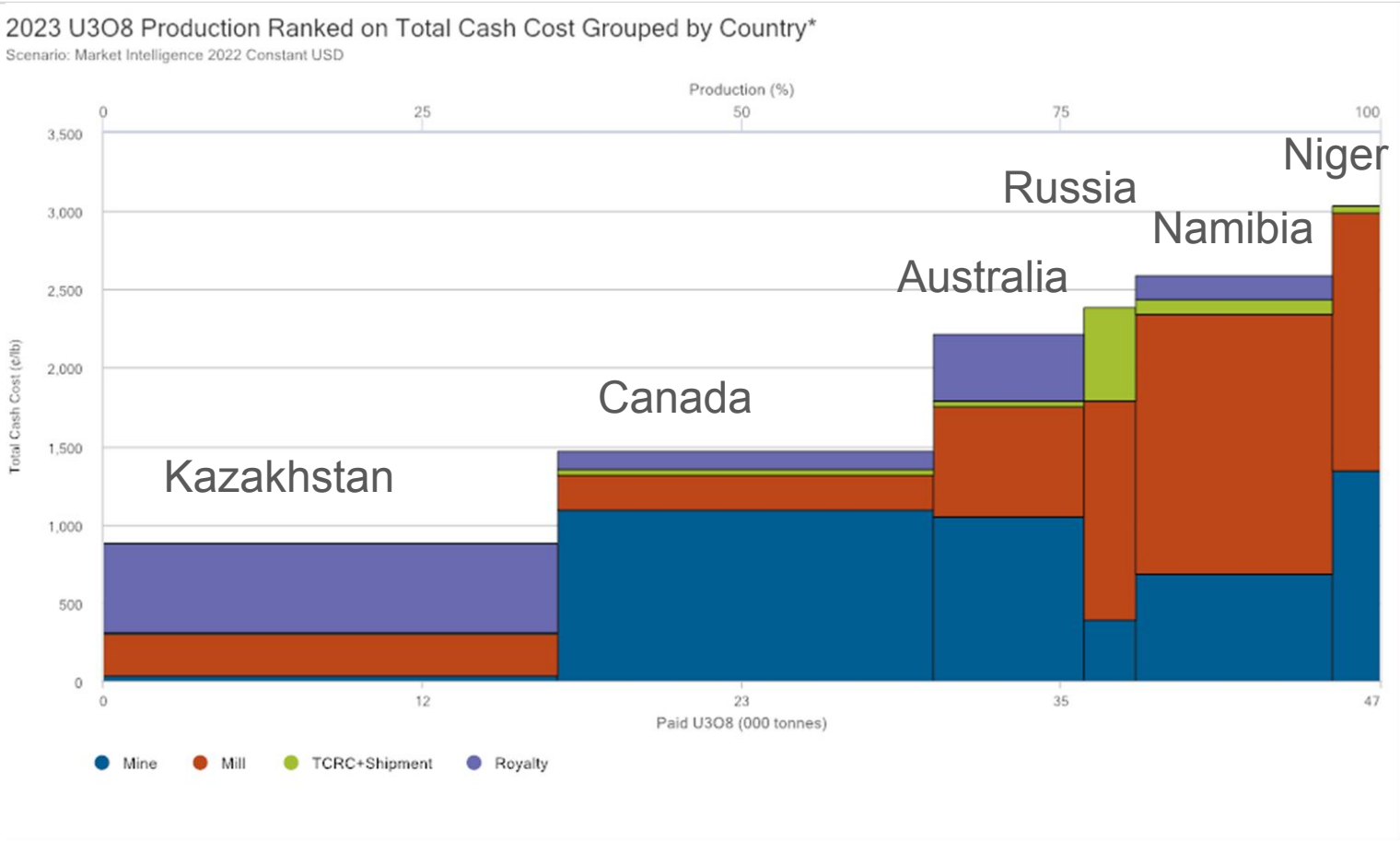
- more abundant than gold, silver or mercury, about the same as tin and slightly less abundant than cobalt, lead or molybdenum.
- Open pit 0.05% to 0.1%
- Underground Canada 15-20%
- Other mineral (0.023% of Olympic Dam, copper gold, silver)
- In-situ Leach (ISL). Acid. Most US/Kazakh.
- Milling: crush then leach
- U3O3 = 85% U by weight.
- Decommissioning nuclear weapons. 12,000 tU per year 15-20%.
- Potential for re-processing
- Many mines under capacity
- Seawater = $200/lb

Uranium:Supply

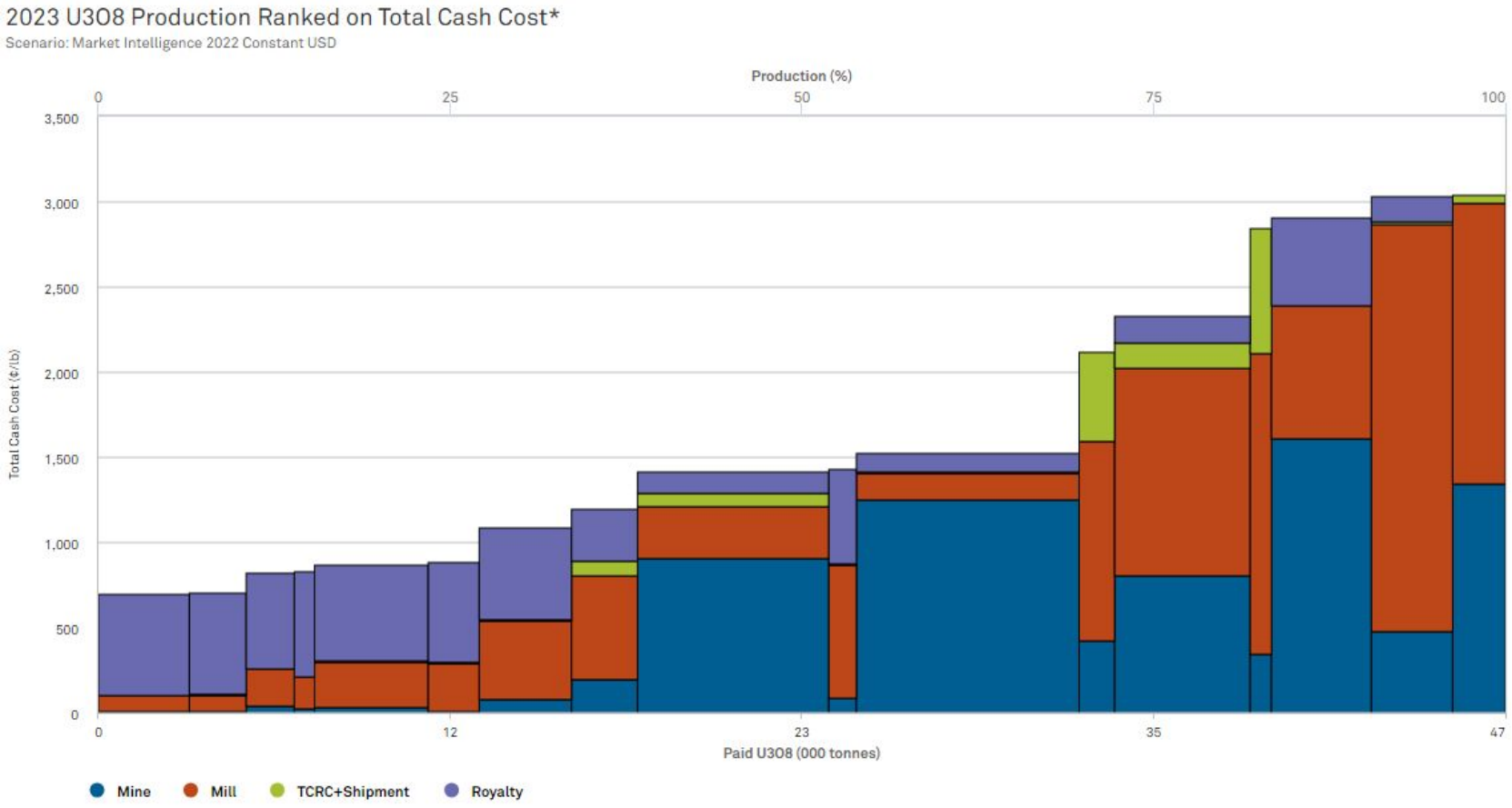
The largest-producing uranium mines in 2022

Mine	Country	Main owner	Type	Production (tonnes U)	% of world
Cigar Lake	Canada	Cameco/Orano	underground	6928	14
Husab	Namibia	Swakop Uranium (CGN)	open pit	3358	7
Inkai, sites 1-3	Kazakhstan	Kazatomprom/Cameco	ISL	3201	7
Olympic Dam	Australia	BHP Billiton	by-product/underground	2813	6
Karatau (Budenovskoye 2)	Kazakhstan	Uranium One/Kazatomprom	ISL	2560	5
Rössing	Namibia	CNNC	open pit	2255	5
SOMAIR	Niger	Orano	open pit	2020	4
Four Mile	Australia	Quasar	ISL	1740	3
Central Mynkuduk	Kazakhstan	Ortalyk	ISL	1650	3
South Inkai 4	Kazakhstan	Uranium One/Kazatomprom	ISL	1600	3
Top 10 total				**28,125**	**57%**

Uranium: Cost Structure



Uranium: Cost Structure



Uranium: Cost Structure

Recent Feasibility studies

Stock	Country	Approx Size		Approx Cost (USD)	
		Mlb/y	% World	Initial Capex	AISC / lb
Deep Yellow	Namibia	3.6	2.2%	$360m	$38
Alligator	Australia	1.2	0.7%	$130m	$33
Denison	Canada	7.6	4.7%	$550m	$25-30*
Laramide	USA	1.0	0.6%	$50m	$35
Fission	Canada	10	6.1%	$850m	$25-30*

Uranium: Cost Structure

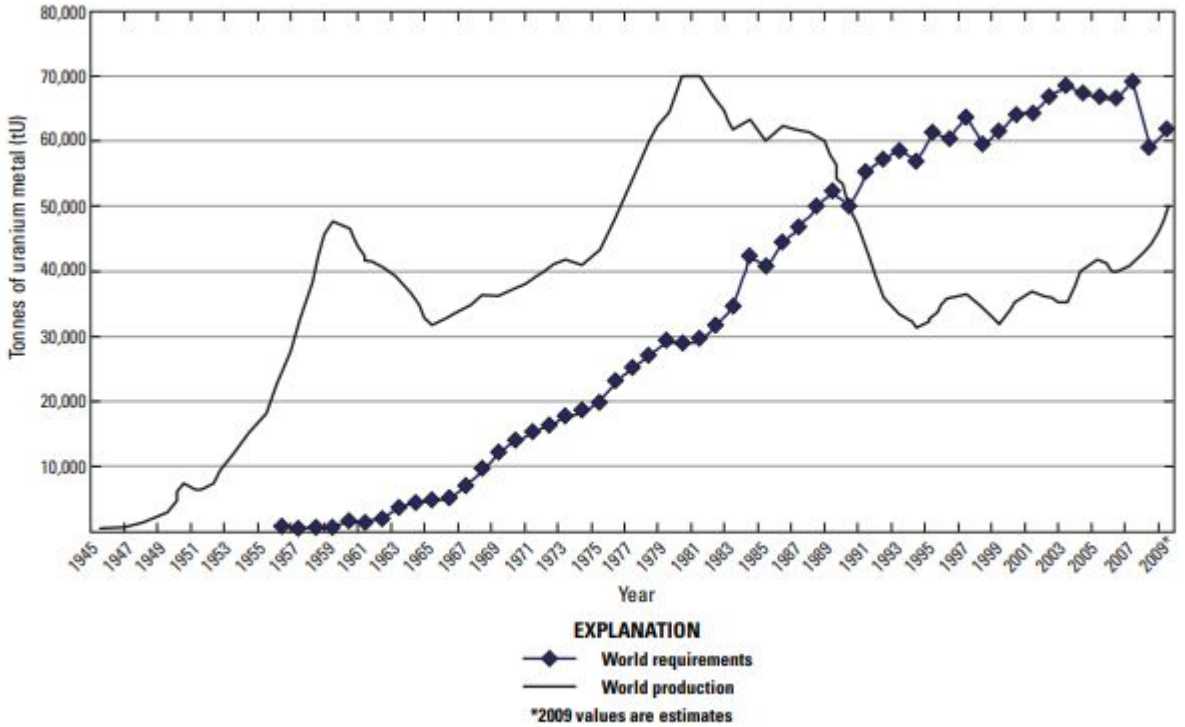


Figure 2. Historic uranium production and nuclear powerplant requirements, 1945–2009. From NEA–IAEA (2010), reproduced with permission.

Uranium: Cost Structure

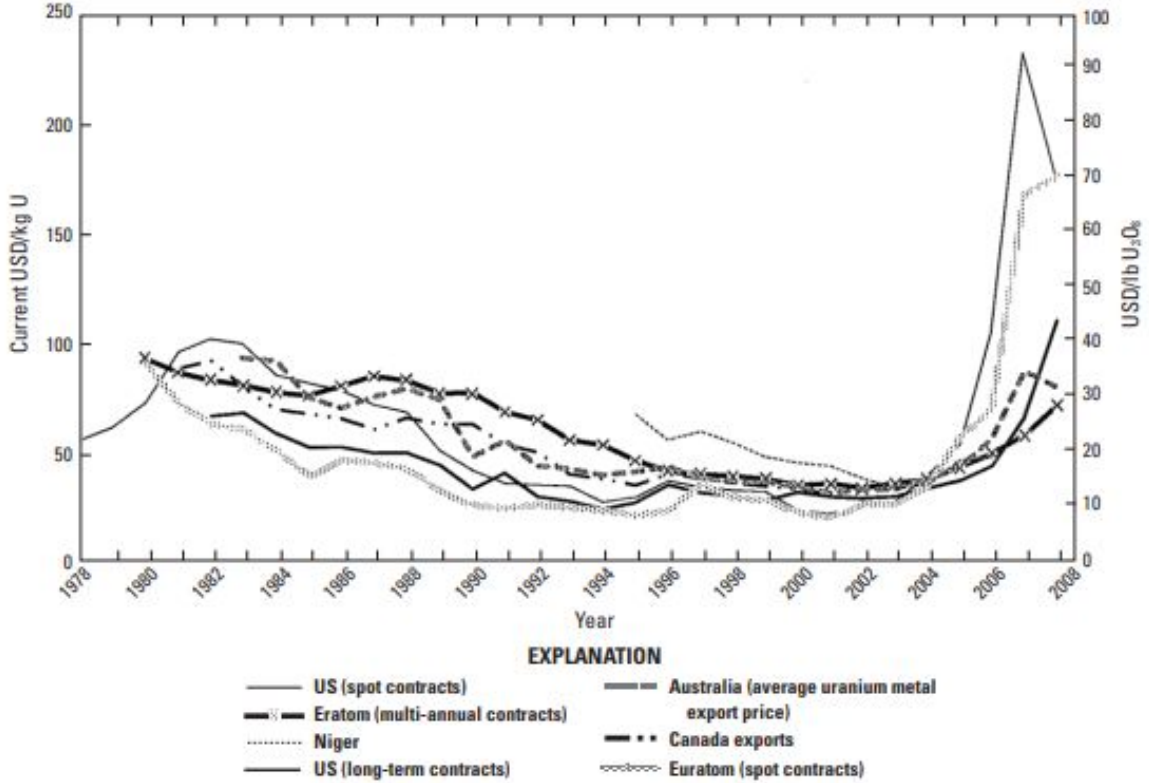
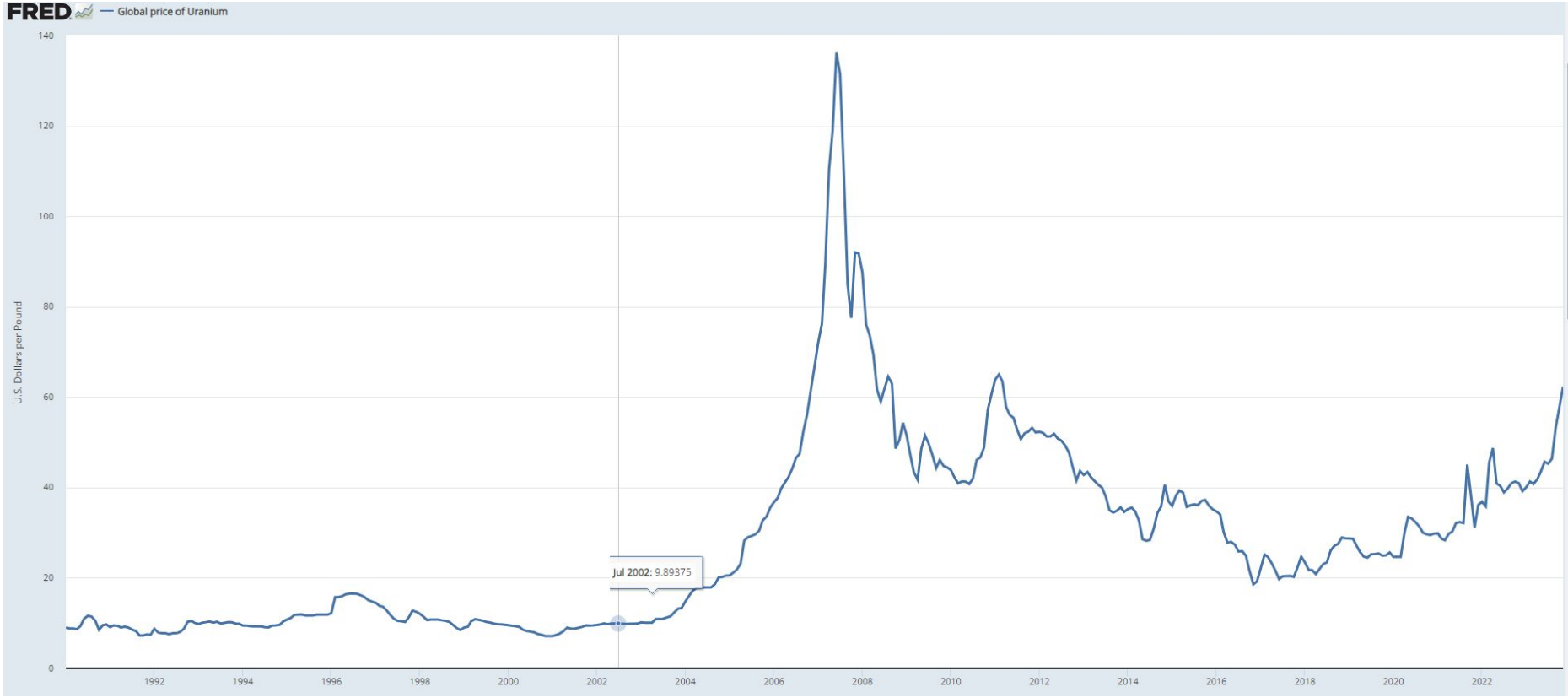


Figure 5. Uranium prices in U.S. dollars per pound of uranium oxide (U_3O_8), by type of contract, by major buyers, 1978–2009. From NEA–IAEA (2010), reproduced with permission.

Uranium: Cost Structure



Uranium: bubble 2007

- Flooding of Cigar Lake mine (now world's biggest)
- India/China nuclear plans
- Reduced weapons grade uranium from 2004.
- Renaissance in discussions of Nuclear power
- 2011 Fukashima

Personalise Your Portfolio

Screens

You can exclude the below to customise your portfolio

Climate Change | War | Human Rights | Health | Vices

Animal Rights | Religion | Asset Class | Thematic

- No Fossil Fuels (Worst Offenders)
- No Fossil Fuels (Any)
- No Coal Seam Gas or Fracking
- No Nuclear Power
- No Old Growth Forest Logging

Tilts

You can add the below to customise your portfolio

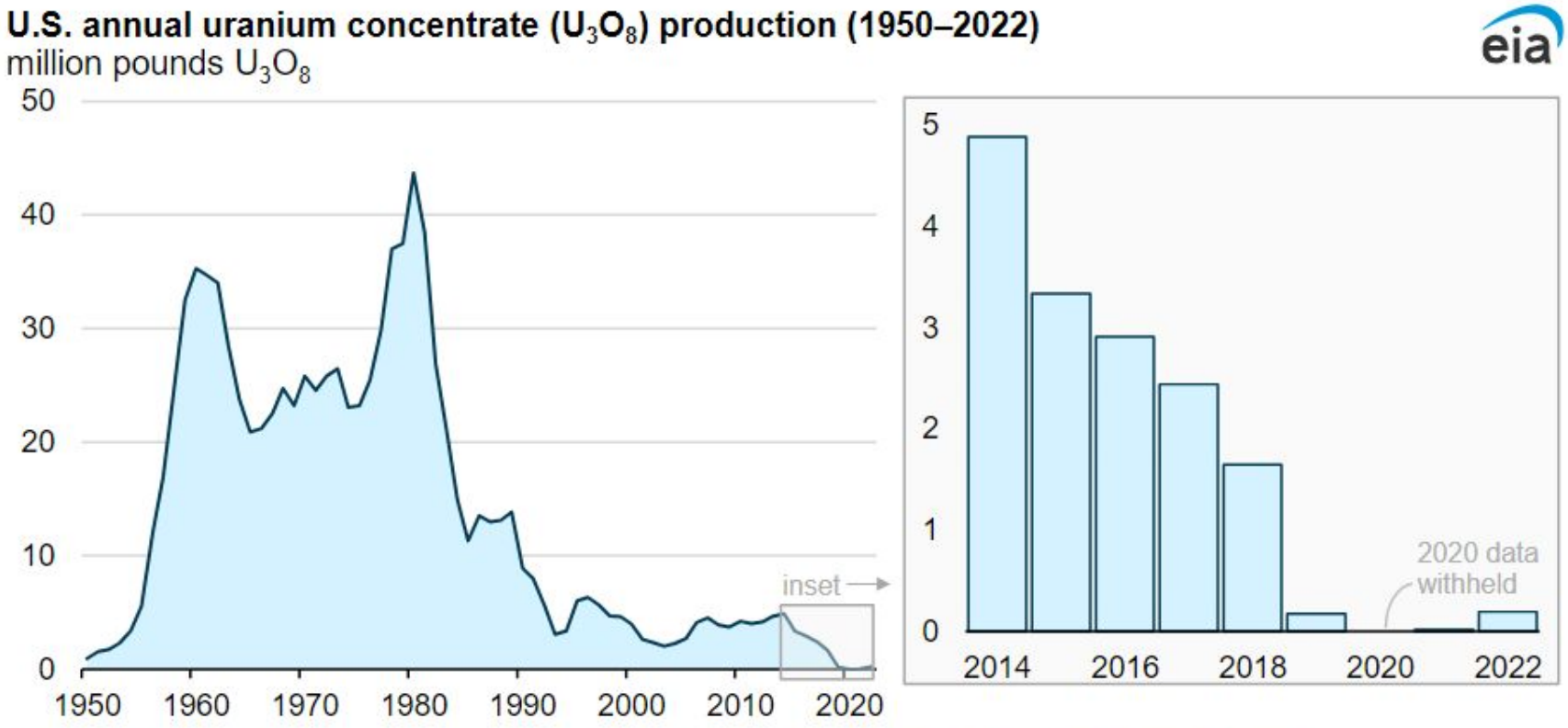
Investment Style Factors | Climate Change | Technology

Consumption | Commodities | Military | GICS Sectors

- Quality Stocks
- Value Stocks
- Growth Stocks
- Defensives

Personalise your portfolio now ›

Uranium: Demand/Supply



Data source: U.S. Energy Information Administration, *Monthly Energy Review* and *Domestic Uranium Production Report*
Note: Data for 2020 withheld to avoid disclosure of individual company data.

Uranium: Demand/Supply

- US ban on Russian uranium. Rosatom = 30% of EU, 25% of US, more so enrichment than U3O3. Enrichment issues.
- 50% of uranium via Kazakhstan/Uzbekistan/Russia
- US establishing strategic reserve
- Nuclear weapons?
- Niger coup (6% world production)
- Inventory destocking probably over

Uranium: Inventories

- 6 years of supply? 1b pounds, down from 2b
- Murky waters, probably 40% China, maybe they need more?
- Japan selling down reserve, had 4 years of inventory (about 50% of global production)
- New nuclear needs 2-3x annual. Plus reserve.
- Destocking by utilities
- Not enough contracted supply

Uranium: Traders

- Annual consumption
- Its a really (really) small market. $10-20b per year. About 2 days of oil.
- Sprott + Yellow Cake own ~85m pounds. >100% of annual global demand…
- 40-50 hedge funds with licences to buy

Viewer question of the week:

Is a uranium super-cycle on the way?

Drop your answers in the comments

Investment Outlook

- Nuclear Power tilt. Nuclear energy and weapons screen.
- I do not want to stand in the way of this one. It is a tiny market,
- Regulation? Speculator tax would dump multiple years of supply onto the market
- We can mine heaps more Uranium at $35. Cash costs much lower. $50 should be more than enough.
- Lots of other factors going on though.

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