Seven Problems With Nuclear Energy

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1. Long planning-to-operation times
2. High costs
3. Weapons proliferation risks
4. Meltdown risks
5. Waste storage issues and risks
6. Carbon dioxide, water vapor, and heat emissions
7. Underground uranium mining lung cancer risks

Small Modular Reactors, which do not exist commercially, will carry similar risks

Nuclear Planning-to-Operation Times

	Construction Time (Years)	Plan-to-Operation Time (Years)	Cost $/W
Olkiluoto 3 (Finland)	18	23	8
Hinkley Point (UK)	11-13	21-23	19
Vogtle 3 and 4 (US)	10-11	17-18	16
Flamanville (France)	17	20	16
Haiyang 1 and 2 (China)	9	13-14	
Taishan 1 and 2 (China)	10-11	12-13	
Shidao Bay (China)	10	17	
Barakah 1-4 (UAE)	9	12-15	

Issues With New Nuclear Reactors

Take 12-23 y between plan & operation v 0.5-5 y for new solar/wind

Capital costs 10-20 x and cost per unit energy 3-8 x those of wind/solar

Produce 9-37 times more CO_2e and pollution per unit energy than wind

IPCC 2014: P. 517. "Robust evidence, high agreement" that increased use of nuclear leads to more

(a) Weapons proliferation risk
(b) Meltdown risk
(c) Waste risk for 200,000+ years
(d) Underground uranium mining lung cancer risk from radon

All-Sector End-Use Power Demand BAU v WWS

Year and Fuel Type	149 Countries
2020 End-use demand	12.6 TW
2050 Demand with current fuels (BAU)	18.9 TW
2050 Demand with WWS	8.6 TW
2050 Demand reduction with WWS 19.7% efficiency of BE, HFC v. ICE 4.1% efficiency of electric industry 13.1% efficiency of heat pumps 10.9% eliminating fuel mining 6.6% efficiency beyond BAU	54.4%

Comparison of Wind-Water-Solar (WWS) vs Carbon Capture (CC)/Direct Air Capture (DAC): 4 Cases

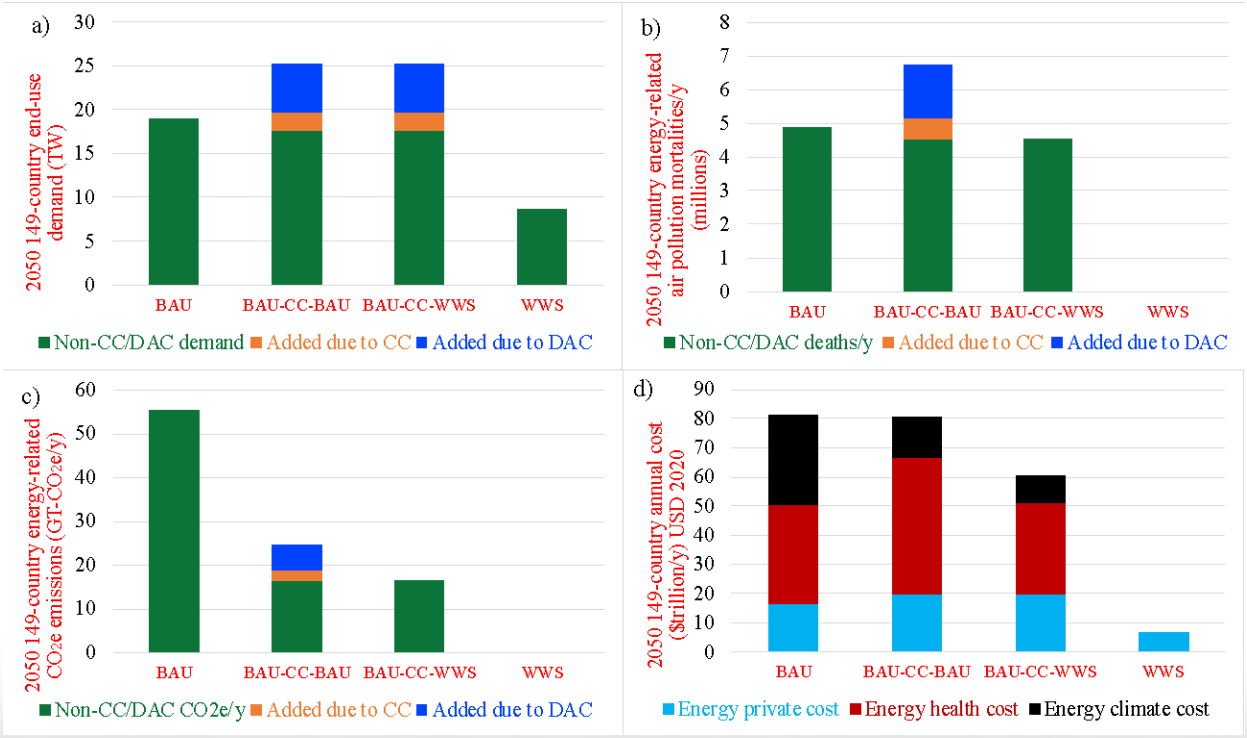
BAU: Business-As-Usual

BAU-CC-BAU: CC attached to fossil and bioenergy electricity and industrial point sources; DAC offsetting mobile and distributed CO_2 sources, and using BAU sources to supply the electricity for CC and DAC

BAU-CC-WWS: Same as BAU-CC-BAU, but using WWS sources to supply the electricity for CC and DAC

WWS: Replace all non-WWS BAU energy with WWS (Wind-Water-Solar)

a) Energy Demand; b) Air Pollution Deaths/y; c) CO_2e/y; d) Social Cost Across 149 Countries in Four Cases



Conclusion With Respect to CC/SDACC

Climate policies proposing CC and/or SDACC will increase air pollution, CO_2e emissions, energy needs, and private energy costs, thus social energy costs 9.1 to 12.1 times those of policies requiring 100% WWS.

The conclusions apply to any level of carbon removal above zero.

CC and SDACC may, in the limit, cause millions of unnecessary air pollution deaths each year and substantial climate damage in the short and long term.

As such, policies promoting CC and SDACC should be abandoned.

Evaluation of Nuclear
https://web.stanford.edu/group/efmh/jacobson/WWSStillNMN/SNMN-WhyNotNuclear.pdf

Evaluation of Carbon Capture/Direct Air Capture
https://web.stanford.edu/group/efmh/jacobson/WWSStillNMN/SNMN-WhyNotCCorDAC.pdf

Book on 100% WWS Versus Other Techs ("No Miracles Needed")
https://web.stanford.edu/group/efmh/jacobson/WWSNoMN/NoMiracles.html