Debunking the myths around Small Modular Reactors

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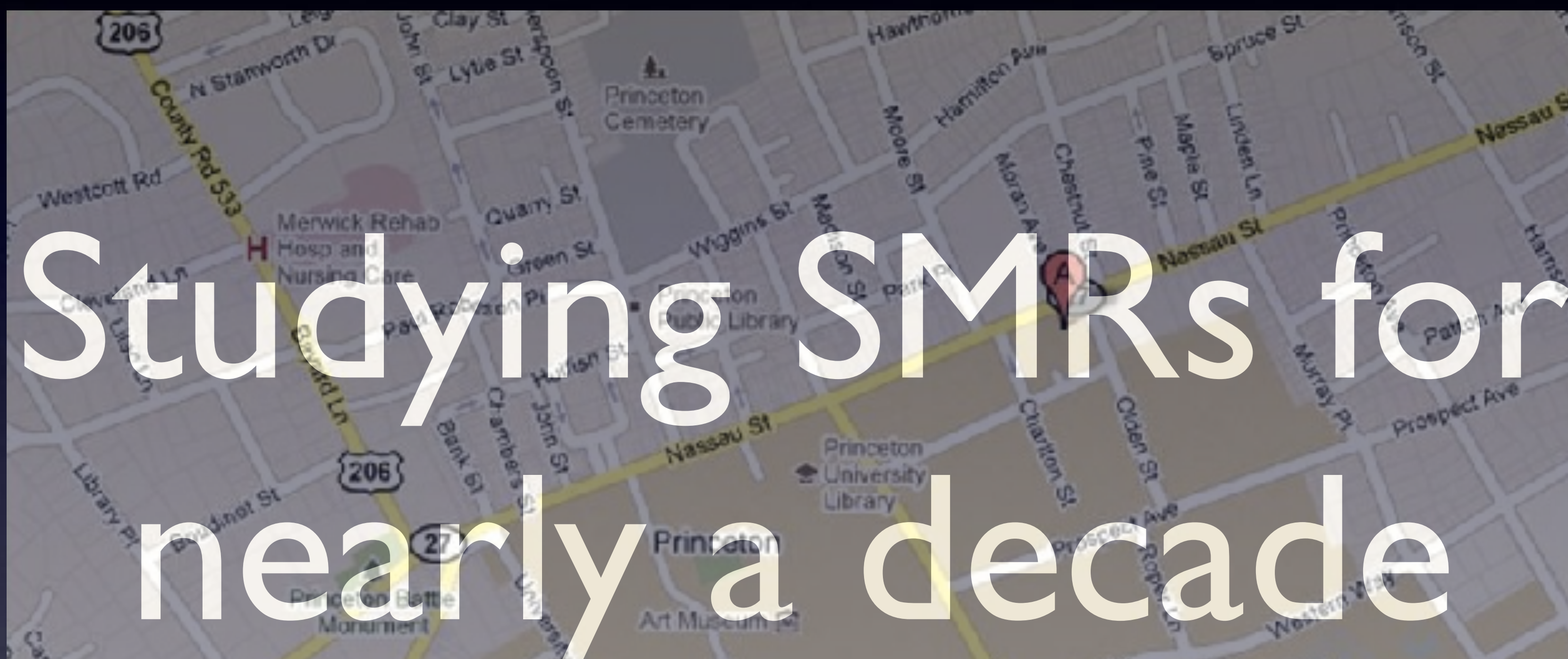
Webinar organized by
Beyond Nuclear
Canadian Environmental Law Association
Coalition for Responsible Energy Development in New Brunswick
October 21, 2020

Studying SMRs for nearly a decade



Energy Research & Social Science 2 (2014) 115–124

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Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Original research article

One size doesn't fit all: Social priorities and technical conflicts for small modular reactors

M.V. Ramana, Zia Mian

RESOURCE REQUIREMENTS AND PROLIFERATION RISKS ASSOCIATED WITH SMALL MODULAR REACTORS

ALEXANDER GLASER,* LAURA BERZAK HOPKINS, and M. V. RAMANA

NUCLEAR TECHNOLOGY VOL. 184 OCT. 2013

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Too small to be viable? The potential market for small modular reactors in mining and remote communities in Canada

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SCIENCE & GLOBAL SECURITY

Routledge Taylor & Francis Group

Accident Scenarios Involving Pebble Bed High Temperature Reactors

Matthias Englert[a], Friederike Frieß[b], and M. V. Ramana[c]

Energy Research & Social Science

Original research article

Thinking big? Ghana, small reactors, and nuclear power

M.V. Ramana, Priscilla Agyapong

Energy Policy

Wishful thinking and real problems: Small modular reactors, planning constraints, and nuclear power in Jordan

M.V. Ramana, Ali Ahmad

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Energy

journal homepage: www.elsevier.com/locate/energy

Licensing small modular reactors

M.V. Ramana, Laura Berzak Hopkins, Alexander Glaser

Nuclear Futures Laboratory and Program on Science and Global Security, Princeton University

BULLETIN OF THE ATOMIC SCIENTISTS, 2016

FEATURES

The checkered operational history of high-temperature gas-cooled reactors

M. V. Ramana

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Small Reactors aren't new

REACTORS

Name	Type	Status	Location	Reference Unit Power [MW]	Gross Electrical Capacity [MW] ▲	First Grid Connection
SAXTON	PWR	Permanent Shutdown		3	3	1967-03-01
PIQUA	X	Permanent Shutdown	Piqua	12	12	1963-07-01
BONUS	BWR	Permanent Shutdown	Rincon	17	18	1964-08-14
CVTR	PHWR	Permanent Shutdown	Parr	17	19	1963-12-18
ELK RIVER	BWR	Permanent Shutdown		22	24	1963-08-24
GE VALLECITOS	BWR	Permanent Shutdown	Pleasanton, Sunol	24	24	1957-10-19
PEACH BOTTOM-1	HTGR	Permanent Shutdown	YORK COUNTY	40	42	1967-01-27
LACROSSE	BWR	Permanent Shutdown	GENOA	48	55	1968-04-26
PATHFINDER	BWR	Permanent Shutdown		59	63	1966-07-25
FERMI-1	FBR	Permanent Shutdown	LAGOONA BEACH	61	65	1966-08-05
HUMBOLDT BAY	BWR	Permanent Shutdown	EUREKA	63	65	1963-04-18
SHIPPINGPORT	PWR	Permanent Shutdown		60	68	1957-12-02
BIG ROCK POINT	BWR	Permanent Shutdown	CHARLEVOIX	67	71	1962-12-08
HALLAM	X	Permanent Shutdown	Lincoln	75	84	1963-09-01
YANKEE NPS	PWR	Permanent Shutdown	ROWE	167	180	1960-11-10
DRESDEN-1	BWR	Permanent Shutdown	MORRIS	197	207	1960-04-15
INDIAN POINT-1	PWR	Permanent Shutdown	BUCHANAN	257	277	1962-09-16

Source: https://pris.iaea.org/PRIS/CountryStatistics/CountryDetails.aspx?current=US

"Rural America's First Atomic Power Plant"

Source: Ramana, M.V. 2015. "The Forgotten History of Small Nuclear Reactors." *IEEE Spectrum*, May 2015. http://spectrum.ieee.org/energy/nuclear/the-forgotten-history-of-small-nuclear-reactors.

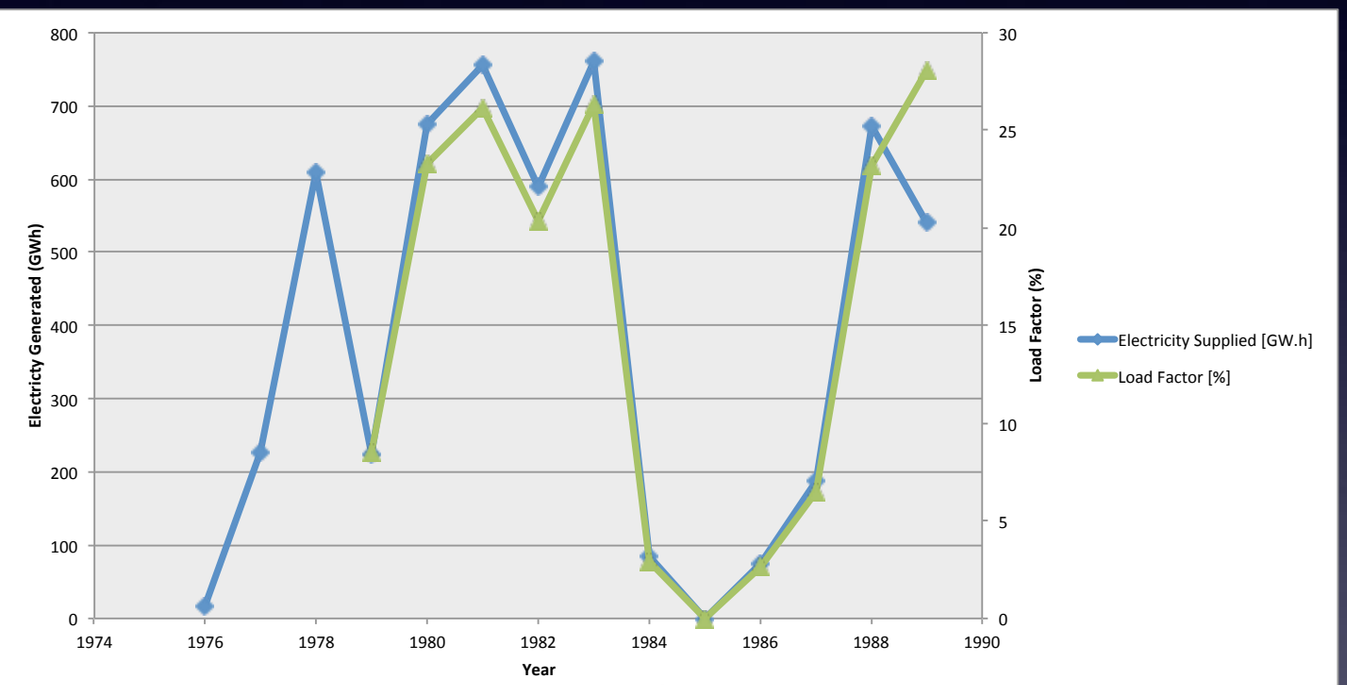
Elk River: 1964 - 1968 (operations)

Construction cost over 250% of initial estimate

Source: http://www.ansnuclearcafe.org/wp-content/uploads/2013/04/ElkRiverPostCard04.jpg

Fort St. Vrain (1974-1988)

Or what looks good on paper might not be so good in practice



Safest Reactor Is Closing Because It Rarely Runs

By MATTHEW L. WALD

New York Times, December 8, 1988

VOL. 72, NO. 3, 171–179
http://dx.doi.org/10.1080/00963402.2016.1170395
Routledge
Taylor & Francis Group

FEATURES

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Small also means…

More cost

$$\frac{K_1}{K_2} = \left(\frac{S_1}{S_2}\right)^{0.6}$$

More spent fuel/waste

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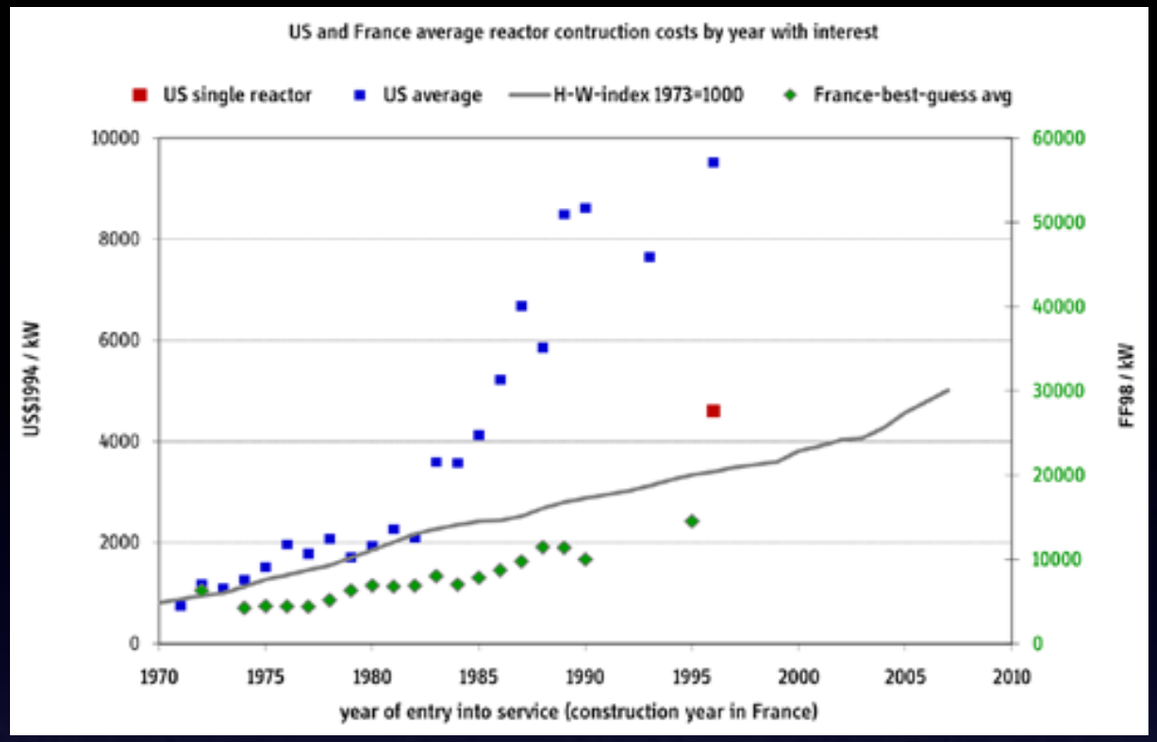
"Learning" might make plants more expensive



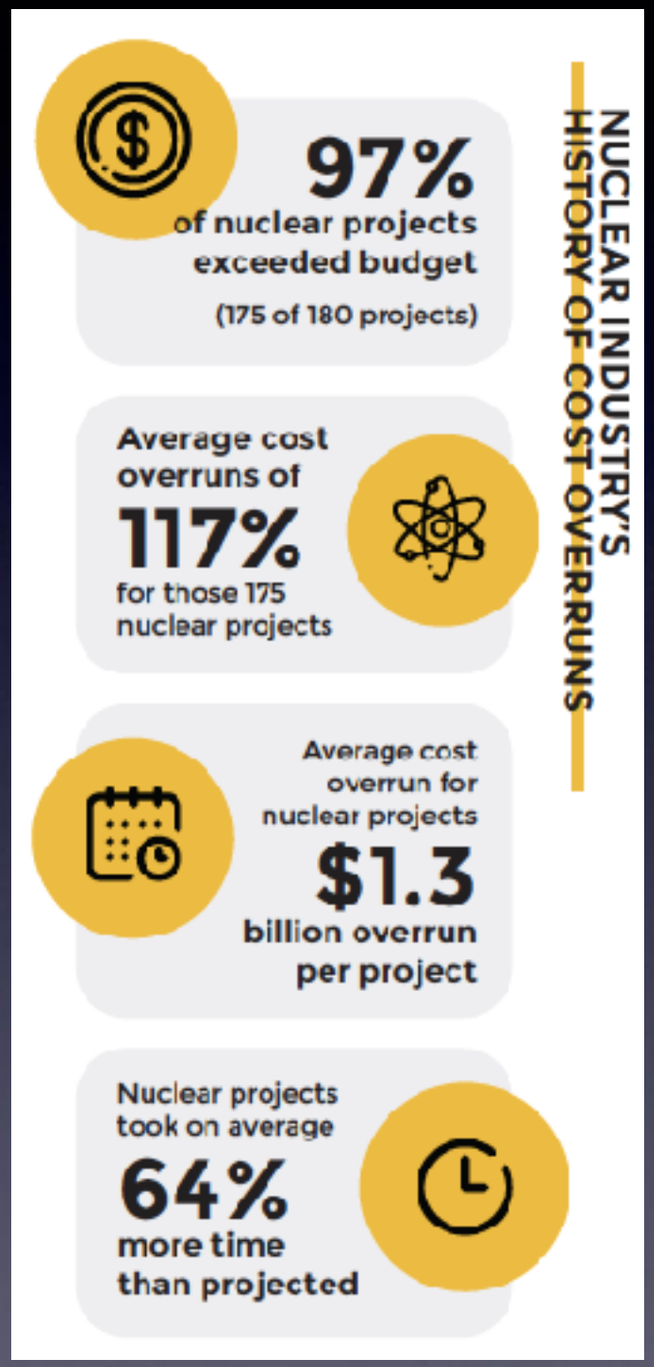
Grubler, Arnulf. 2010. "The Costs of the French Nuclear Scale-up: A Case of Negative Learning by Doing." Energy Policy 38 (9): 5174–88.

Even if there was learning, too many "loss leaders" have to be built

Learning Rate	Diseconomies of Scale Exponent 0.6	0.8
10%	700	80
5%	60,000	780

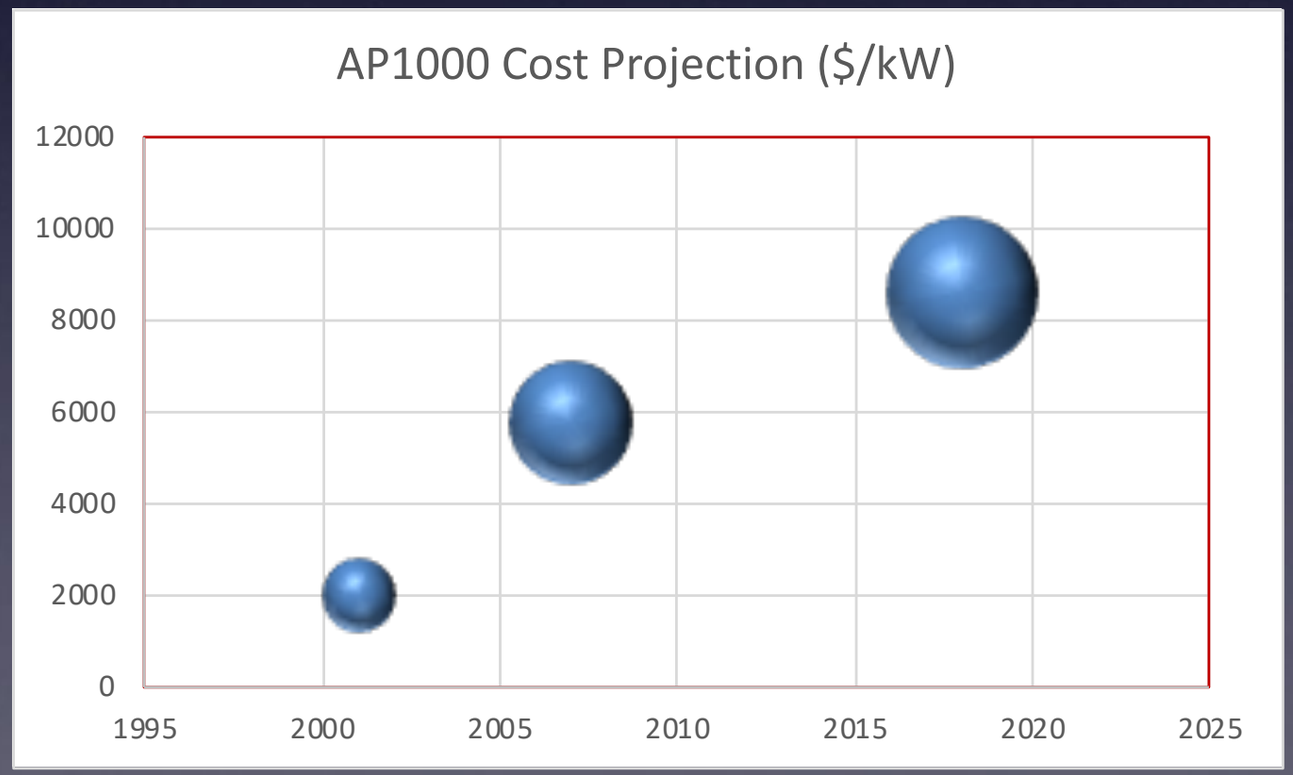
Glaser, Alexander, M.V. Ramana, Ali Ahmad, and Robert Socolow. 2015. "Small Modular Reactors: A Window on Nuclear Energy." An Energy Technology Distillate. Princeton, N.J.: Andlinger Center for Energy and the Environment at Princeton University. http://acee.princeton.edu/distillates/distillates/small-modular-reactors/.

Initial cost estimates not reliable

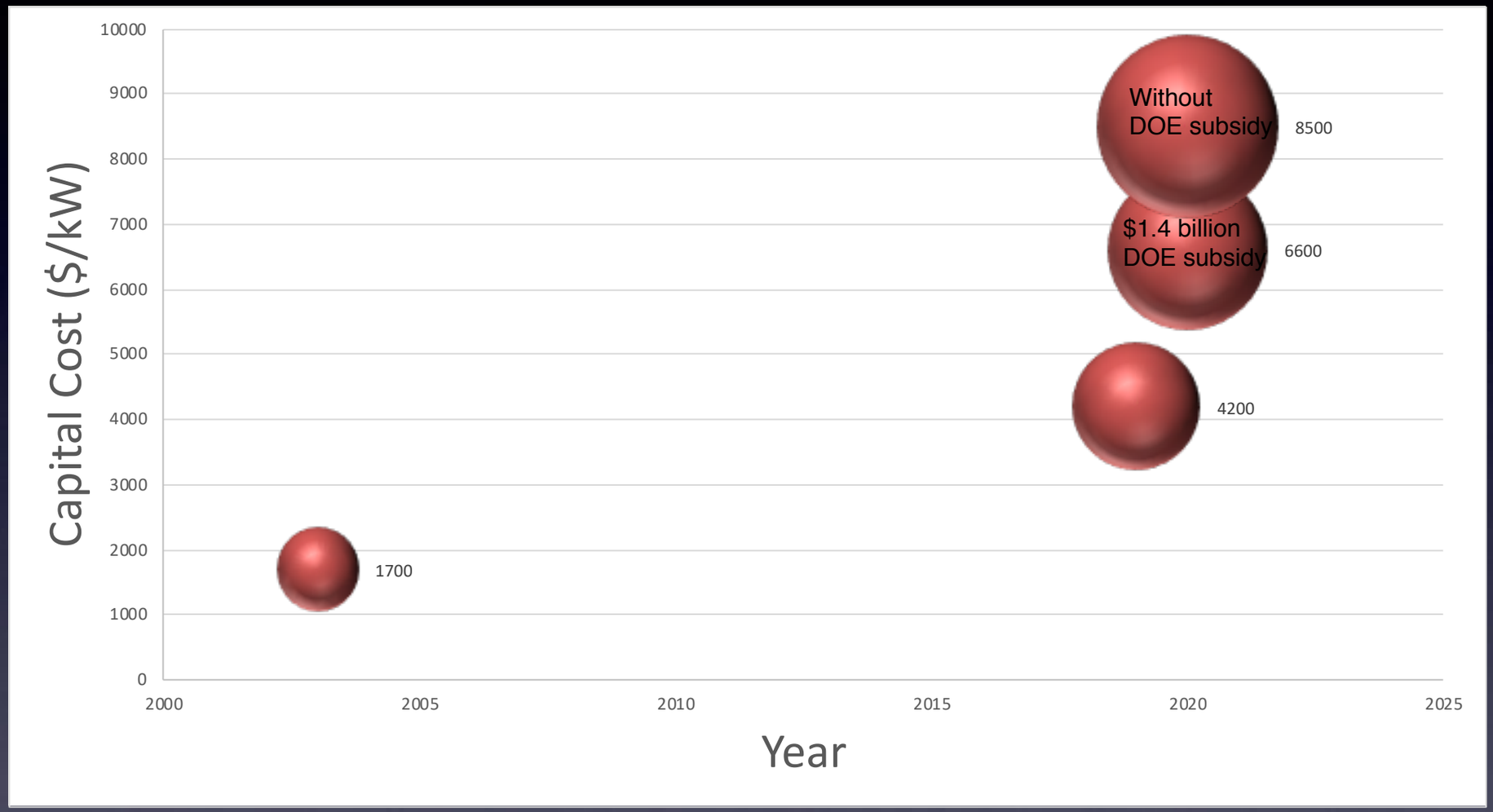


Source: Sovacool, Benjamin K., Alex Gilbert, and Daniel Nugent. 2014. "Risk, Innovation, Electricity Infrastructure and Construction Cost Overruns: Testing Six Hypotheses." *Energy* 74 (September): 906–17. https://doi.org/10.1016/j.energy.2014.07.070.

Case of AP1000 cost estimates for Vogtle project in Georgia - still not complete

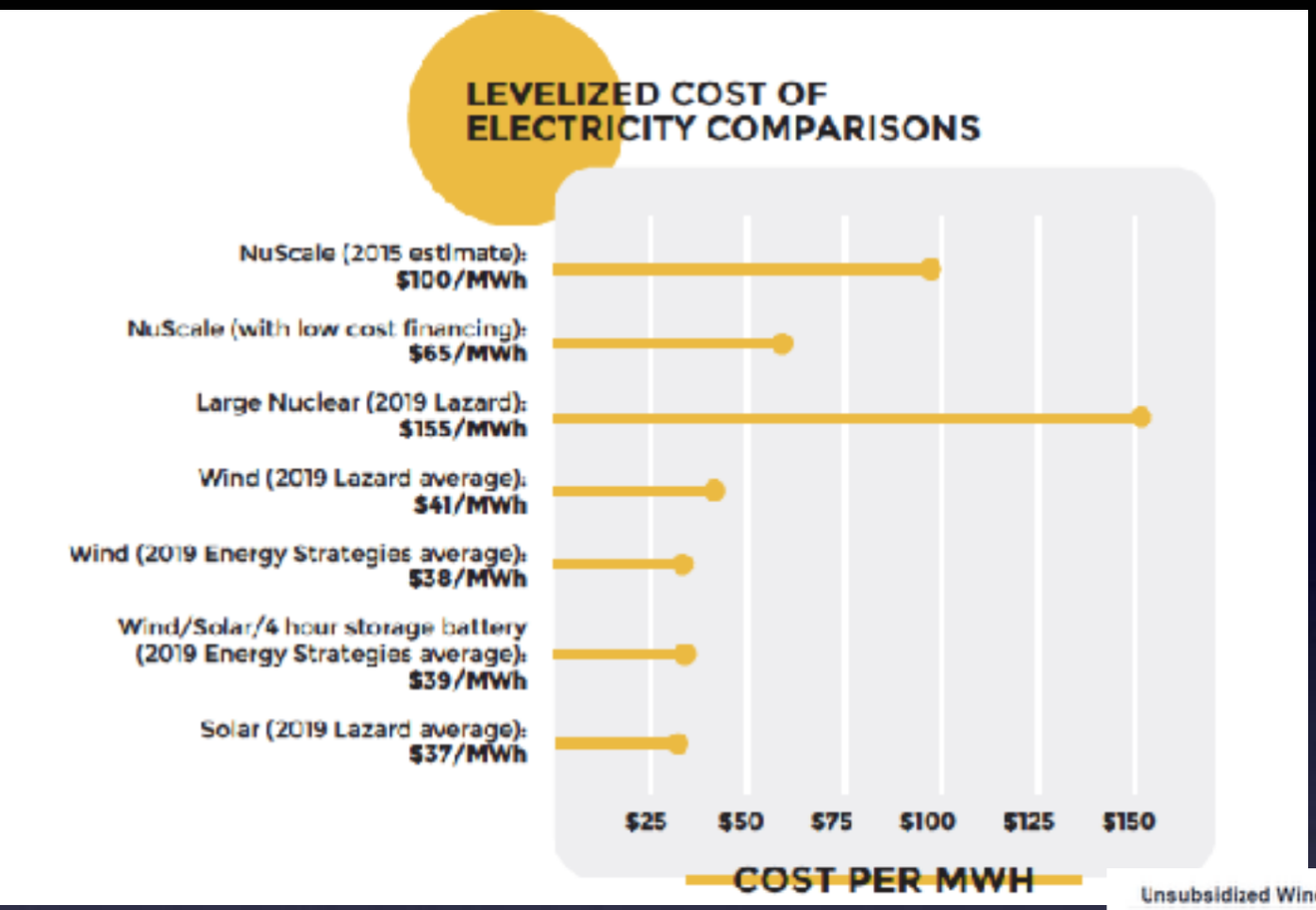


NuScale estimated costs have also gone up

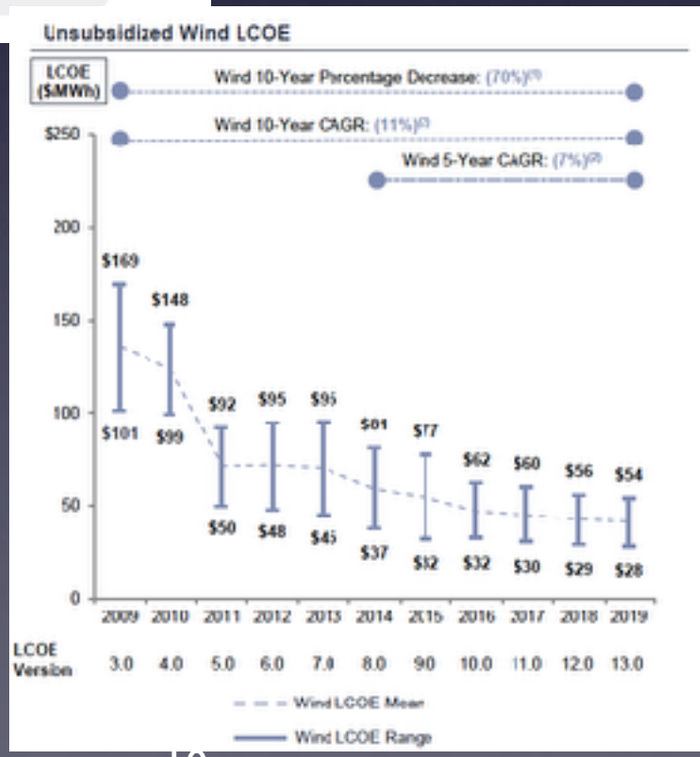


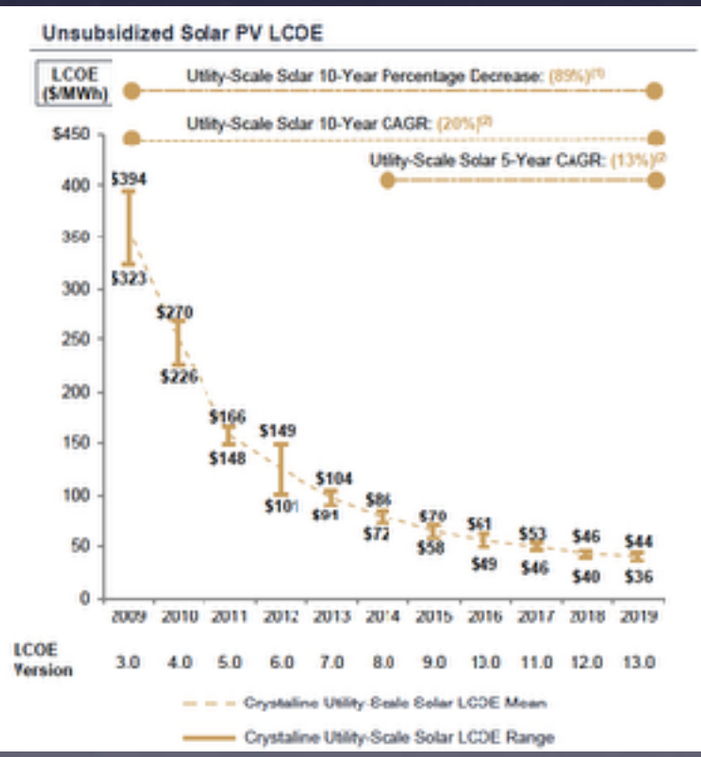
Claim of $55/MWh for cost of electricity does not bear critical scrutiny

Other sources of electricity are cheaper



And becoming cheaper

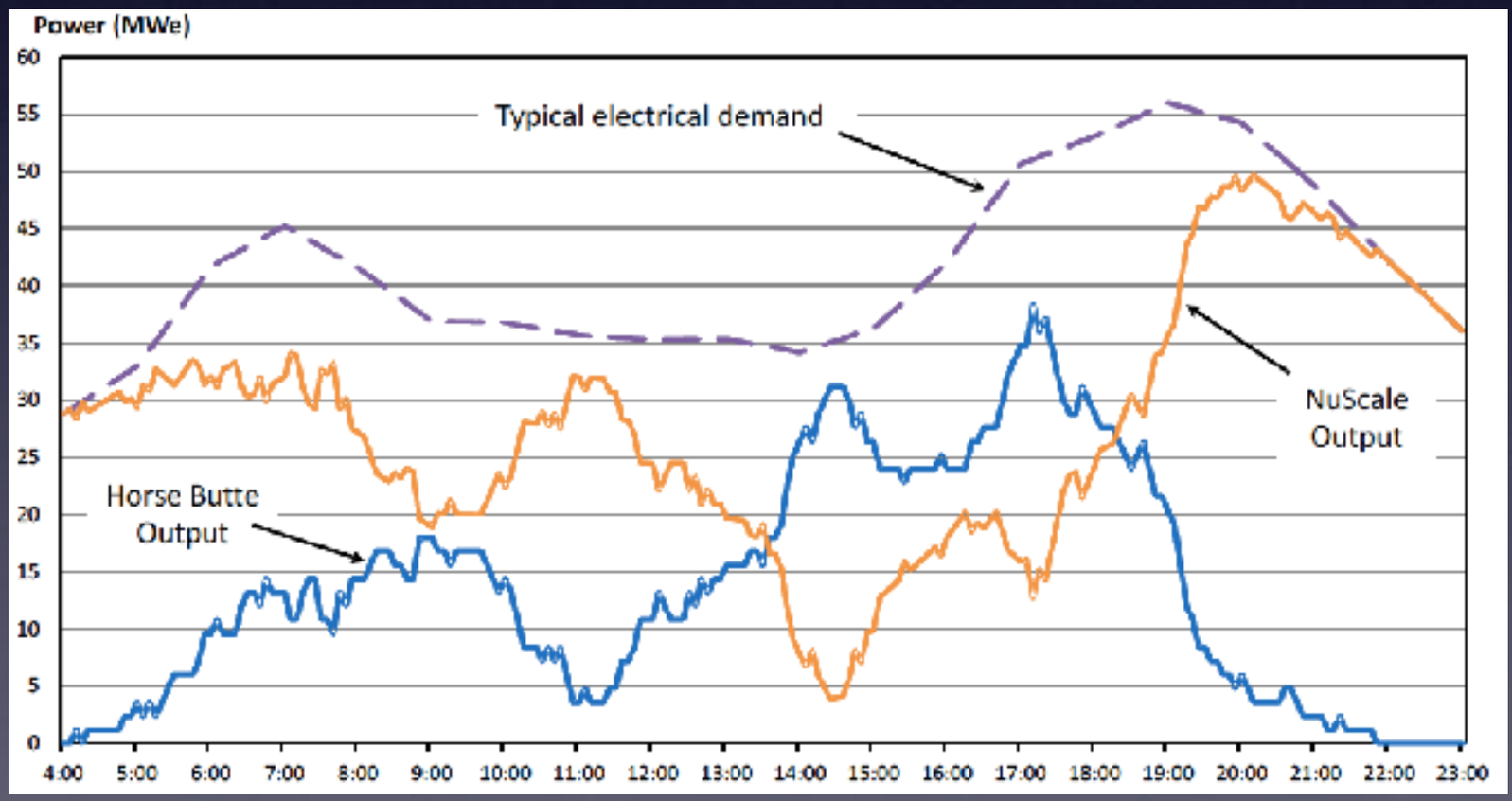




Source: Lazard. 2019. “Lazard’s Levelized Cost of Energy-Version 13.0.” New York: Lazard. h

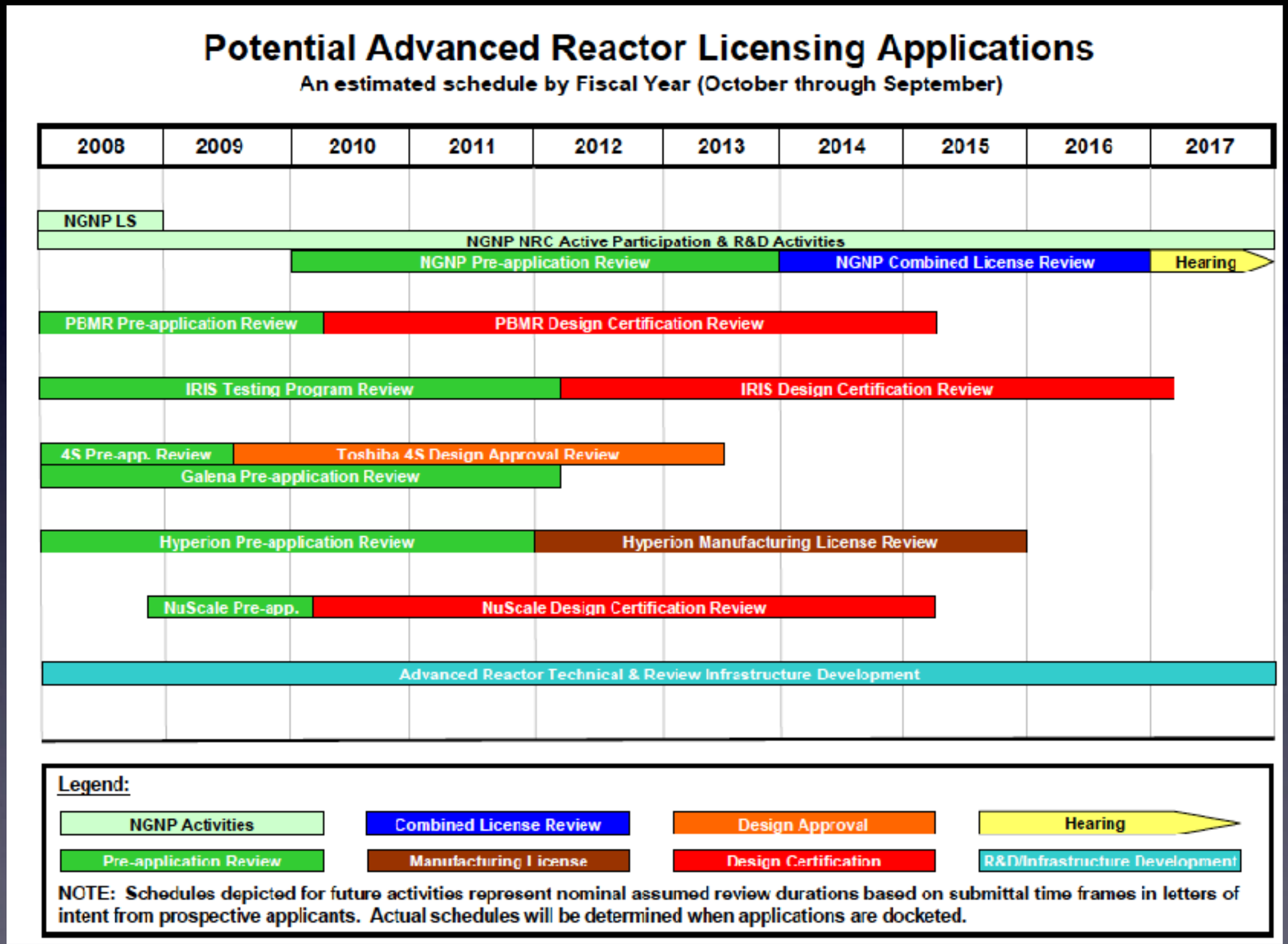
Using SMR to back up intermittency of renewables will drive up cost (fewer kWh)

Capacity factor of 75 percent => roughly 20 percent increase in levelized cost



Source: Ingersoll, D.T., C. Colbert, Z. Houghton, R. Snuggerud, J. W. Gaston, and M. Empey. 2015. “Can Nuclear Power and Renewables Be Friends?” In Proceedings of ICAPP 2015. Nice, France. https://www.nuscalepower.com/-/media/Nuscale/Files/Technology/Technical-Publications/can-nuclear-power-and-renewables-be-friends.ashx?la=en&hash=2A0EB3B5CA22BF25F90FF16BA060835A0B2DFDF2.

Significantly Delayed Compared to Claims



Source: Edward Baker, "NRC's Advanced Reactor Program," 16 October 2008, http://web.mit.edu/ans/www/documents/seminar/F08/baker.pdf, accessed 19 May 2015

Is there a market in Canada?

"SMR concepts were considered an attractive solution for remote off-grid communities and industries operating in remote locations, such as mining"

Diesel	SMR	Solar	Wind
$0.33	$3.70	$0.21	$0.30

Hybrid system involving wind and diesel would also be far cheaper, even with a carbon tax of $100/ton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Too small to be viable? The potential market for small modular reactors in mining and remote communities in Canada

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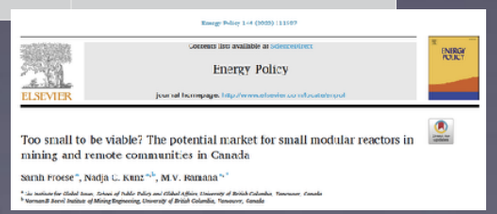
Estimating Energy Demand

	Operational (13)	Development (11)	Total (24)	In 2028 (19)
Installed Capacity	307	310	617	500
Peak Demand	170	172	343	277
Average Installed Capacity	24	28	26	26
Average Peak Demand	13	16	14	15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Translating to SMRs

Less than 600 MW of demand in all

Factor of 3 to 7 lower than “full order book” estimates made by Westinghouse and mPower

Not worth setting up a factory to manufacture them

Source: https://pixabay.com/photos/order-book-old-book-ledger-vintage-3813956/

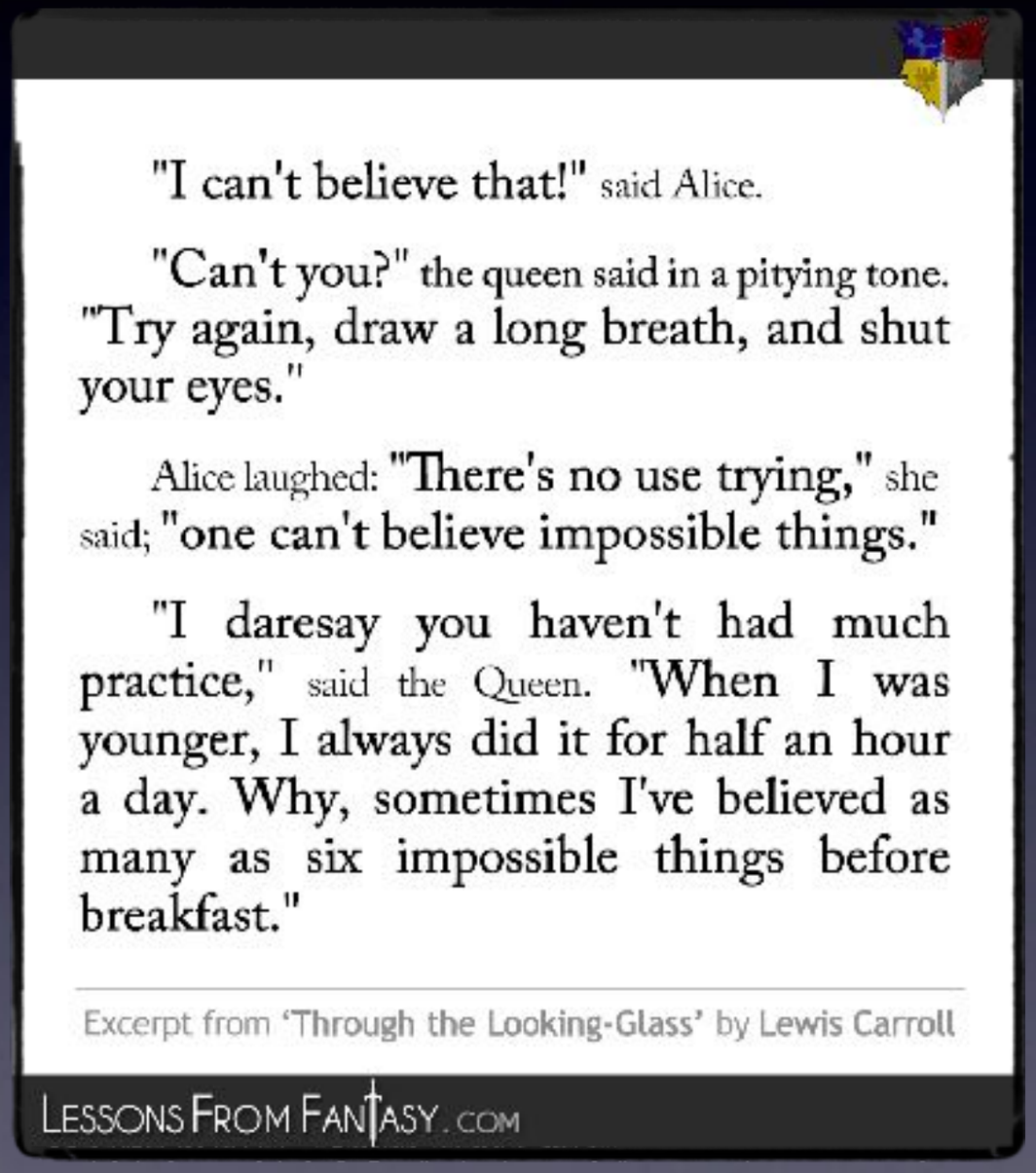
Take home messages

SMRs will be more expensive per unit of electricity generation capacity (MW) and per unit of electricity generated (kWh); will generate more radioactive waste per kWh when compared to large reactors

Long history of claims about construction times, costs, and operational efficiency being shown to be false

Unlikely to have a stable market (can at best be a boutique enterprise)

Nuclear Advocacy Strategy



Gatsby believed in the green light, the orgiastic future that year by year recedes before us. It eluded us then, but that's no matter—tomorrow we will run faster, stretch out our arms farther . . . And one fine morning—So we beat on, boats against the current, borne back ceaselessly into the past.