Small Modular Reactors

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Still Under Construction

But my research to-date is already summarized

in this noteset's web-posted **Resources webpage** (link),

which includes links to & cached copies of almost 200 sources, organized by topic:

Resources: Nuclear Power - Small Modular Reactors

> WCFTO Home > Energy Home> Web Notes > Nuclear > Resources: Nuclear Power - Small Modular Reactors

Corresponding Web Notes: Nuclear Power - Small Modular Reactors (pptx / pdf / key)

Under Construction 2025

Relevant Governmental Organizations:

DOE - Department of Energy, United States (link)

NRC - Nuclear Regulatory Commission, United States (link)

IAEA - International Atomic Energy Administration, United Nations (link)

NEA - Nuclear Energy Agency, Organization for Economic Co-operation & Development (link)

Setting the Stage - Part I: Commercial Failure of "Gen III" AP1000 Nuclear Reactors

Overviews:

AP1000 Overview - AP1000 Technology Chapter 1.0, Nuclear Regulatory Commission (link / cached copy)

AP1000 Overview Slides, Westinghouse 2011 / IAEA download (link / cached copy)

AP1000, Wikipedia 2025 (link / cached copy)

Vogtle Electric Generating Plant, Wikipedia 2025 (link / cached copy)

Blow-by-blow History:

New Nukes, MIT Technology Review 2009 (link / cached copy)

A Bitterssweet Milestone for the World's Safest Nuclear Reactors, IEEE Spectrum 2017 (link / cached copy)

Cost to Complete Vogtle AP1000 Nuclear Units Could Balloon to $20 Billion, PowerMag 2017 (link / cached copy)

Will AP1000 Reactor Projects be Completed and Will More Be Built? WiseInternational.org 2017 (link / cached copy)

How Two Cutting Edge U.S. Nuclear Projects Bankrupted Westinghouse, Reuters 2017 (link / cached copy)

Safety Problems Again Delay China's Sanmen Westinghouse AP1000 Nuclear Energy Project, CleanTechnica 2018 (link / cached copy)

How the Vogtle Nuclear Expansion's Costs Escalated, PowerMag 2018 (link / cached copy)

China Ditches U.S. Nuclear Technology in Favour of Home-Grown Alternative, WorldNuclearReport.org 2020 (link / cached copy)

U.S. Attorney Details Illegal Acts In Construction Projects Sealing the Fate of the Nuclear Renaissance, Bulletin of the Atomic Scientists 2021 (link / cached copy)

Vogtle Project Update: Cost Likely to Top $30 Billion, American Nuclear Society 2022 (link / cached copy)

Overnight Capital Cost of the AP1000, MIT Dept. of Nuclear Science & Engineering 2022 (link / cached copy)

AP1000 Remains Attractive Option for U.S. Market Says MIT, World Nuclear News 2022 (link / cached copy)

Further Delay in Startup of Vogtle AP1000s, World Nuclear News 2022 (link / cached copy)

Timeline: How Georgia and South Carolina Nuclear Reactors Ran so far off Course, AP News 2023 (link / cached copy)

What Vogtle's Stumbling Finish Means for U.S. Nuclear Energy, E&E News by Politico 2023 (link / cached copy)

Vogtle Unit 4 In-Service Date Pushed Back Due To Fault In Reactor Coolant Pump, NucNet.org 2023 (link / cached copy)

Vogtle's Troubles Bring U.S. Nuclear Challenge into Focus, Reuters 2023 (link / cached copy)

Vogtle 4 Start-up Moved to 2024, World Nuclear News 2023 (link / cached copy)

Georgia Nuclear Rebirth Arrives 7 Years Late, $17B Over Cost, AP News 2023 (link / cached copy)

Georgia's Plant Vogtle is a $35B Boondoggle, Utility Dive 2023 (link / cached copy)

We've Only Just Begun . . . the Journey Ahead for Vogtle's AP1000s, Medium.com 2024 (link / cached copy)

Setting the Stage - Part II: Lessons from Past Nuclear Accidents

Metal Fire Implications for Advanced Reactors - Part 2 - PIRT Results - Sandia National Lab 2007 (link / cached copy)

Metal Fire Implications for Advanced Reactors - Part 3 - Experimental and Modeling Results - Sandia National Lab 2007 (link / cached copy)

50 Years After America's Worst Nuclear Meltdown, EnviroReporter 2009 (link / cached copy)

Nuclear Plant Accidents: Sodium Reactor Experiment, Union of Concerned Scientists 2016 (link / cached copy)

Radiation Requiem - 60 Years After America's Worst Nuclear Meltdown, EnviroReporter 2019 (link / cached copy)

America's Worst Nuclear Disaster Was in California - Who Knew? Engineering_com 2020 (link / cached copy)

As echoed in the 1995 sodium fire at Japan's Monju Nuclear Power Plant (link / cached copy)

Graphite Moderated Reactor Fires & Meltdowns:

Windscale Fire (and meltdown of two UK reactors in 1957), Wikipedia (link / cached copy)

When Windscale Burned, Nuclear Engineering International 2007 (link / cached copy)

Report on the Accident at Windscale No. 1 Pile on 10 October 1957, W. Penney et al., Journal of Radiological Protection 37(3) p780 2017 (link / cached copy)

Chernobyl Disaster, Wikipedia (link / cached copy)

The Chernobyl Accident - International Nuclear Safety Advisory Group - 1992 (link / cached copy)

Chernobyl Accident - World Nuclear Organization - Updated 2014 (link / cached copy)

Three Decades after Chernobyl - Technical or Human Causes, The Technological and Economic Future of Nuclear Power, 2019 (link / cached copy)

Nuclear Graphite, Wikipedia (link / cached copy)

Phenomenology of Graphite Burning in Air Ingress - Moormann 2011 (link / cached copy)

Meltdowns due to Failure of "Active" (powered) Reactor Cooldown Systems:

Three Mile Island Accident, Wikipedia (link / cached copy)

Report of the President's Commission on the Accident at Three Mile Island, 1979 (link / cached copy)

Fukushima Nuclear Accident, Wikipedia (link / cached copy)

My analysis of Three Mile Island and Fukushima Disasters in the noteset. But they blow up! (pptx / pdf / key)

Loss-of-coolant Accident, Wikipedia (link / cached copy)

Passive Nuclear Safety, Wikipedia (link / cached copy)

Passive Safety Systems and Natural Circulation in Water Cooled Nuclear Power Plants, IAEA 2009 (link / cached copy)

Might Small Modular Reactors (SMRs) be the Answer?

Small Modular Reactor, Wikipedia (link cached copy)

The Next Nuclear Plants Will Be Small Svelte and Safer, Wired 2019 (link / cached copy)

What Should I Do if a Small Modular Reactor Loses Off-Site Power? Absolutely Nothing!, U.S. Department of Energy 2020 (link / cached copy)

So What Exactly Are Small Modular Nuclear Reactors? GreenTechMedia 2020 (link / cached copy)

What are Small Modular Reactors (SMRs), IAEA 2023 (link / cached copy)

Small Nuclear Power Reactors, World Nuclear Association 2023 (link / cached copy)

Policy Paper: Advanced Nuclear Technologies, U.K. Government 2024 (link / cached copy)

SMRs and Their Role as Nuclear Energy Gamechangers, Energy Magazine 2025 (link / cached copy)

Idaho National Laboratory - Advanced Small Modular Reactors, Idaho National Laboratory 2025 (link / cached copy)

Microreactors, Idaho National Laboratory 2025 (link / cached copy)

Could Built-in "Passive" (unpowered) Cooling Shut Down SMRs?

Key Terms: Emergency Core Cooling System (ECCS) & Loss of Cooling Accident (LOCA)

Small Modular Reactors: Assessing the Passive Safety Advantage (plain language overview in the technical press), InnovationNewsNetwork 2024 (link / cached copy)

LOCA-type Scenario Simulation for NuScale-SMR, Conference Paper 2019 - via Research Gate (link / cached copy)

Report on the Safety Aspects of the NuScale Small Modular Reactor, U.S. Nuclear Regulatory Commission 2020 (link / cached copy)

Natural Convection and Passive Cooling, Nuclear Heat Transfer and Passive Cooling, Volume 3, December 2021 (link / cached copy)

Advances in Small Modular Reactor Technology Developments - Supplement to IAEA Advanced Reactors Information System - ARIS, IAEA 2022 (link / cached copy)

Unique Safety Features and Licensing Requirements of the NuScale Small Modular Reactor, Frontiers in Energy Research 2023 - via Research Gate (link / cached copy)

Evaluating Direct Vessel Injection Accident-Event Progression of AP1000 and Key Figures of Merit to Support the Design and Development of Water-Cooled Small Modular Reactors, Idaho National Lab 2024 (link / cached copy)

Lessons Learned for Design of ECCS Valve obtained from NRC Design Review (for NuScale SMR) - Korean Nuc Soc - 2024 (link / cached copy)

Advanced Nuclear Power Feasibility Report, Florida Public Service Commission 2025 (link / cached copy)

The lack of non-paywalled / publicly-available SMR safety studies (for all except the NuScale SMR):

Results of a web search (cached copy)

Pay-per-view webpage for a single "Science Direct" Elsevier publication (cached copy)

For profit publishers vs. the public's need-to-know:

The Cost of Knowledge, Wikipedia (link / cached copy)

Elsevier Clamps Down on Academics Posting their own Papers Online, WIRED 2013 (link / cached copy)

6 Major Academic Publishers Face Antitrust Lawsuit, Higher Ed Dive 2024 (link / cached copy)

Academic Publishing is a Multibillion-Dollar Industry - It's Not Always Good for Science, The Conversation 2025 (link / cached copy)

The Preemptive Campaign to Weaken Nuclear Safety Standards for SMRs

States and Startups are Suing the US Nuclear Regulatory Commission, Wired, April 2025 (link / cached copy):

"The lawsuit argues that by mandating a cumbersome licensing process for all types of reactors - including those that are safer because of their size" (i.e., SMRs) "the NRC is both violating the Atomic Energy Act and stifling progress."

Trump Fires Commissioner of Preeminent Nuclear Safety Institution (i.e., Christopher Hanson, the NRC chairman Trump appointed in 2020 and Biden reappointed in 2024), ARS Technica, June 2025 (link / cached copy)

These Nuclear Reactors Fit on a Flatbed Truck. How Safe are They? The Washington Post, 8 August 2025 (link / cached copy)

Is a 'Nuclear Renaissance' Possible in the United States? Uctark.org, 8 September 2025 (link / cached copy)

Supporting Arguments?

1) SMR meltdowns are far less likely 2) An SMR meltdown would have a much smaller impact

Argument #1: As documented in the following section, not a single SMR is yet in operation (worldwide). Further, to date, the possibility of an SMR meltdown has been carefully modeled for only one SMR design (NuScale, preceding section).

Argument #2: The impact of a meltdown should vary as the amount of nuclear material released. Which, in its limit, should be roughly proportional to the reactor's power capacity. Using this to calculate the likely size of a "Nuclear Exclusion Zone" following an SMR's meltdown:

Power Capacity of the single Chernobyl reactor that melted down AND THEN burned in 1986: 1000 MW

From: Chernobyl Nuclear Power Plant, Wikipedia (link / cached copy)

Power Capacity of three Fukushima Daiichi reactors that melted down in 1986: 460 + 784 + 784 = 2028 MW:

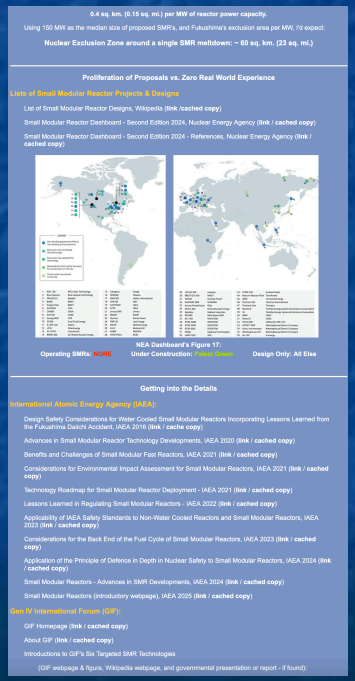
From: Fukushima Daiichi Nuclear Power Plant, Wikipedia (link / cached copy)

Then drawing from Britannica's article on the resulting "Nuclear Exclusion Zones" (link / cached copy):

Exclusion zone around Chernobyl's 1000 MW reactor = 4,143 square km. (1600 square mi.).

4,143 sq. km. (1.6 sq. mi.) per MW of reactor power capacity.

Exclusion zone around Fukushima Daiichi's 2028 MW reactors = 807 sq. km. (311.5 sq. mi.).



0.4 sq. km. (0.15 sq. mi.) per MW of reactor power capacity.

Using 150 MW as the median size of proposed SMR's, and Fukushima's exclusion area per MW, I'd expect:

Nuclear Exclusion Zone around a single SMR meltdown: ~ 60 sq. km. (23 sq. mi.)

Proliferation of Proposals vs. Zero Real World Experience

Lists of Small Modular Reactor Projects & Designs

List of Small Modular Reactor Designs, Wikipedia (link /cached copy)

Small Modular Reactor Dashboard - Second Edition 2024, Nuclear Energy Agency (link / cached copy)

Small Modular Reactor Dashboard - Second Edition 2024 - References, Nuclear Energy Agency (link / cached copy)

NEA Dashboard's Figure 17:

Operating SMRs: NONE Under Construction: Pebble Bloom Design Only: All Else

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Getting Into the Details

International Atomic Energy Agency (IAEA):

Design Safety Considerations for Water Cooled Small Modular Reactors Incorporating Lessons Learned from the Fukushima Daiichi Accident, IAEA 2016 (link / cache copy)

Advances in Small Modular Reactor Technology Developments, IAEA 2020 (link / cached copy)

Benefits and Challenges of Small Modular Fast Reactors, IAEA 2021 (link / cached copy)

Considerations for Environmental Impact Assessment for Small Modular Reactors, IAEA 2021 (link / cached copy)

Technology Roadmap for Small Modular Reactor Deployment - IAEA 2021 (link / cached copy)

Lessons Learned in Regulating Small Modular Reactors - IAEA 2022 (link / cached copy)

Applicability of IAEA Safety Standards to Non-Water Cooled Reactors and Small Modular Reactors, IAEA 2023 (link / cached copy)

Considerations for the Back End of the Fuel Cycle of Small Modular Reactors, IAEA 2023 (link / cached copy)

Application of the Principle of Defence in Depth in Nuclear Safety to Small Modular Reactors, IAEA 2024 (link / cached copy)

Small Modular Reactors - Advances in SMR Developments, IAEA 2024 (link / cached copy)

Small Modular Reactors (introductory webpage), IAEA 2025 (link / cached copy)

Gen IV International Forum (GIF):

GIF Homepage (link / cached copy)

About GIF (link / cached copy)

Introductions to GIF's Six Targeted SMR Technologies

(GIF webpage & figure, Wikipedia webpage, and governmental presentation or report - if found):

Figures being developed for the full noteset:

My cut-and-paste edit of Wikipedia's SMR List → Western designs only, sorted by "Status"

List of small nuclear reactor designs[1]

Name	Gross power (MW_e)	Type	Producer	Country	Status
CAREM	27–30	PWR	CNEA	Argentina	Under construction
VOYGR[48]	50-77 (x6)[49]	PWR	NuScale Power	United States	Licensed in the USA (50 MWe module). Seeking NRC licensing for reactor power output upgrade to 77 MWe of 6 modules (462 MWe).[50]
SMART100	110	PWR	KAERI	South Korea	Licensed in Korea (standard design approval)[37][38]
SMR-300	300	PWR	Holtec International	United States	Seeking UK licensing;[40] US NRC pre-application communications initiated[39]
Rolls-Royce SMR	470	PWR	Rolls-Royce	United Kingdom	Seeking UK GDA licensing in April 2022[30] A 16-month assessment was started in April 2023[31]
ARC-100	100	SFR	ARC Nuclear	Canada	Design (Vendor Review)[4]
BWRX-300[9]	300	BWR	GE Hitachi Nuclear Energy	United States/ Japan	Design (Pre-licensing communications with the US NRC initiated.[10])
eVinci[14]	5	HPR	Westinghouse Electric Company	United States	Design (Pre-licensing communications with the US NRC initiated.[15])
SSR-W	300–1000	MSR	Moltex Energy[43]	United Kingdom	Design (Phase 1, vendor design review).[44]
4S	10–50	SFR	Toshiba	Japan	Design (Detailed)
AP300[3]	300	PWR	Westinghouse Electric Company	United States	Design (Detailed)
BANDI-60	60	PWR	KEPCO	South Korea	Design (Detailed)[6]
IMSR400	195 (x2)	MSR	Terrestrial Energy[17]	Canada	Design (Detailed)
S-PRISM	311	FBR	GE Hitachi Nuclear Energy	United States/ Japan	Design (Detailed)
Nuward	unknown	PWR	consortium	France	Design (Conceptual). In July 2024, existing design discontinued for a simpler redesign.[23][24]
G4M	25	LFR	Gen4 Energy	United States	Design (Conceptual) (Company Ceased Trading)
CANDU SMR	300	PWR (Heavy)	Candu Energy Inc.	Canada	Design (Conceptual)
Copenhagen Atomics Waste Burner	50	MSR	Copenhagen Atomics	Denmark	Design (Conceptual)
Energy Well[12]	8.4	MSR	cs:Centrum výzkumu Řež[13]	Czechia	Design (Conceptual)
Flexblue	160	PWR	Areva TA / DCNS group	France	Design (Conceptual)
Fuji MSR	200	MSR	International Thorium Molten Salt Forum (ITMSF)	Japan	Design (Conceptual)
GT-MHR	50	GTMHR	General Atomics, Framatome	United States/ France	Design (Conceptual)
HAPPY200	200 MWt	PWR	SPIC	China	Design (Conceptual)
HTMR-100	35	GTMHR	Stratek Global	South Africa	Design (Conceptual)[2]
Last Energy	20	PWR	Last Energy	United States	Design (Conceptual)[19]
MCSFR	50–1000	MCSFR	Elysium Industries	United States	Design (Conceptual)
MRX	30–100	PWR	JAERI	Japan	Design (Conceptual)
NP-300	100–300	PWR	Areva TA	France	Design (Conceptual)
OPEN100	100	PWR	Energy Impact Center	United States	Design (Conceptual)[25]
TEPLATOR	50 (non-electric)	PWR (heavy water)	University of West Bohemia	Czech Republic	Design (Conceptual)
TMSR-500	500	MSR	ThorCon[45]	Indonesia	Design (Conceptual)
Xe-100	80	HTGR	X-energy[52]	United States	Design (Conceptual)
IRIS	335	PWR	Westinghouse-led	International	Design (Basic)
i-SMR	170	PWR	Innovative Small Modular Reactor Development Agency (KHNP and KAERI)	South Korea	Design (Basic)
SEALER[32][33]	55	LFR	Blykalla [sv]	Sweden	Design
MMR	5-15	HTGR	Ultra Safe Nuclear Corporation [d] purchased by NANO Nuclear Energy	United States/ Canada	Company filed for Chapter 11 bankruptcy.[20] Had been seeking licensing[21] Design acquired by Nano Nuclear Energy.[22]
SMR-160	160	PWR	Holtec International	United States	US NRC pre-application suspended in favor of SMR-300 design[39]
Westinghouse SMR	225	PWR	Westinghouse Electric Company	United States	Cancelled. Preliminary design completed.[51]
U-Battery	4	HTGR	U-Battery consortium[b]	United Kingdom	Cancelled. Design archived.[47]
PBMR-400	165	HTGR	Eskom	South Africa	Cancelled - demonstration plant postponed indefinitely[26]
B&W mPower	195	PWR	Babcock & Wilcox	United States	Cancelled

In Operation as of 2025 (0)

Under Construction (1 in Argentina)

Licensed (2) or Seeking License (2)

Detailed Design → Design Concept only

Abandoned or Cancelled

PWR = Pressurized Water Reactor
SFR = Sodium Cooled Fast Reactor
HPR = Heat Pipe Reactor

F = Fast = Using fast / unmoderated Neutrons
BWR = Boiling Water Reactor
MSR = Molten Salt Reactor

FBR = Fast Breeder Reactor
GTHMR = Gas Turbine Helium Modular Reactor
HTGR = High Temperature Gas Cooled Fast Reactor

LFR = Lead Cooled Fast Reactor
MCSFR = Molten Chloride Salt Fast Reactor

Drawn from: https://en.wikipedia.org/wiki/List_of_small_modular_reactor_designs

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