OpenMinds

Accelerating Nuclear Deployment in the U.S.: Addressing Bottlenecks Across the Value Chain

December 2025

Microsoft

Project Scope and Approach

US-specific challenges and bottlenecks

Light water and small modular reactors

Open-ended search for challenges and solutions

Approach

1. Map systemic challenges across permitting, supply chain, and capital access
2. Quantify potential acceleration from targeted interventions
3. Provide an implementation roadmap for policymakers, investors, and operators

Introducing Our Team

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Columbia University
MPA Climate, Energy and Environment

Project sponsor: Microsoft

Our Work to Date

Initial Research

The team focused on desktop research, mapping out the potential bottlenecks and summarizing key literature

Data Compilation & Projections

Summarized findings from the previous two months and built capacity projections for different technologies

July | August | September | October

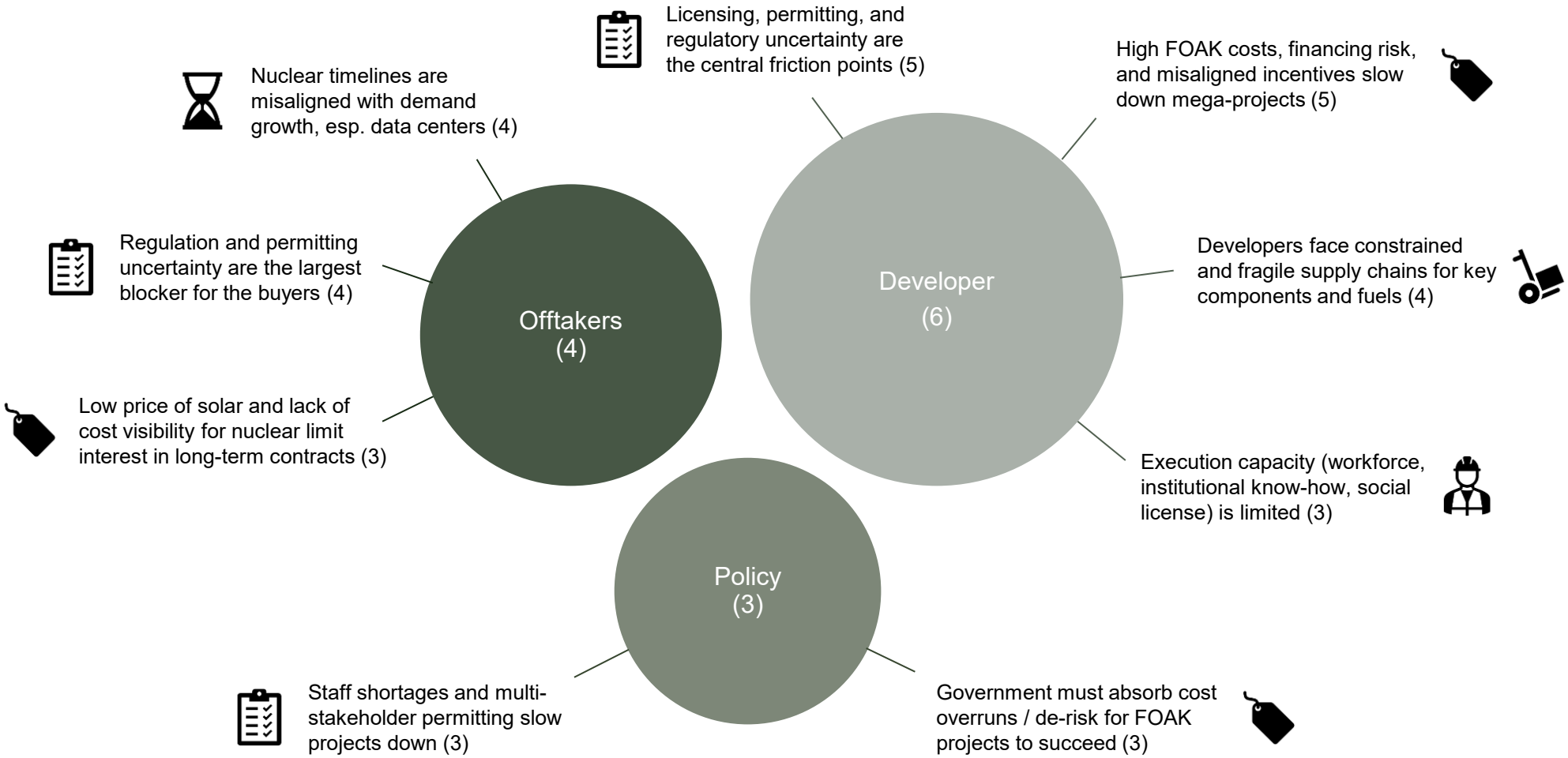
Expert Interviews

Conducted 15 interview with experts from the private sector, government and academia

Bottlenecks Analysis

Synthesized literature and expert views on possible capacity unlock and timelines for nuclear energy (how much and how fast?)

Key Trends from Expert Interviews



Values in parentheses indicate the number of interviews in each category / experts mentioning given issue or idea.

Where Are We Now?

We Need Nuclear to Keep Up with AI Energy Demands

Demand Pull

Clean. Reliable. Large-Scale.

NextEra Energy partners with Google to restart Iowa nuclear plant

ENERGY

Meta signs nuclear power deal with Constellation Energy

PUBLISHED TUE, JUN 3 2025·6:31 AM EDT | UPDATED TUE, JUN 3 2025·10:57 AM EDT

Google to fund development of three nuclear power sites

Wednesday, 7 May 2025

NATIONAL

Three Mile Island nuclear plant will reopen to power Microsoft data centers

SEPTEMBER 20, 2024 · 1:40 PM ET

Policy Push

Secure. Domestic. Labor-Intensive.

ENERGY

Trump nuclear power investment in Westinghouse could lead to IPO with U.S. government as shareholder

World Bank and IAEA backing new nuclear for development

Thursday, 26 June 2025

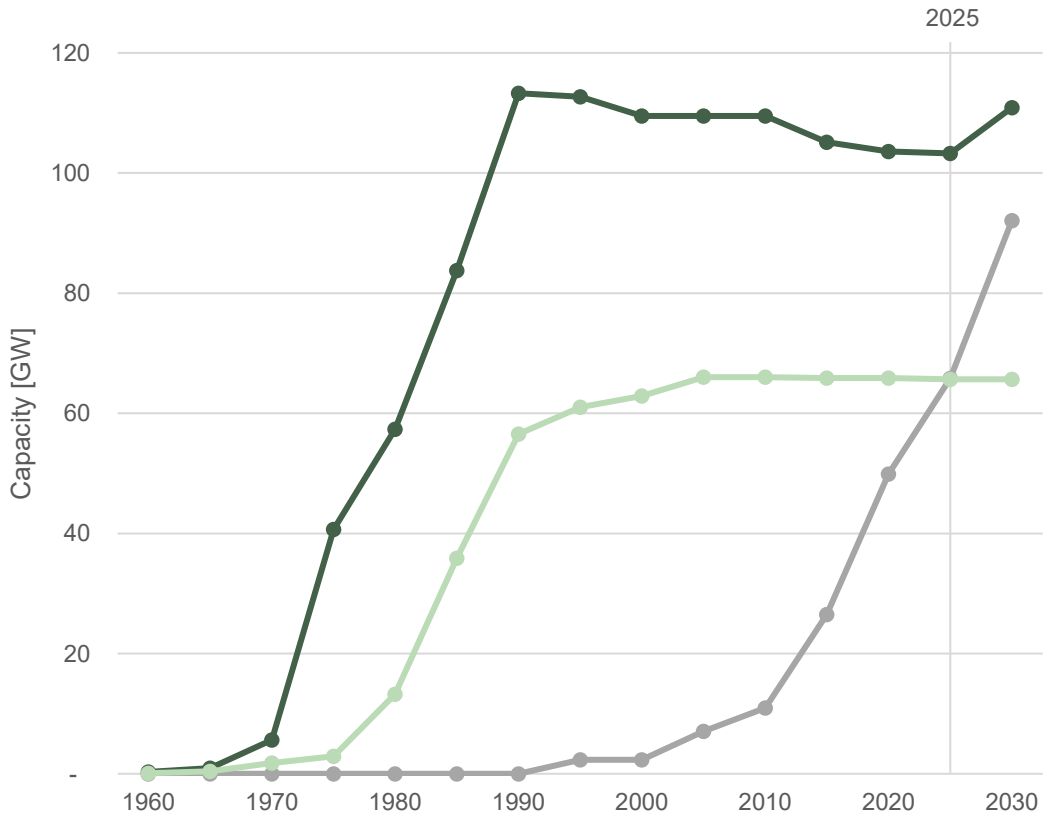
Newly Signed Bill Will Boost Nuclear Reactor Deployment in the United States

ADVANCE Act is latest legislative win to revitalize domestic nuclear power sector in U.S.

Belgium reverses phase-out policy as Denmark reconsiders nuclear

Friday, 16 May 2025

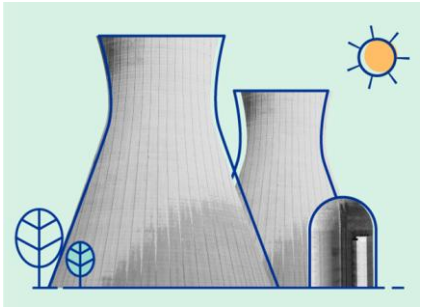
Nuclear Power Generation in the US Has Stagnated



	Operating reactors	Reactors in construction	Share of power generation
United States	94 (97.0 GW)	0 (0 GW)	18%
China	56 (54.4 GW)	30 (32.5 GW)	5%
France	56 (61.4 GW)	1 (1.6 GW)	65%

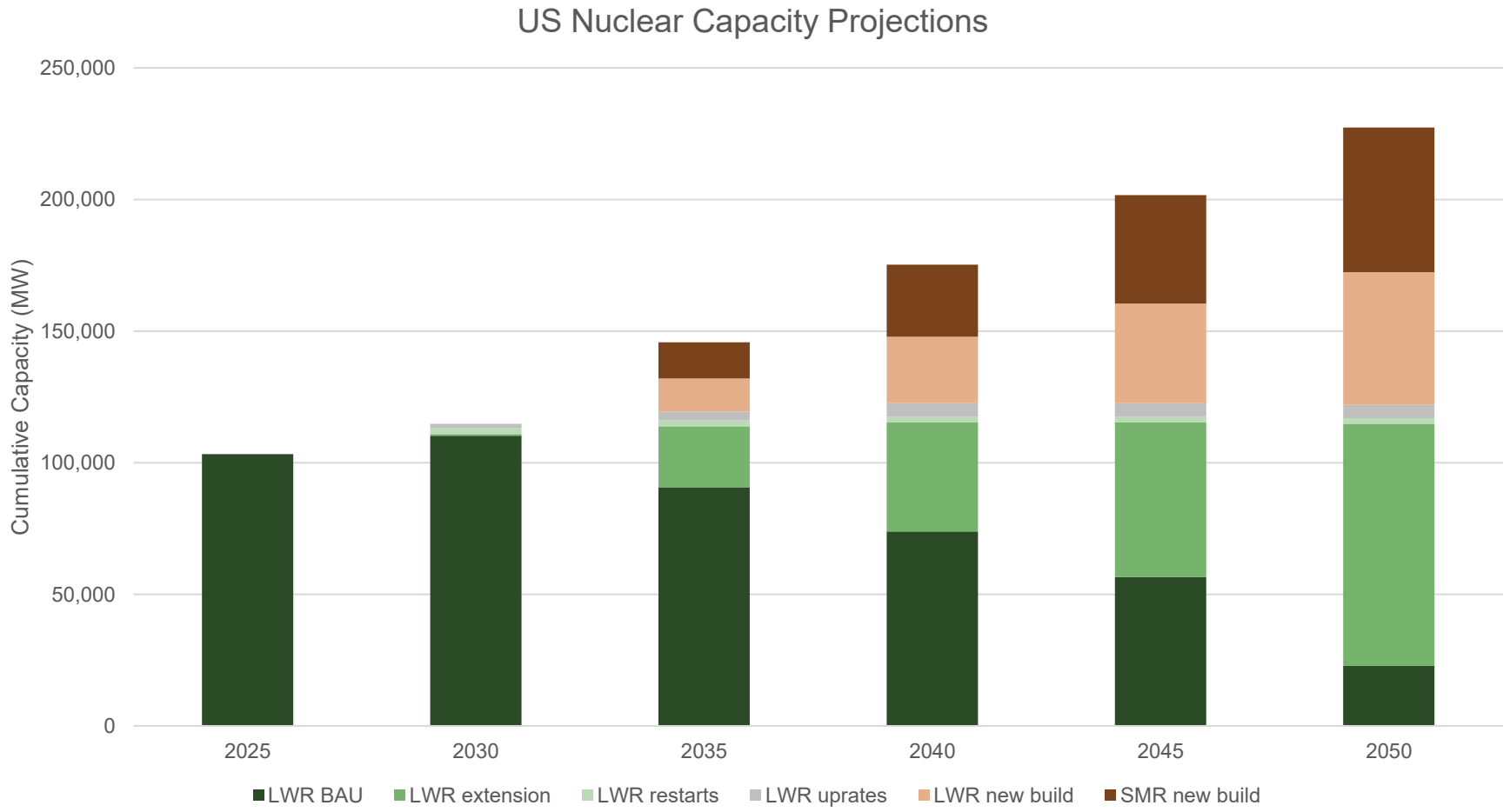
Where Are We Headed?

Uprates and Restarts Are the Fastest Capacity Additions



Technology	Conventional reactors				Small modular reactors (SMR)
Unit size	900-1,600 MW				50-300 MW
Pathway	**Uprate**	**Restart**	**Lifetime extension**	**New build**	**New build**
New cumulative capacity potential relative to BAU					
By 2030	~1.7 GW	~2.2 GW	0.6 GW	0 GW	>0 GW
By 2040	~5 GW	~4.2 GW	41.5 GW	13+ GW / ?	20+ GW / ?

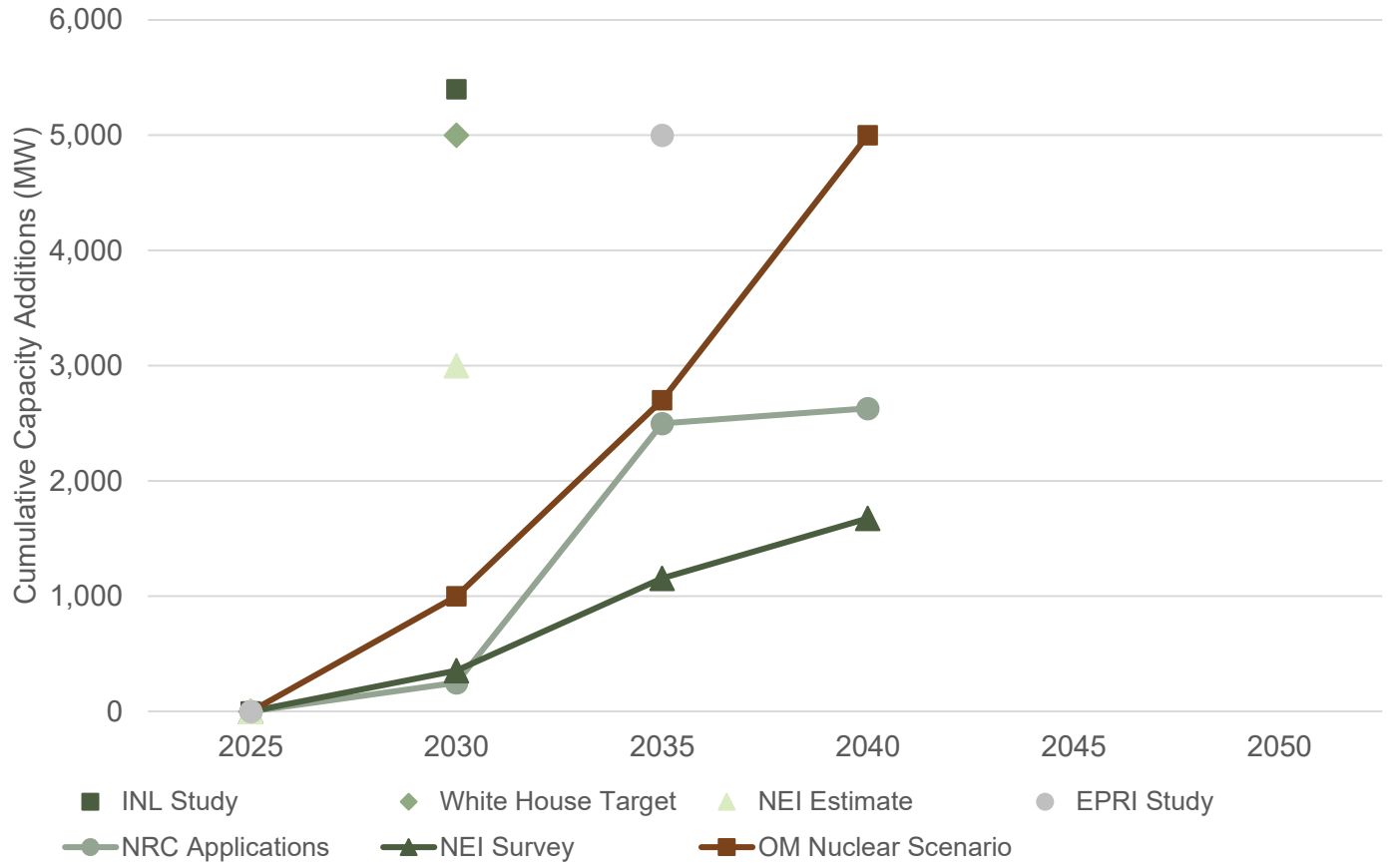
US Nuclear Capacity Projections – OM Nuclear View



Assumptions: LWR extension – all existing plants are extended to 80 years
LWR restarts – Duane Arnold and Palisades restarted by 2030
LWR uprates, LWR new build, SMR new build – see slides below

LWR Uprates Projections

OM Nuclear Base Case Forecast:
- 1 GW by 2030
- 5 GW by 2040

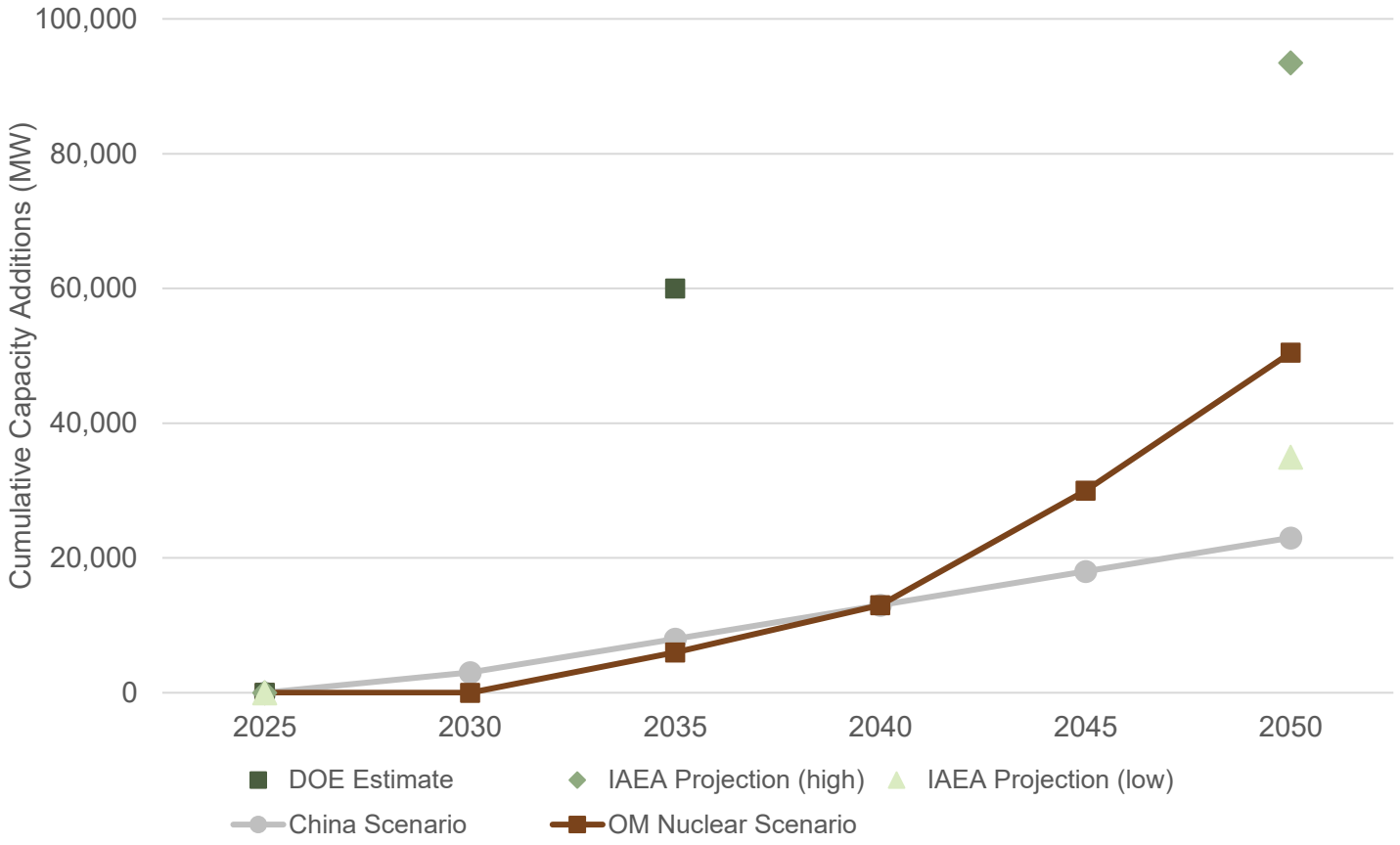


- **Government goal**: The White House has a target of 5 GW of uprates of existing reactors by 2030
- **Current state:** Anticipated applications for uprates to NRC suggest that additions due to uprates will be closer to 1.7-2.7 GW by 2040
- **Short-term:** Studies from the industry (EPRI, NEI) and national labs (INL) suggest that realistic additions due to uprates are between 3-5 GW by 2030-2035
- **Our projection:** We follow a midpoint between current trajectory and realistic capacity add based on literature

Sources: INL (2025), "Power Uprates". White House (2025), "Fact Sheet: President Donald J. Trump Reinvigorates the Nuclear Industrial Base". NEI (2024), "The Future of Nuclear Power". EPRI (2024), "Unlocking the Equivalent of 9 Large Units from the Existing U.S. Nuclear Fleet". NRC (n.d.), "Expected Applications for Power Uprates".

LWR New Build Projections

OM Nuclear Base Case Forecast:
- 0 GW by 2030
- 13 GW by 2040
- 50 GW by 2050

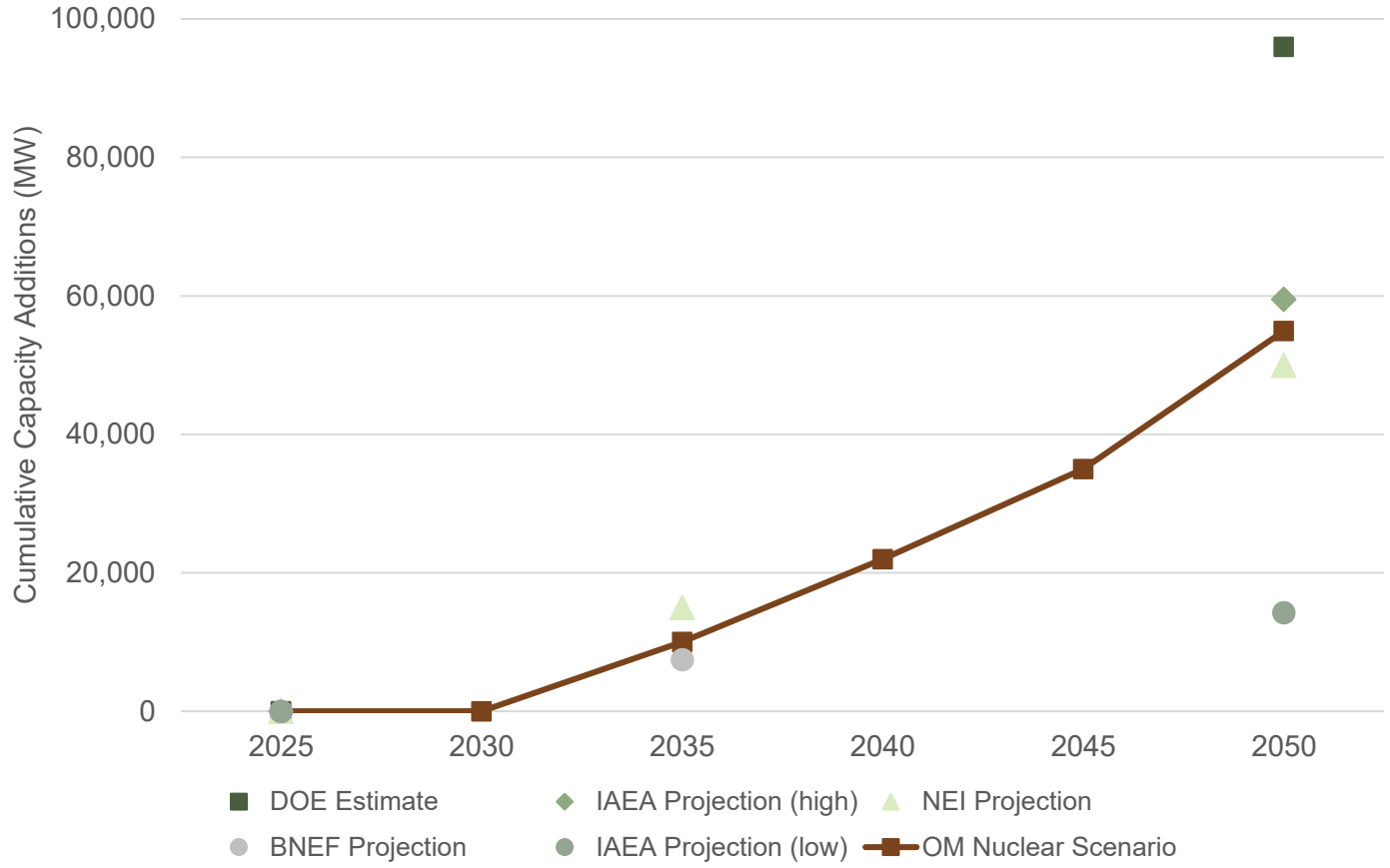


- **Government goal**: DOE estimates that up to 60 GW of new build LWR capacity can be added by 2035
- **Current state:** Currently, there are no LWR projects under development in the US
- **Long-term:** Future capacity additions estimates from the IAEA suggest a wide range of 27-95 GW capacity added by 2050
- **Our projection:** We assume that the US will be able to achieve and exceed capacity additions pace of China by mid-century

Sources: DOE (2024), "U.S. Sets Targets to Triple Nuclear Energy Capacity by 2050". IAEA (2025), "IAEA Raises Nuclear Power Projections for Fifth Consecutive Year". Global Energy Monitor data.

SMR New Build Projections

OM Nuclear Base Case Forecast:
- 0 GW by 2030
- 22 GW by 2040
- 55 GW by 2050

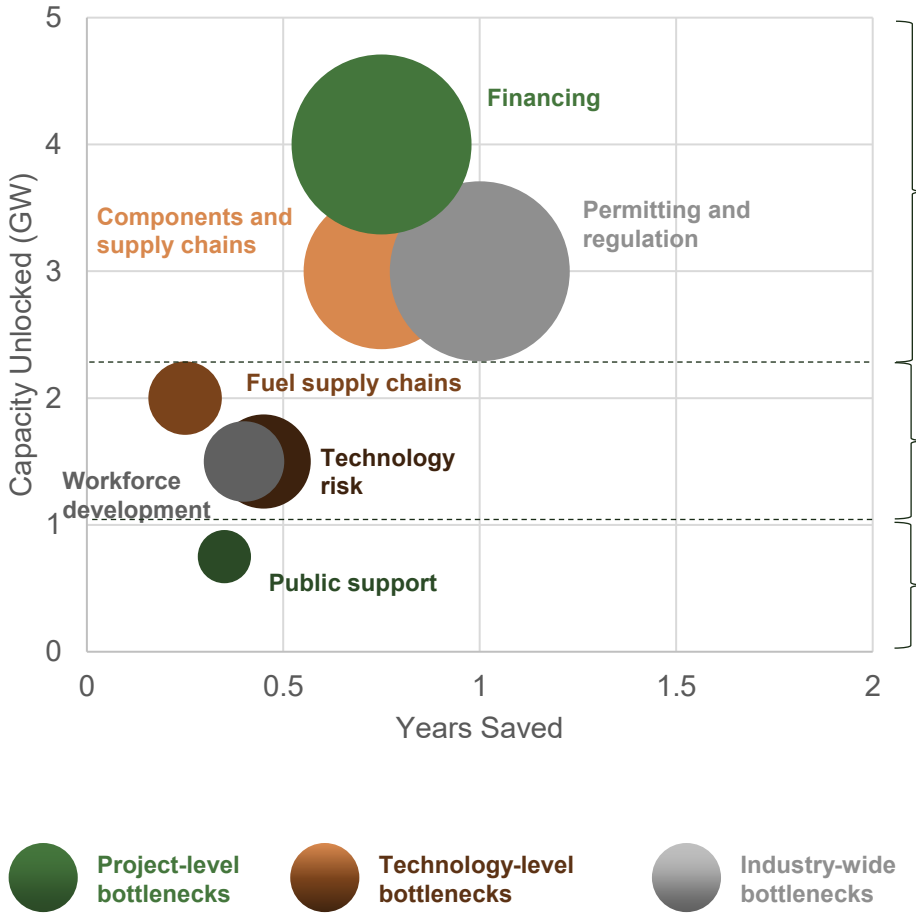


- **Government goal:** DOE estimates that up to 97 GW of new build SMR capacity can be added by 2050
- **Current state:** There are no SMR projects under development in the US and only two operational worldwide
- **Short-term**: BNEF and NEI estimate that 7.5-15 GW of SMR capacity can be built in the short term, by 2035
- **Long-term:** Other estimates expect 17-60 GW of SMR capacity by 2050
- **Our projection:** We assume that the US will follow the BNEF/NEI estimate and reach ~55 GW by 2050

Sources: DOE (2023), "DOE Releases New Reports on Pathways to Commercial Liftoff to Accelerate Clean Energy Technologies". IAEA (2025), "IAEA Raises Nuclear Power Projections for Fifth Consecutive Year". NEI (2022), "Advanced Nuclear Roadmap 2022". BloombergNEF (2025), "New Energy Outlook 2025".

How Can We Get There Faster?

LWR Uprates: Proven Technology Deployed on Existing Platforms



Tier 1: Program Levers

- **Financing**: Expanded DOE LPO coverage, tax credit eligibility, and standardized financing templates
- **Permitting & regulation**: Implementation of staffing forecasts, earlier approvals and consistent EA categorization by NRC
- **Components & supply chains**: Aggregated multi-plant orders under fleet-level framework contracts, greater throughput of uprate projects

Tier 2: Execution Levers

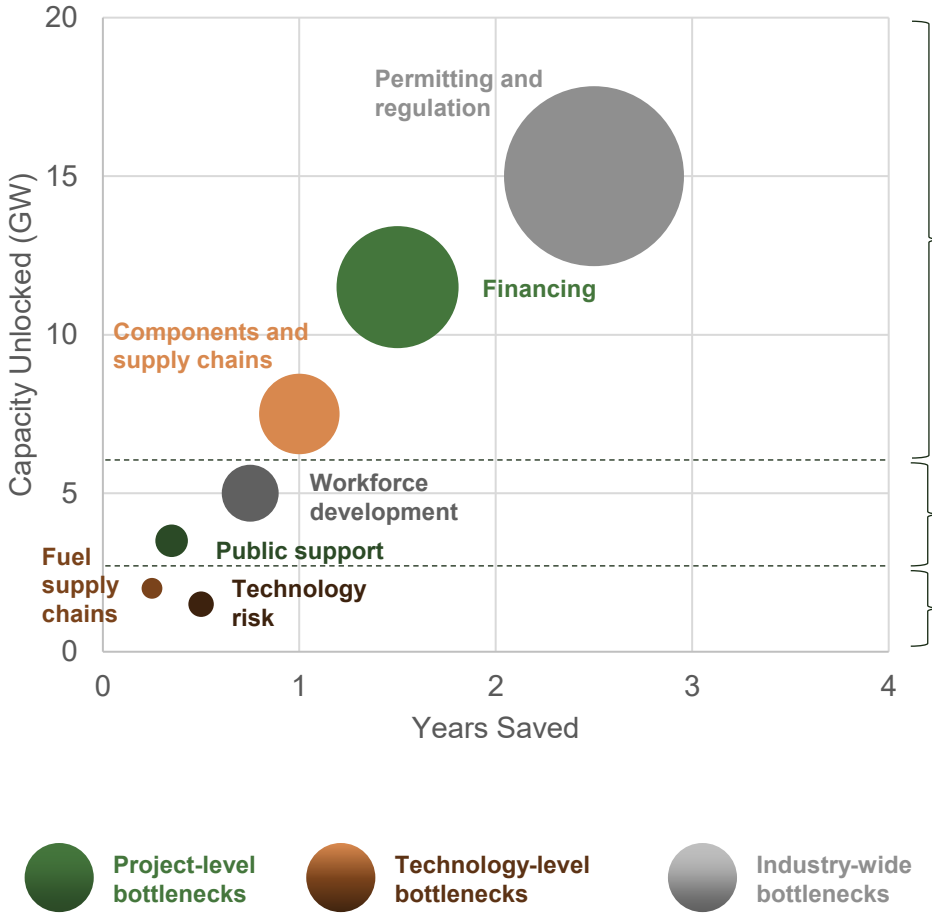
- **Fuel supply chains (LEU)**: Reduced long-term supply risk and improved investor confidence through diversification
- **Workforce development**: Coordinated outage scheduling, modular workpacks, and regional training pipelines; higher annual execution throughput
- **Public support & social license**: Transparent modeling of environmental effects, fewer procedural delays

Tier 3: Background Levers

- **Technology risk:** Expanded use of NRC-approved topical reports; reduced redesign or re-analysis cycles

Cumulative unlocked and accelerated capacity: up to 5 GW/year

LWR New Builds: Highest Potential Technology with Outstanding Unmitigated Risks



Tier 1: Program Levers

- **Permitting & regulation**: Shortened COL + NEPA via FAST 41, 2-year EIS, 18-month NRC; projects pulled forward, reduced cancellations
- **Financing (WACC, guarantees)**: Scaled DOE LPO and regulated-revenue models; large LWR projects financeable at reasonable cost of capital
- **Components & supply chains**: Framework orders and new qualified forges/RCP vendors; removed long lead bottlenecks and enabled parallel builds

Tier 2: Execution Levers

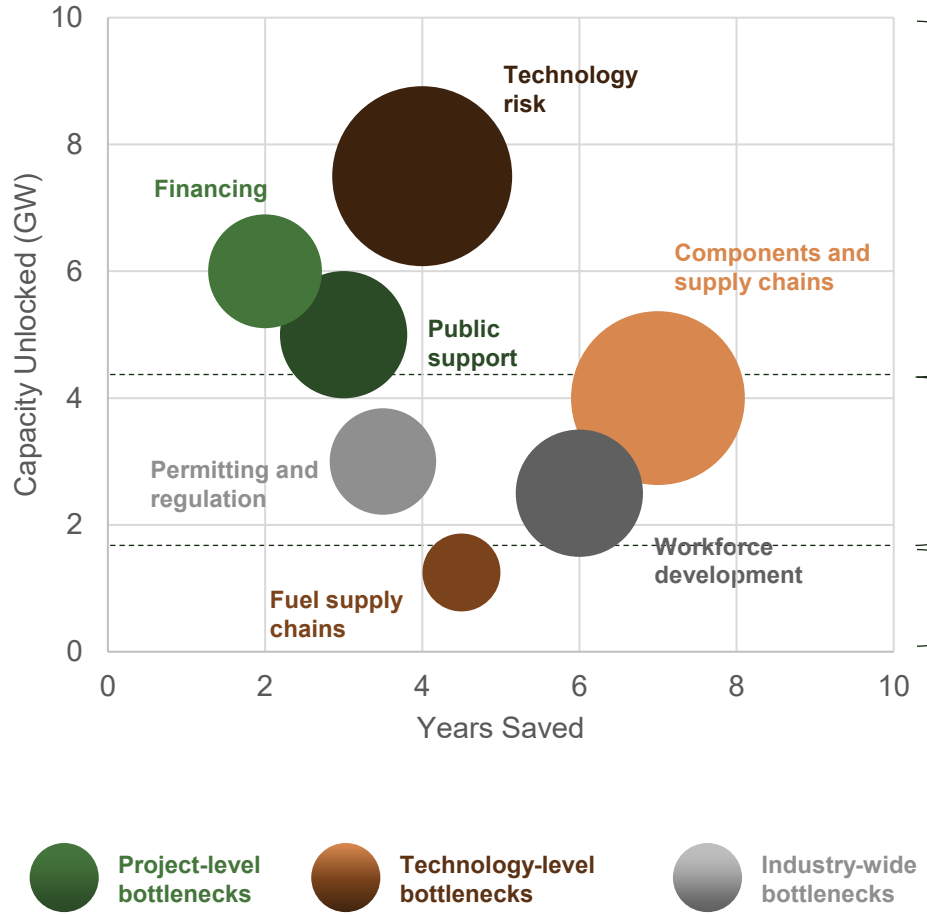
- **Workforce development**: Dedicated nuclear craft pipelines and programme-level labour planning; limits schedule slippage from missing trades
- **Public support & social licence**: Early engagement and standard community-benefit packages; reduced local opposition risk on siting

Tier 3: Background Levers

- **Fuel supply chains (LEU)**: Expanded Western enrichment/fabrication and diversify fuel contracts; lowered geopolitical and financing risk
- **Technology risk:** Standard reference designs and strict change control; cut redesign churn and predictable schedules

Cumulative unlocked and accelerated capacity: up to 25 GW/year

SMR New Build Projections: New Technology with New Risks



Tier 1: Program Levers

- **Technology risk:** FOAK proving cost/schedule and O&M; design freeze and strict change-control enabling rapid NOAK replication across fleets
- **Financing**: Risk-sharing (DOE LPO, CfDs, rate-base, data-center PPAs), standardized multi-unit financing packages, and stacked tax credits
- **Public support & social licence**: Early engagement, coal-to-nuclear site reuse, and clear safety/waste communication

Tier 2: Execution Levers

- **Components & supply chains**: Qualified SMR module factories, frame agreements across fleets, and expanded N-stamp capacity; parallel factory lines enabling 5–10 units/yr
- **Workforce development**: SMR-focused craft pipelines, vendor academies, and regional deployment hubs
- **Permitting & regulation**: Standardized licensing for SMRs (Part 53 + Canadian precedents), programmatic siting, and repeatable multi-unit approvals; faster throughput as first design certifications complete

Tier 3: Background Levers

- **Fuel supply chains**: SMRs rely on existing LEU supply; advanced SMRs contingent on HALEU ramp-up from pilot volumes to industrial scale

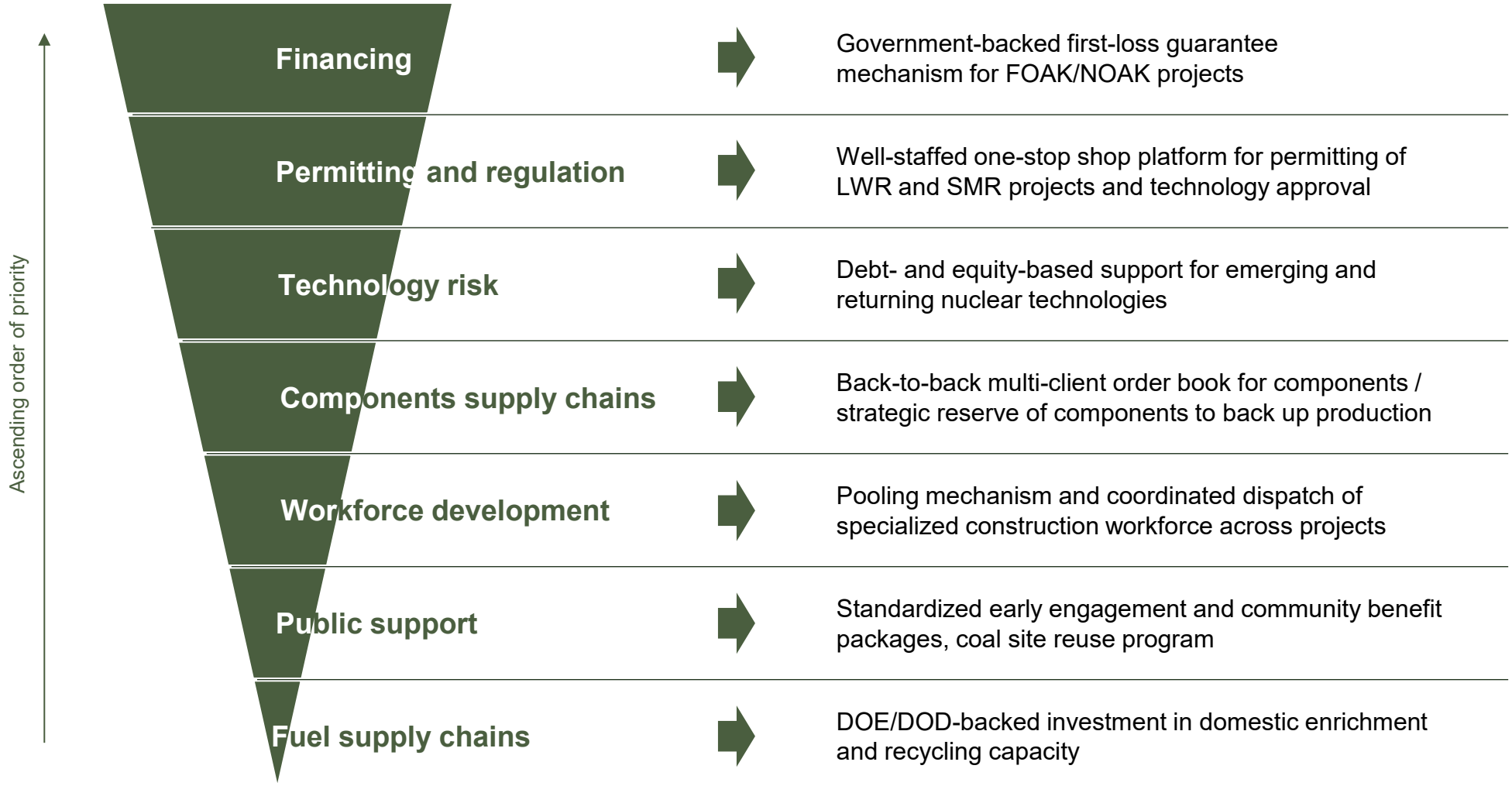
Cumulative unlocked and accelerated capacity: up to 20 GW/year

Deployment Bottlenecks Vary Between Technologies

Low priority | Medium priority | High priority

		LWR Uprates	LWR New Builds	SMR New Builds
Project-level bottlenecks	Financing	◔	◔	●
	Public support	◔	◔	◔
Technology-level bottlenecks	Technology risk	◔	◑	●
	Components and supply chains	◑	◑	◔
	Fuel supply chain	◔		◑
Industry-level bottlenecks	Workforce development		◑	
	Permitting and regulation	◑	●	◔

U.S. Inc. Actions for Addressing the Bottlenecks

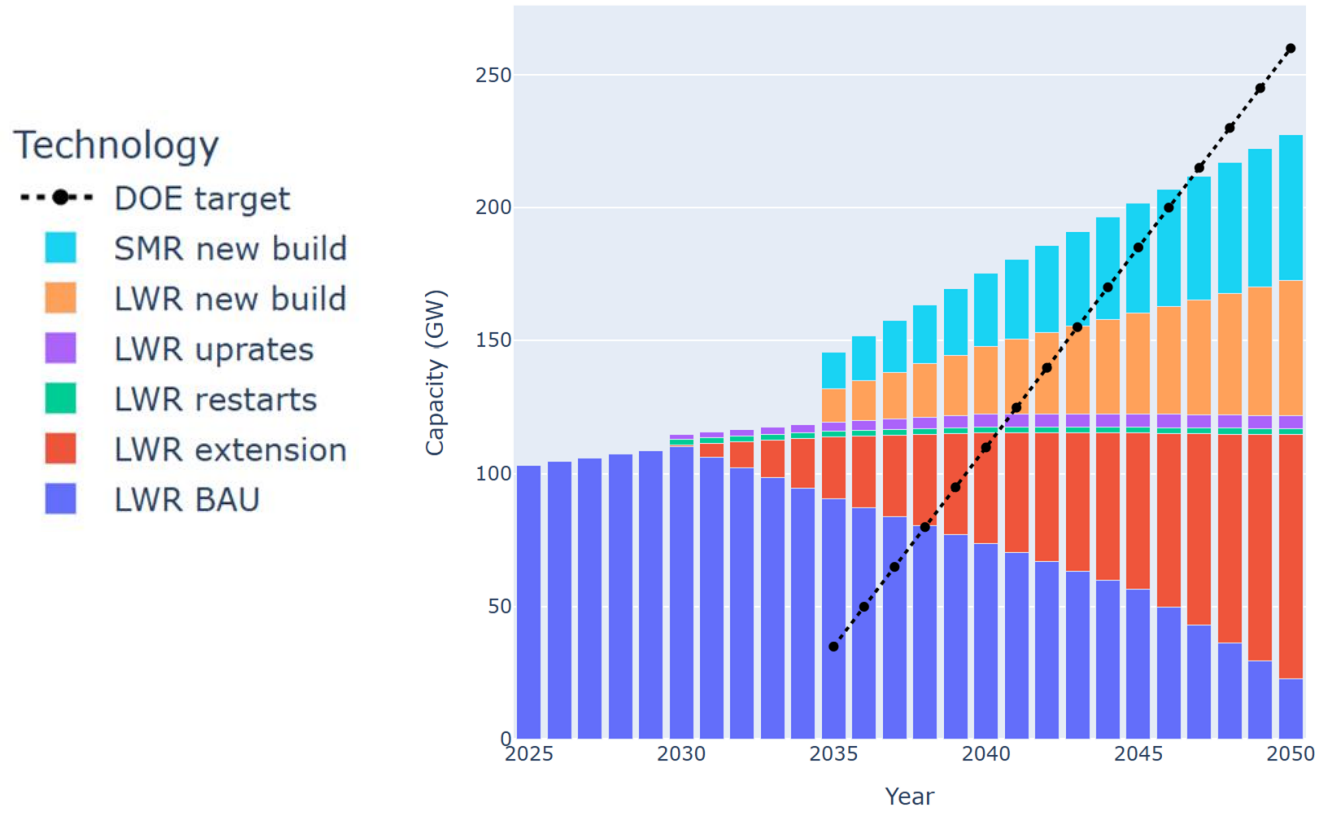


Model Demonstration

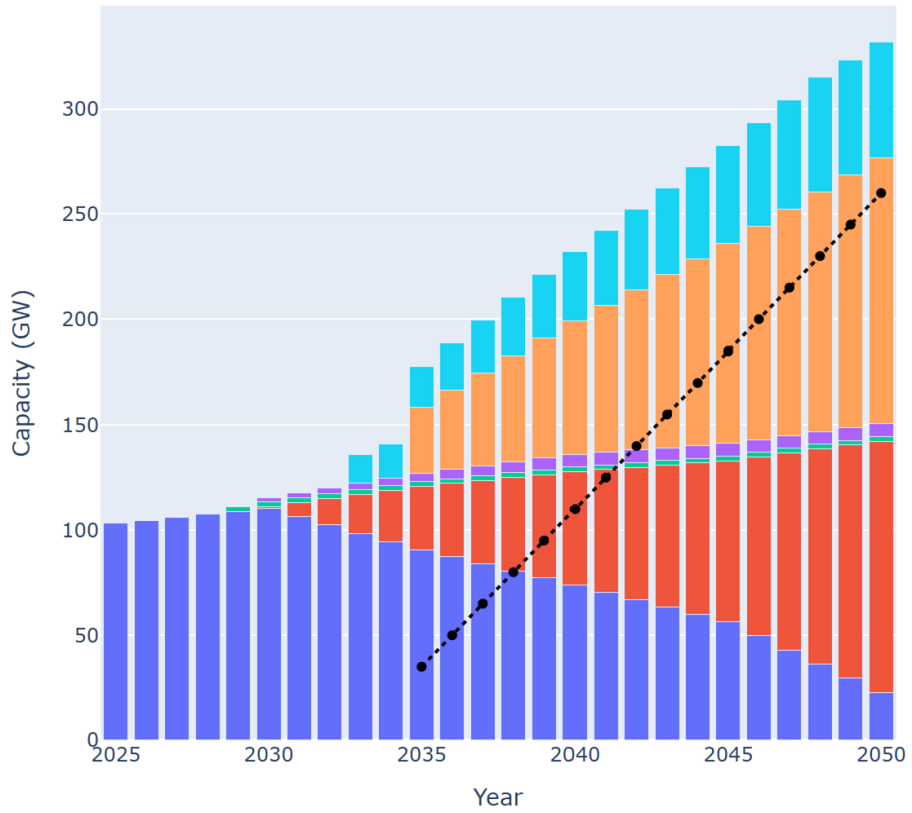
Dynamic Modeling: Nuclear Capacity (GW) in the U.S.

- ➔ Licensing reform for SMR
- ➔ Full loan guarantees for LWR new builds, but construction delays (-30%)
- ➔ Fast track re-licensing of LWR restarts
- ➔ 20% boost of LWR uprates
- ➔ 30% LWR extension

Without catalytic acceleration efforts:



With “levers pulled”:



"All models are wrong, but some are useful." - statistician George E. P. Box

The best time to build nuclear was 20 years ago.
The second-best time is NOW.


OpenMinds
Thank you!
Questions?

Solving for the
Dual Challenge.