CLIMATE INSIDER
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Small Modular Reactors

Assessing The Commercial Readiness, Market Pathways and Implementation Opportunities For Industrial Stakeholders

April 2025

The SMR Market Opportunity

Small Modular Reactors are entering the commercial deployment phase in 2025, offering a reliable zero-carbon energy option for electricity generation and industrial heat applications. This report examines leading SMR technologies, their readiness for market, and provides practical guidance for organizations evaluating SMR adoption as part of their long-term energy strategy.

Market Potential & Key Designs

$300B(1)
Global Market Potential by 2040
Representing a huge clean energy investment opportunity

15Gt
CO_2 Reduction by 2025
If SMRs scale as envisioned (~21 GWe by 2035)(2)

80+
Design Options
In various stages of development worldwide, with several nearing deployment readiness

Target Segment Value Propositions

Segment	Value propositions
Industrial users	• **Decarbonization**: Substitute fossil fuels in hard-to-abate sectors, potentially reducing emissions by 50–80% • **Energy security:** Secure reliable, high-temperature heat and electricity
Infrastructure developers	• **Versatility:** Integrate SMRs into smart grids, micrograds, and district heating systems • **Urban Integration:** Ideal for data centres and transport hubs seeking stable, decarbonized baseload power with a limited spatial footprint
Utilities and power providers	• **Grid stability:** Enable firm, dispatchable zero-carbon generation, complementing variable renewables and balancing grid volatility • **Economic efficiency:** Potential for multi-SMR fleet efficiencies, reducing operational costs over time

(1) N. Katsiotis, “Small Modular Reactors: Redefining Global Energy Security for a Digitalized Future”, Strategy international, February 2025. (2) “The NEA Small Modular Reactor (SMR) Strategy”, Nuclear Energy Agent, 2025.

SMR Commercial Deployment Roadmap 2025-2035

Commercialization timeline

Non-exhaustive

2025

Demonstration Project Development and Licencing Milestones

- X energy submitted a construction permit application to the U.S. Nuclear Regulatory Commission (NRC)
- 9 EU selected project working groups in 2024 move ahead in development

2026

First Commercial Onshore Deployment

- China's Linglong One SMR expected to become operational(1)

2027-29

North American and European Advances

- Canada's Darlington site to deploy BWRX-300 reactors(2)
- Poland to deploy BWRX-300 reactors, marking a significant step in European SMR adoption(3)

2030

US and UK Milestones

- Tennessee Valley Authority to deploy BWRX-300 reactor for the Clinch River site(4), and UK to complete four AP300 SMRs(5)

2035

Global Integration

- SMRs become mainstream power source with advanced designs entering mainstream deployment

(1) "World's first commercial small modular reactor powers up 'brain' in China", CGTN, May 2024. (2) J. Adkins, "Darlington BWRX-300 To Receive Construction Permit 'By End 2024'", NUCNET, July 2023. (3) "OSGE initiates working group within the European Industrial Alliance on SMR", OSGE, July 2024. (4) S. Patel, "TVA Taps Bechtel, Sargent & Lundy, and GE Hitachi for Clinch River SMR Nuclear Project", Powermag, 2023. (5) "UK's First SMR Nuclear Project to Showcase Four Westinghouse AP300 Reactors", Powermag, 2024.

Market Drivers & Strategic Value Propositions

SMRs address critical challenges across various sectors. Their strategic value varies by customer segment, from utilities seeking scalable deployment and enhanced grid integration to energy-intensive industries requiring reliable process heat and on-site power generation.

Market Drivers

Decarbonization Imperatives: Governments and industries pursuing net-zero goals need stable, clean electricity sources. SMRs offer reliable, low-carbon alternatives to fossil fuels.
Energy Security Concerns: Fluctuating fuel prices and geopolitical tensions drive interest in domestically deployable energy sources that reduce reliance on imports.
Industrial Heat Demand: Many industrial processes require high-temperature heat (300-850°C). SMRs efficiently provide this heat as a cleaner alternative to fossil fuels.
Grid Reliability and Capacity Replacement: Aging infrastructure and intermittent renewables create demand for dependable power generation. SMRs can replace retiring plants and ensure grid stability.
Economic Development: SMR projects can stimulate local economies through job creation in manufacturing, construction, and operations.
Cost Stability: SMRs can provide more predictable energy costs, aiding long-term financial planning for businesses and utilities.

Strategic Value Propositions

Utilities:
- Scalable Deployment: SMRs allow utilities to incrementally add capacity in line with demand, optimizing capital expenditure.
- Enhanced Grid Integration: SMRs can provide baseload power or load-following capabilities, facilitating the integration of variable renewable energy sources.

Energy-Intensive Industries:
- Reliable Process Heat: SMRs can deliver consistent, high-temperature heat required for industrial processes, reducing reliance on carbon-intensive sources.[(1)]
- On-Site Power Generation: Locating SMRs near industrial sites minimizes transmission losses and enhances energy security.

Remote Communities and Mine Sites:
- Energy Access: SMRs can provide a stable power supply to remote or off-grid areas where extending traditional power infrastructure is challenging.
- Reduced Fuel Dependency: By decreasing the demand for diesel or other imported fuels, SMRs can lower energy costs and environmental risks associated with fuel transportation.

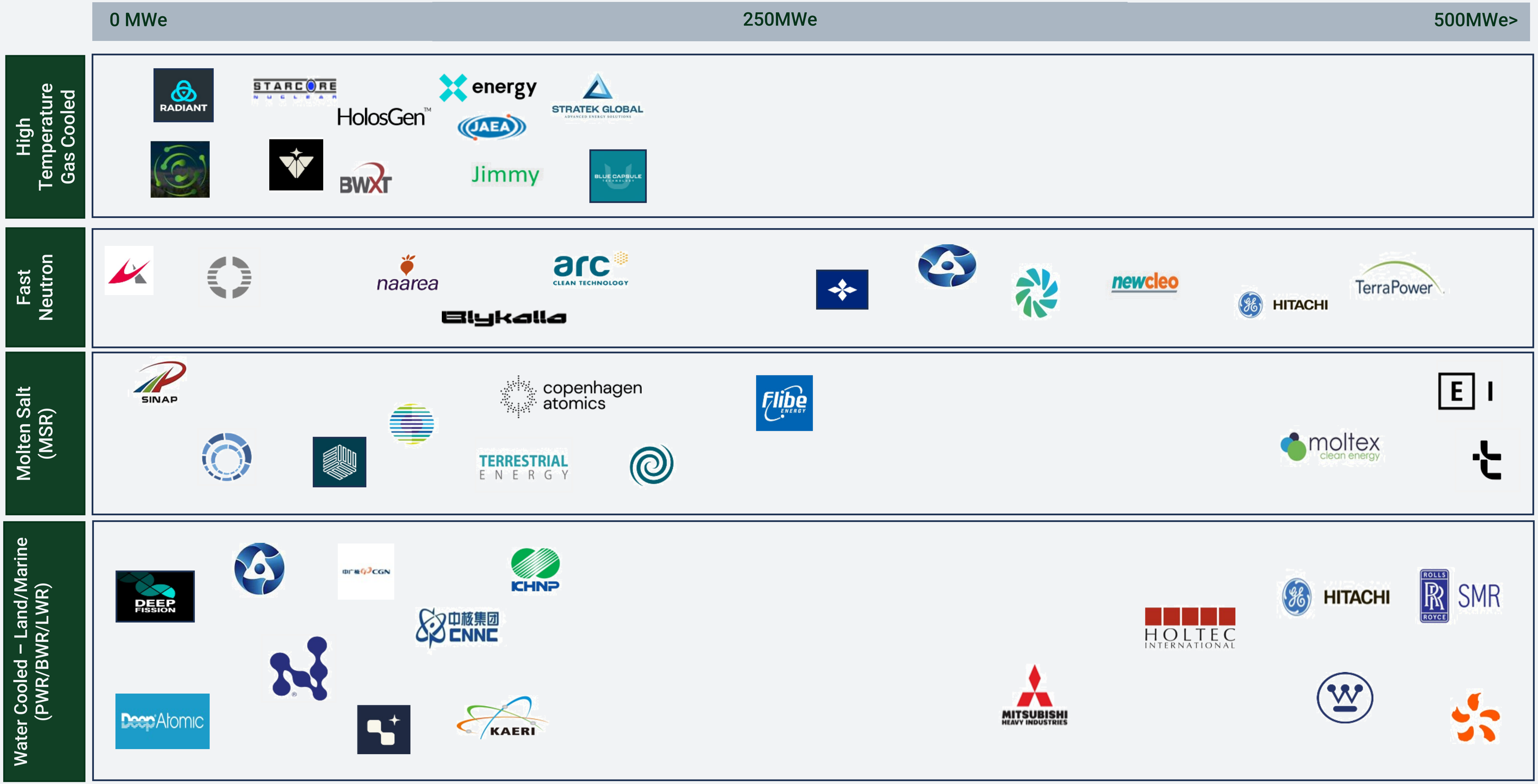
Data Centers and Technology Firms:
- Sustainable Power Supply: As data centers' energy demands grow, SMRs offer a carbon-free solution to meet sustainability targets.[(2)]
- High Reliability: SMRs provide consistent and reliable power, crucial for data center operations that require uninterrupted electricity supply.

Desalination: SMRs are adaptable to any desalination method and can be scaled to meet project needs[(3)].

Hydrogen production: SMRs generate high-temperature heat for efficient thermochemical hydrogen production[(4)] at a lower cost than conventional methods[(5)].

(1) Accelerating new nuclear and small modular reactor deployment, World Economic Forum, November 2024. (2) R. Mammadov, SMRs and data centers: The race for sustainable power solutions, Fuld & Company, 2025. (3) Y. Yoo, "Evaluating the economic and environmental viability of small modular reactor (SMR)-powered desalination technologies against renewable energy systems", Desalination, Elsevier, January 2025. (4) "Small Modular Reactors (SMRs) and Hydrogen Production", Small modular reactors, 2024. (5) "Study reveals low cost of nuclear H2", UCL energy, May 2024.

Market Map for SMRs by Climate Insider



Source: Climate Insider Intelligence Platform

Technical | Market | Policy | Organizational

Case study: NuScale Power

NUSCALE Power for all humankind exhibits high readiness across all four dimensions of the framework, positioning it as a leading contender in the SMR market

Technical Readiness

First SMR of its type to receive U.S. Nuclear Regulatory Commission design approval, indicating high Technology Readiness Level (TRL). Comprehensive testing programmes have been conducted to validate safety and performance[1]

Market Readiness

Secured international deployment agreements in countries like Ghana and Romania[2]. Established partnerships with firms like Doosan Enerbility and Sargent & Lundy to support manufacturing and deployment.

Policy Readiness

Successfully navigated regulatory frameworks to achieve NRC design approval. Projects have received backing from U.S. government initiatives, facilitating policy support for deployment.

Organizational Readiness

Demonstrated organizational maturity through strategic partnerships and a clear path to commercialization. Structured testing and validation processes indicate proactive risk mitigation.

(1) S. Singer, “NuScale Power’s small modular reactor design is first in US to get NRC approval”, Utility Dive, January 2023. (2) S. Writer, “Ghana secures NuScale SMR agreement”, Nuclear engineering international, September 2024.

Commercial Readiness Framework

Climate Insider's Four-Dimensional Readiness Framework provides a comprehensive methodology for assessing SMR commercial viability. These dimensions are interconnected, creating feedback loops that impact overall readiness, e.g., technical advancements enhance market confidence, while market demand informs R&D priorities and design choices.

Technical Readiness

Technology maturity, safety validation and performance verification

Market Readiness

Supply chain reliability, commercial ecosystem and cost competitiveness

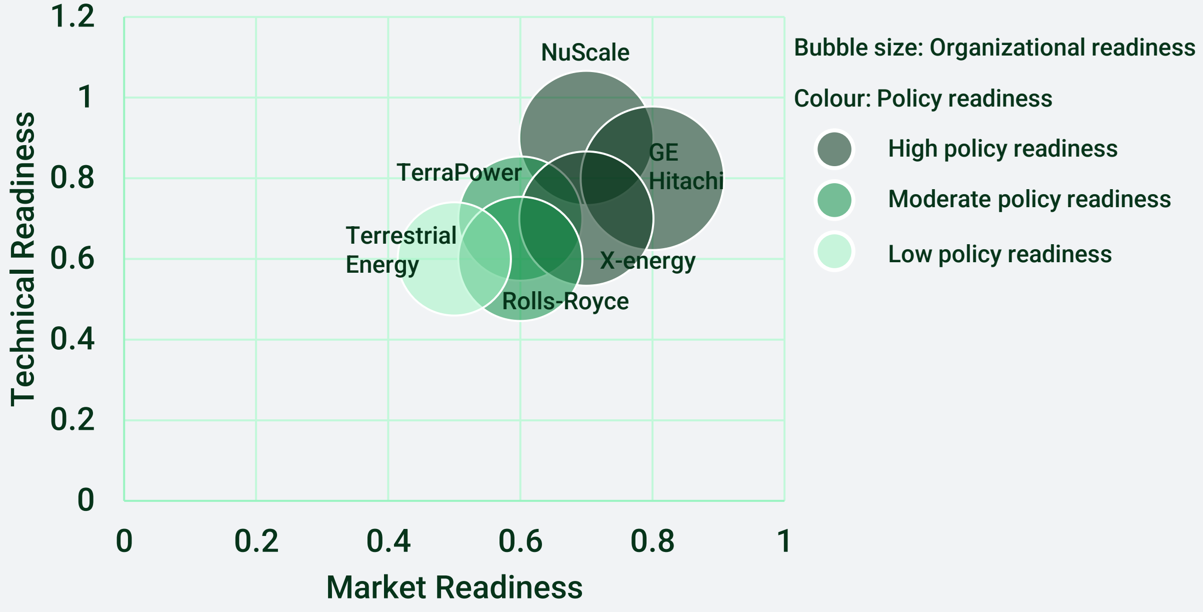
Commercial Readiness

Policy Readiness

Regulatory frameworks, financial incentives and stakeholder engagement

Organizational Readiness

Capabilities assessment, partnerships strategies and risk management



Technical Readiness Assessment of leading SMR designs

Technical readiness is evaluated across 7 key criteria: Technology Readiness Level (TRL), Safety Demonstration Maturity, Performance Metrics Validation, Design Maturity & Engineering, Fuel Qualification Status, Component Demonstration, and Simulation & Modeling Validation. Each criterion is scored on a 1-5 scale, with higher scores indicating greater readiness for commercial deployment.

SMR Design	Reactor Type	TRL	Safety Demo	Performance	Design Maturity	Fuel Qualification	Component Testing	Modeling
NuScale VOYGR[1]	Integral PWR	8-9	Extensive	Proven scalability	Fully engineered	Standard LEU	Completed	Simulation validated
BWRX-300[2]	BWR	8	Simplified passive	High efficiency	Step 2 of UK GDA	Standard BWR	Commercially adapted	Under review
Xe-100[3]	HTGR	7-8	Robust under stress	High-temp. output	NRC Construction Permit filed	TRISO fuel licensed path	Advanced development	Advanced modeling
IMSR[4]	MSR	6-7	Inherent safety	Strong thermal output	Vendor design review complete	Molten salt under review	Early-stage	Limited validation
Natrium[5]	Sodium Fast	7	Advanced passive safety	Hybrid thermal and grid flexibility	Construction underway	Under development	Progressing	Simulation progressing
Rolls-Royce SMR[6]	PWR	7-8	Factory-built, safety-focused	Flexible, modular output	Step 2 GDA completed	Standard LEU planned	Pre-qualified	Simulation ongoing

NuScale leads with NRC certification and extensive validation, while GE Hitachi follows leveraging existing BWR technology. High-temperature designs like X-energy's Xe-100 offer industrial applications but face additional fuel qualification challenges. Advanced concepts like TerraPower's Natrium show promise but require further development.

(1)"The ideal energy solution for AI", NuScale, 2025. (2) "BWRX-300", Hitachi, 2025. (3) X-Energy website. (4) "Integral Molten Salt Reactor: Carbon-free, Low-cost, High-impact. Flexible and Resilient", Terrestrial energy, 2024. (5) "The Plant", TerraPower, 2025. (6) "Our vision", Rolls-Royce SMR, 2025.

Deployment Archetypes & Pathways

SMR Deployment Archetypes

SMR Deployment Archetype	Typical Capacity Range (MW)	Capital Cost Range	Construction Timeline	Regulatory Complexity	Key Requirements for Success	Examples of Companies
Grid-Scale (Utilities)	300–1000 MW	$5,000–10,000/kW (FOAK)	8–10 years	High	Transmission access, modularity, regulatory maturity	GE Hitachi BWRX-300 (Darlington, Canada), TVA Clinch River Site (US), Rolls-Royce SMR (UK)
Industrial Co-Generation	50–300 MW	$4,000–8,000/kW	5–9 years	Medium-High integration complexity, industrial safety licensing	Heat/electricity integration, industrial partnerships	Xe-100 at Dow (US), IMSR for Alberta oil sands (Canada)
Remote/ Distributed Power	1–50 MW	$100M–$300M+ per unit	5–7 years	Medium-High	Refuelling intervals, autonomous ops, logistics	DOD Project Pele (US), Microreactor pilots (Canada)
District Heating / Desalination	100–300 MWt	$3,000–6,000/kW	6–10 years	Medium	Urban infrastructure integration, seasonal demand management	ACP100 (China), European studies (Poland, Finland)

Design Decision Pathways

1. **Capacity Need & Scalability**
   Modular SMRs allow phased buildout
2. **Cost & Financing**
   LCOE analysis and financing options
3. **Regulatory Environment**
   Jurisdictional support influences selection
4. **Site Suitability**
   Brownfield sites simplify permitting and logistics
5. **Partnership Models**
   Strategic partnerships reduce FOAK risk

Policy Readiness Assessment

Regulatory Framework Maturity

The extent to which a country has a transparent and streamlined regulatory system for nuclear technologies—especially SMRs:

- Existence of an established licensing body (e.g., CNSC in Canada, NRC in the U.S.) with published procedures for SMR licensing.
- Technology-neutral frameworks that can accommodate different SMR types (LWR, MSR, HTGR, etc.).
- Pre-licensing tools like Canada's Vendor Design Review (VDR), allowing early-stage regulatory engagement.
- Use of existing environmental assessments (e.g., Darlington's reused EA) to reduce project duplication and accelerate approval.

Financial Incentives

Government mechanisms that reduce capital expenditure or improve project bankability through direct or indirect financial support:

- Production tax credits (PTCs) or investment tax credits (ITCs) – e.g., U.S. IRA's 45U nuclear PTC.
- Loan guarantees – e.g., Canada Infrastructure Bank's $970M loan to Darlington BWRX-300.
- Clean energy grants or cost-sharing programs – e.g., U.S. DOE's ARDP, Canada's Strategic Innovation Fund (SIF).
- Carbon pricing – Implicit incentives for low-emission generation

Stakeholder Engagement

The degree to which community members, Indigenous groups, environmental NGOs, labour unions, and other stakeholders are included in SMR project development:

- Transparent, early engagement—sharing timelines, risks, and safety information.
- Indigenous inclusion—consultation, partnership models, procurement preferences, co-ownership opportunities.
- Public hearings and participatory processes—mandated by regulators or voluntarily adopted by developers.
- Environmental justice considerations—particularly relevant in siting near vulnerable or historically underserved communities.

Technical | Market | Policy | Organizational

Policy Readiness Assessment: Canada's landscape

Regulatory Framework Maturity

Examples

Canada's robust system includes the Vendor Design Review (VDR) pre-licensing process, streamlined environmental assessments, and international regulatory collaboration. The CNSC's adaptive approach accelerates approval timelines while maintaining safety standards.

Lessons

- Early engagement between regulators and developers reduces licensing delays.
- International coordination enhances efficiency and confidence.
- Adaptive, transparent processes support both innovation and safety.

Financial Incentives

Examples

Key economic instruments and supports include the Strategic Innovation Fund and Canada Infrastructure Bank's $970M loan to the Darlington BWRX-300 project(1).

Lessons

- Public financing can de-risk FOAK projects.
- Strategic funds help unlock private investment and accelerate timelines.
- Long-term price signals or offtake mechanisms are still needed for NOAK scaling.

Stakeholder Engagement

Examples

Canada emphasizes transparent, inclusive practices including public consultation, Indigenous s partnerships like the Bruce Power co-ownership with Saugeen Ojibway Nation, and ongoing discussions with remote communities about microreactor deployment.

Lessons

- Co-ownership models (e.g., with Indigenous partners) build long-term trust.
- Early consultation strengthens social license and reduces opposition.
- Tailored outreach is essential for remote and underserved communities.

The Darlington BWRX-300 project(2) serves as a case study in effective policy implementation. With site preparation underway and operation targeted for 2029, it demonstrates Canada's engineer-procure-construct model and will serve as a reference plant for future deployments. While Canada offers one of the most supportive SMR policy environments globally, opportunities remain to enhance economic policy tools and accelerate fuel supply readiness.

(1) "CIB commits $970 million towards Canada's first Small Modular Reactor", CIB, October 2022. (2) "The Darlington New Nuclear Project", OPG, 2023.

Market Readiness

Supply chain maturity	**Manufacturing Facilities** Rolls-Royce plans to establish 3 UK factories for mass-producing SMR modules(1). NuScale partners with Doosan and BWXT for North American module components manufacturing(2).	**Fuel Supply** HALEU is a bottleneck, with alone US needing 40+ MT by 2030(3). DOE programs include Centrus enrichment demo and $700M in funding. Urenco has announced plans to produce HALEU in the UK(4). TRISO-X, X-energy subsidiary, will open the first advanced nuclear fuel facility in North America in 2025(5)	**Construction & Engineering Workforce** Western construction lags China, South Korea and the UAE(6). The U.S. and Canada are expanding nuclear engineering programs, trade union training, and operator certification. Indiana's study also highlighted workforce development as **a critical priority(7).**	
Infrastructure & Commercial Readiness	**Grid Integration** SMRs require grid stability studies. Co-location with renewables creates integration complexity.	**Module Transportation** Given that bottlenecks exist in bridge load limits, port handling, and customs clearance, logistical planning should be enhanced in early design stages.	**Site Preparation & Construction** Brownfield sites, such as retired coal plants, may streamline permitting and infrastructure requirements, though construction timelines still vary widely based on foundation type, seismic preparation, and local permitting processes.	**Workforce Availability** Skilled labour shortages persist in regions without active nuclear infrastructure, with deployment archetypes—such as remote microreactors and large grid-scale SMRs—demanding different trades and skill sets.
Commercial ecosystem development	**Contract Evolution** PPAs, take-or-pay agreements, and BOO models emerging(8)(9). US DOE exploring standardized contracts.	**Insurance & Liability** Nuclear insurance pools are available but require adaptation for small modular units, while civil liability regimes—such as Price-Anderson in the U.S.—vary, necessitating clearer guidelines for co-located users.	**Capital markets** Investors view SMRs as FOAK projects, needing public-private financing. Infrastructure funds and green bond markets are emerging as potential sources, e.g., Canada's Green Bond Framework supporting nuclear development.	**Industry Standards Development** ASME, CSA, and IEC are working to codify standards for SMR-specific designs, while regulatory harmonization through organizations like the IAEA and SMR Vendor Forums will support global scalability.

(1) "Three UK sites in running to host first Rolls-Royce SMR factory", World nuclear news, December 2022. (2) "Doosan starts forging components for NuScale SMR", World nuclear news, May 2023. (3) "U.S. Department of Energy Seeks Input on Creation of HALEU Availability Program", Office of Nuclear Energy, December 2021. (4) "Advanced fuels announcement", Urenco, May 2024. (5) "X-energy marks start of construction at US fuel plant", World nuclear news, October 2022. (6) Z. Beck et al, "What's Holding Back Nuclear in the West?", BCG, March 2025. (7) "SMR TECHNOLOGY AND ITS IMPACT FOR INDIANA", Indiana office of energy development, November 2024. (8) J. weibezahn, "Fission for funds: The financing of nuclear power plants". Elsevier, December 2024. (9) "Contracting and Ownership Approaches for New Nuclear Power Plants", IAEA, 2024.

Organizational Readiness

Organizational readiness requires strong technology developers with financial and technical stability and cross-sector collaboration, alongside prepared end-users with nuclear project management experience.

Technology Developer Capabilities
Funding adequacy, technical expertise, manufacturing
partnerships, project delivery track record and IP positioning

End-User Readiness
Project management, technical capacity, stakeholder
management, risk systems and executive alignment

Partnership Ecosystem Development
Strategic alliances across supply chain, knowledge transfer,
IP & risk sharing, cross-sector collaboration and JV structures

⇧ High (3 pts) ⇨ Moderate (2 pts) ⇩ Low (1 pt)

Comparative assessment of organizational readiness for 6 leading SMR developers

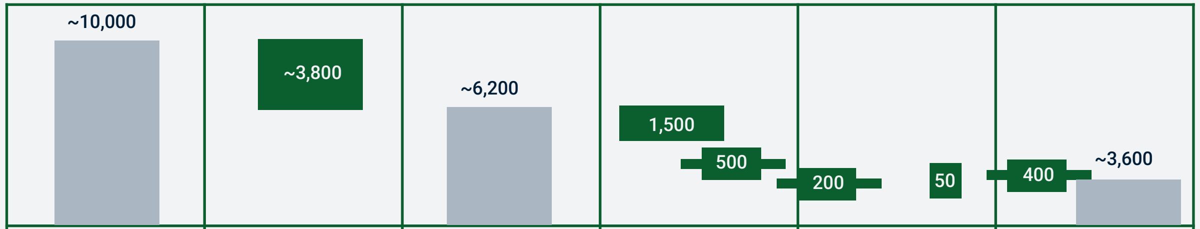
Company	Funding Adequacy	Technical Team & Regulatory Exp.	Manufacturing Partnerships	Project Mgmt Track Record	Ecosystem & Stakeholder Engmt.	Score
GE Hitachi (BWRX-300)	Backed by GE & Hitachi; progressing in Canada, Poland, and the UK ⇧	Deep BWR lineage; NRC and CNSC engagement; UK GDA Step 2 underway ⇧	Established supply chain; partnerships with BWXT, Hitachi, others ⇧	Selected by OPG; Darlington FOAK project advancing ⇧	Strong global partnerships; GDA public consultations; stakeholder trust ⇧	15
Terra Power (Natrium)	$2B DOE cost-share; significant private support ($1B) ⇧	Advanced sodium fast reactor knowledge; NRC pre-licensing ongoing ⇧	EPC partnership with Bechtel; contracts for simulator, monitoring systems awarded ⇧	Wyoming FOAK broke ground 2024; other contracts progressing ⇧	Strong federal and industry support; global alliances forming ⇧	15
X-energy (Xe-100)	$700M Series C-1 (including Amazon); DOE support ⇧	HTGR experience; TRISO fuel licensing underway; NRC application filed ⇧	TRISO-X plant in Oak Ridge; manufacturing partnership with Dow ⇨	Texas FOAK with Dow submitted to NRC in 2025 ⇨	Strong industrial partners (Dow); federal and energy stakeholder ties ⇧	13
NuScale Power	Raised $1.4B, but recent losses; canceled UAMPS order ⇨	First and only NRC-certified SMR; deep regulatory familiarity ⇧	Partners include BWXT, Doosan, Samsung; mature fabrication capab. ⇧	Idaho FOAK in development; momentum slowed after project loss ⇨	U.S. agency support; limited new commercial traction ⇨	12
Rolls-Royce SMR	£405M total raised; seeking deployment deals abroad ⇨	UK GDA Step 2 complete; experienced PWR engineering team ⇨	Three UK factories planned; supply deal with Siemens Energy ⇧	No FOAK, but detailed plans; growing interest in Czech Republic and UK ⇨	Strong UK government backing; exploring international partnerships ⇨	11
Terrestrial Energy (IMSR)	Strategic Innovation Fund; going public via SPAC (~$280M goal) ⇨	CNSC Vendor Design Review complete; molten salt reactor expertise ⇨	MOU with Schneider Electric for energy solutions ⇨	No FOAK; development-stage project; commercializ. plan by 2030s ⇩	Canadian MOUs; early global interest; pre-deployment stage ⇨	9

Financing Mechanisms

Comparative analysis of financing mechanisms

Financing Approach	Key Cost Attributes	Examples
Traditional Project Finance	High cost of capital, private sector bears risk	Rolls-Royce SMR exploring private investment models including pension funds and sovereign wealth funds
Public-Private Partnerships	Shared risk model; requires clear contractual structure	GE Hitachi – TVA Collaboration (US) – Though TVA is a public utility, it's entering into a structured agreement with GEH and the DOE
Regulated Asset Base	Allows cost recovery during construction; consumers share risk(1)	UK government approved the RAB model in 2021 for large-scale nuclear; Rolls-Royce SMR is lobbying for its application to SMRs
Government-Backed Loans	Reduces developer risk; US DOE LPO supports advanced reactors	X-energy (US) – Received a $1.2B award from DOE under the Advanced Reactor Demonstration Program (ARDP), and is also exploring DOE LPO mechanisms for project financing.
Tax Credit-Enhanced Financing	Monetize credits by selling them to investors to reduce capital costs	TerraPower (US) – To leverage the 45U PTC for nuclear and 48E ITC for storage; confirmed intent to use transferable tax credits, enabling third-party investors to purchase credits

SMR cost reduction pathway: FOAK to NOAK ($/kW)(4)



Recent FOAK projects	Recent reductions driven by the best practices	Best practices FOAK	Yard/cooling/ installation; EPC	Nuclear island equipment; Turbine island equipment	Owner's Cost; NOAK
Cost reductions by individual cost category	30-40%		40-50%; 40-50%	20-30%; 10-20%	30-40%; ~40% Total cost reduction
Examples	Better project scoping, fewer redesigns during construction		Standardized site layouts, smaller footprint “Learning by doing” on repeat builds	Standardization & better procurement; Incremental gains from scale/supply chain	Faster timelines, reduced risk premiums
Key drivers of cost reduction	Investment in improved pre-project planning		Learning by doing; Standardization; Build time reduction	Supply chain development; Modularization	Drive by reductions in other cost categories

(1) “The Regulatory Asset Base and Project Finance Models”, International Transport Forum, OECD, 2016. (2) “Zero-Emission Nuclear Power Production Credit”, IRS, 2022. (3) “Guide to the Federal Investment Tax Credit for Commercial Solar Photovoltaics”, US Department of Energy, January 2020. (4) “Pathways to Commercial Liftoff: Advanced Nuclear”, US Department of Energy, March 2023.

Building Effective SMR Partnerships

Strategic alliances across the SMR value chain

Vendor-EPC Alliances	**GE Hitachi – SNC Lavalin – Aecon** Collaborative approach combining reactor technology, regulatory knowledge, and construction capability for Darlington(1).	**Jacobs – Rolls-Royce** Technical program delivery and reactor development support for the United Kingdom's naval nuclear propulsion program(2).	**NuScale Power – Fluor Corporation - Samsung C&T** Collaboration to advance the global deployment of NuScale's SMR technology, with Fluor as the lead EPC partner and Samsung C&T as an investor and business collaborator(3).
Customer-Vendor Partnerships	**X-energy – Dow Chemical** Joint development of Xe-100 demonstration plant for industrial steam and electricity at Dow's UCC1 Seadrift Operations(4).	**X-energy - Amazon** Investment to deploy up to 5 GW of SMR capacity in the USA by 2039, supporting Amazon's carbon-free energy commitment(5).	
Supply Chain Integration initiatives	**Siemens Energy – Rolls-Royce** Siemens Energy to supply key conventional island equipment for Rolls-Royce's SMR program, including steam turbines and generators(6).	**USNC – Framatome** Joint venture to manufacture TRISO and FCM® fuel for USNC's Micro-Modular™ Reactor and other advanced designs(7).	
Cross-border Collaborations	**U.S.-Canada-UK** Memorandum of Cooperation signed by the U.S., Canada, and the UK to collaborate on technical reviews and regulatory efficiency for advanced reactor and SMR technologies(8).		

Strategic partnership metrics

High-performing partnerships typically exhibit:

- **Clear Value Flows:** Allocation of capital, IP rights, and operating revenue by phase.
- **Risk Sharing:** Defined thresholds for cost overruns, schedule changes, and regulatory outcomes.
- **Governance Models:** Joint steering committees, shared reporting structures, escalation protocols.

(1) "GE Hitachi Signs Contract for the First North American Small Modular Reactor", GE Vernova, January 2023. (2) "Jacobs Awarded $132 Million UK Ministry of Defence Research and Technology Contract", Jacobs, January 2025. (3) "NuScale Power secures investment and support from Samsung C&T corporation for global SMR deployment, NuScale, July 2021. (4) G. Bock, "Dow and X-Energy Submit Construction Permit Application for Advanced Nuclear Project in Texas", Climate Insider, March 2025. (5) "Amazon invests in X-energy, unveils SMR project plans", World nuclear news, October 2024. (6) "Siemens Energy to supply Rolls-Royce with equipment for small nuclear reactors", Reuters, February 2025. (7) "USNC Framatome Joint Venture", USNC, November 2023. (8) "Transatlantic collaboration on SMR regulation expanded", World nuclear news, March 2024.

Technical | Market | Policy | Organizational

Risk Assessment & Mitigation Strategies

	Technical Risk	Market Risk	Policy Risk	Organizational Risk	Systemic Risk
Examples	• FOAK component challenges such as supply chain and regulatory delays • HALEU fuel qualification bottlenecks • New fuel waste stream (e.g., molten salt)	• Cost overruns can significantly impact project feasibility, especially for FOAK deployments • Demand uncertainty • Competition from long-duration storage or green hydrogen	• Licensing delays can hinder deployment timelines, particularly for reactor designs requiring new safety standards • Insufficient incentives • Reputational spillover from unrelated nuclear events	• Workforce availability • Weak vendor project delivery history may lead to face execution challenges, • Inefficient collaboration among stakeholders can lead to misaligned goals and project inefficiencies	• Fuel, market, and regulatory interactions can create cascading challenges • Supply chain strain from uncoordinated orders • Delays causing knock-on effects across multiple projects
Mitigation approaches	• Funding for FOAK projects (e.g., The Generation III+ SMR Program) • Parallel supply chain development (e.g., HALEU availability program)	• Multi-unit procurement models (e.g., UK SMR fleet) • Secured power purchase agreements (e.g., Dow & X-Energy's agreement)	• Policy alignment (e.g., Canada-Japan MOC) • Strategic innovation funds (e.g., Canada's SIF) • Public education and engagement programs	• EPC/vendor partnerships (e.g., GE Hitachi-SNC Lavalin-Aecon) • Joint procurement consortia, capacity-building programs (e.g., simulators, trades training)	• Scenario planning & modelling tools • Risk-sharing contracts (e.g., Build-Own-Operate) • Diversified deployment pathways (e.g., microreactors, industrial heat, remote power)

Roadmap to SMR Commercialization: 2025 – 2035

	Industry Milestones	Stakeholder Actions	Decision Criteria	Leading Indicators
2025-2026: Foundation phase	• Final design certifications for BWRX-300 and Xe-100 • Construction starts in Canada and the US • HALEU supply chain initiatives launched	• Utilities: Select technologies for FOAK projects targeting 2030-32 • Industrial Users: Complete feasibility studies for applications • Governments: Finalize frameworks and financial support mechanisms • Investors: Enter early for equity	• Design certification with no major modifications • Construction permits secured • HALEU production capacity confirmed • Financing secured for FOAK projects	• Regulatory review cycle times. • Vendor design reviews completed. • Site preparation activities confirmed
2027-2028: Demonstration phase	• First SMR operations at Darlington • Performance data published and verified • Second-wave procurement initiated	• Industrial Users: Assess heat demand and retrofit pathways • Infrastructure Developers: Initiate site assessments and community engagement • Governments: Shape siting rules and demand aggregation pools	• First unit operational performance meets 90% of targets • Construction timeframe and budget within 15% of projections • Operational safety metrics achieved • Second wave financing structures • Heat application validation	• Construction milestone for first units • Component manufacturing quality metrics achieved • Industrial heat user commitments • Supply chain delivery performance • Grid integration studies completed
2029-2030: Scaling phase	• Fleet orders initiated in North America/Europe • Standardized licensing introduced globally • First industrial heat applications deployed	• Utilities & Investors: Finalize investment decisions post-demonstration and initiate EPC negotiations • Industrial Users: Finalize co-location agreements and facility preparations • Infrastructure Developers: Secure permits for districts	• FOAK economics validated within 20% of projections • Supply chain capacity sufficient for 3-5x deployment rate • Standardized component fabrication • Regulatory efficiency improved by >30% • Heat application contracts signed	• Order volume growth rate • Component manufacturing lead times • LCOE trajectory by design • Countries with SMR-ready regulation • Average licensing timeline reduction • Qualified personnel pipeline
2031-2035: Expansion phase	• Cost reductions achieved via modular deployment • International exports accelerate • SMRs integrated with renewables/hydrogen production • Remote power applications commercialized	• Utilities: Implement fleet deployment strategies • Industrial Users: Scale SMR heat integration across facilities • Infrastructure Developers: Deploy district energy systems • Expand supply chain partnerships	• NOAK cost reductions by 30% • Factory fabrication achieving quality and schedule targets • Global deployment exceeding 10 GW installed capacity • Proven and independently financed deployment models	• Manufacturing facility utilization rates • Learning rate percentage (cost reduction per doubling) • LCOE competitive position • Host community acceptance metrics • Integration with clean energy systems • Global harmonization of standards

SMR Deployment Pathways to 2050

Scenario analysis: deployment pathways to 2050

Scenario		Drivers	Outcome	Leading Indicators
1	**High Deployment (>100 GW)**	• Fleet procurement models adopted • Broad industrial uptake across sectors • Harmonized international regulations • Successful FOAK projects within budget	• Global cost parity with renewables by 2035 • SMRs become standard component in energy mix • Multiple vendors with standardized designs	• >3 successful FOAK projects by 2028 • Multiple countries adopting fleet procurement by 2030 • LCOE reduction of >10% between first and third units • Cross-border regulatory harmonization agreements signed • Industrial users forming buying consortia • Supply chain investment exceeding $10B by 2030
2	**Base Case (50-75 GW)**	• Regional adoption with gradual policy support • Limited fuel constraints resolved by 2030 • Selective industrial applications • Mixed FOAK project performance	• Steady rollout in 10-15 countries • Selective competitiveness in specific markets • Consolidation around 3-5 leading designs	• 1-2 successful FOAK projects by 2028 • HALEU supply meeting 70-80% of demand by 2030 • LCOE declining but remaining 10-20% above alternatives • 5-7 countries with active construction by 2032 • Industrial heat applications limited to 2-3 sectors • Selective policy support in key markets
3	**Limited Deployment (<25 GW)**	• Policy delays and inconsistent support • Low public acceptance • FOAK cost overruns >30% • Cheaper alternatives dominate • Fuel supply constraints persist	• Niche applications only • Minimal private sector interest • Limited to countries with strong nuclear legacy	• Major FOAK projects delayed >2 years • Cost overruns exceeding 30% on initial projects • Limited progress on regulatory harmonization • HALEU supply meeting <50% of demand by 2030 • Declining investor interest after 2028 • Policy support fragmented or reversed

Strategic Recommendations

Stakeholder	Timeframe	Action Steps	Decision Points	Alternative Pathways
Industrial Manufacturers	Immediate Actions (2025-2026)	• Complete heat demand assessment • Identify SMR sites • Form task force • Engage vendors for feasibility studies	• Q4 2025: Go/No-Go on feasibility studies • Heat demand thresholds determine investment or consortium approach	• Secure long-term contracts • Pilot smaller SMRs with expansion options • Join industry consortium
	Medium-Term (2027-2029)	• Secure site permits • Form joint ventures • Develop financing structure • Begin workforce training	• Q2 2027: Technology selection decision • Q1 2028: Investment structure decision	• Phased integration of applications • Multi-vendor strategy • Wait-and-see approach
	Long-Term (2030+)	• Scale deployments • Integrate hydrogen production • Establish excellence centres	• Q3 2030: Scale-up based on FOAK results • Q1 2032: Integration decision	• Transition to NOAK designs • Combine SMRs with renewables and storage
Infrastructure Developers	Immediate Actions (2025-2026)	• Map energy loads • Identify brownfield sites • Engage municipal stakeholders • Initiate regulatory discussions	• Q3 2025: Site selection framework • Q1 2026: Market model decision	• Mixed-use developments • Target coal plant conversions • Hybrid projects with renewables
	Medium-Term (2027-2029)	• Begin permitting process • Secure anchor customers • Develop district energy systems	• Q4 2027: Project structure decision • Q2 2028: Financing approach decision	• Modular deployment strategy • Energy hub model • Expand services around energy availability
	Long-Term (2030+)	• Operate multi-user hubs • Scale district networks • Enable public-private partnerships	• Q1 2031: Expansion decision • Q3 2033: Business model evolution	• Merchant operations model • Phase in advanced designs • Expand internationally
Utilities	Immediate Actions (2025-2026)	• Define fleet procurement strategy • Assess leading technologies • Engage regulators	• Q2 2025: Technology category decision • Q4 2025: Regulatory strategy decision	• Incremental deployment approach • Multiple technology strategy
	Medium-Term (2027-2029)	• Deploy FOAK project • Establish governance teams • Plan fleet standardization	• Q3 2027: Fleet size decision based on demand and carbon targets	• Acquire operational projects rather than developing from scratch
	Long-Term (2030+)	• Standardize contracts and procurement across fleet	• Q2 2030: Fleet standardization decision	• Transition to Gen IV designs as they mature