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SMRs in Today's Energy Transition

Emerging Opportunities and Risks

Zurich Resilience Solutions highlights that technologies such as Small Modular Reactors (SMRs) will become increasingly important for industrial competitiveness and energy security; this comes as the overall share of existing nuclear power is projected to decline slightly from 22% to 16% over the five years to 2030. For investors, lenders, developers and insurers, the questions are focused on how to deliver them at scale, on time, and deploy them in a commercially resilient way. This paper outlines the strategic opportunities and early to mid-stage risks shaping the role of SMRs as a cornerstone of the world's clean energy and industrial future. Zurich Resilience Solutions continue by sharing critical insights for understanding the risks within the broader industry context, as it is essential for building resilience and achieving commercial readiness.

The changing role of nuclear power in the energy transition

Europe is undergoing a rapid shift to clean energy generation, driven by net zero commitments and the need to achieve security in energy supply (Zurich Resilience Solutions, 2026). Nuclear power addresses the Sustainable Development Goals (SDGs), is recognised by the UN Intergovernmental Panel on Climate Change (IPCC) and the UN Economic Commission for Europe (UNECE). However, the energy transition is still in need for boosted confidence across developers, policymakers, investors, and the market.

What differentiates SMRs from traditional nuclear?

SMRs harness nuclear fission to generate heat to produce energy and are designed to be largely factory-built and assembled on site, reducing the bespoke construction challenges associated with large gigawatt-scale reactors. Typical SMR output ranges from 300MW, with some advanced designs approaching 470-500MW (still less than half the capacity of conventional nuclear units).

The most widely adopted reactors in traditional nuclear power stations are Light-Water Reactors (LWR), with Pressurised Water Reactors (PWR) and Boiling Water Reactors (BWR) being the main choices. The UK has significant experience with Advanced Gas-cooled Reactors (AGR), with 8 in total - 1 operating PWR and 2 PWRs under-construction.

Typical risks related to large nuclear and energy projects are cost overruns, schedule delays and complexity. However, unique challenges are seen through fulfilling Technology Readiness Levels (TRLs) across SMR designs, addressing novel technology safeguarding standards, mobilising finance for technology development, licensing and construction of prototype plants (Tata Consulting Engineers Limited, 2023).

Key SMR opportunities

Energy and technology ecosystem diversification

The Clean Air Task Force (CATF) proposes an expanded SMR market, driving economies with growing energy needs and energy transition ambitions, diversifying energy sources, off-grid applications, energy security, and maritime and transportation logistics.

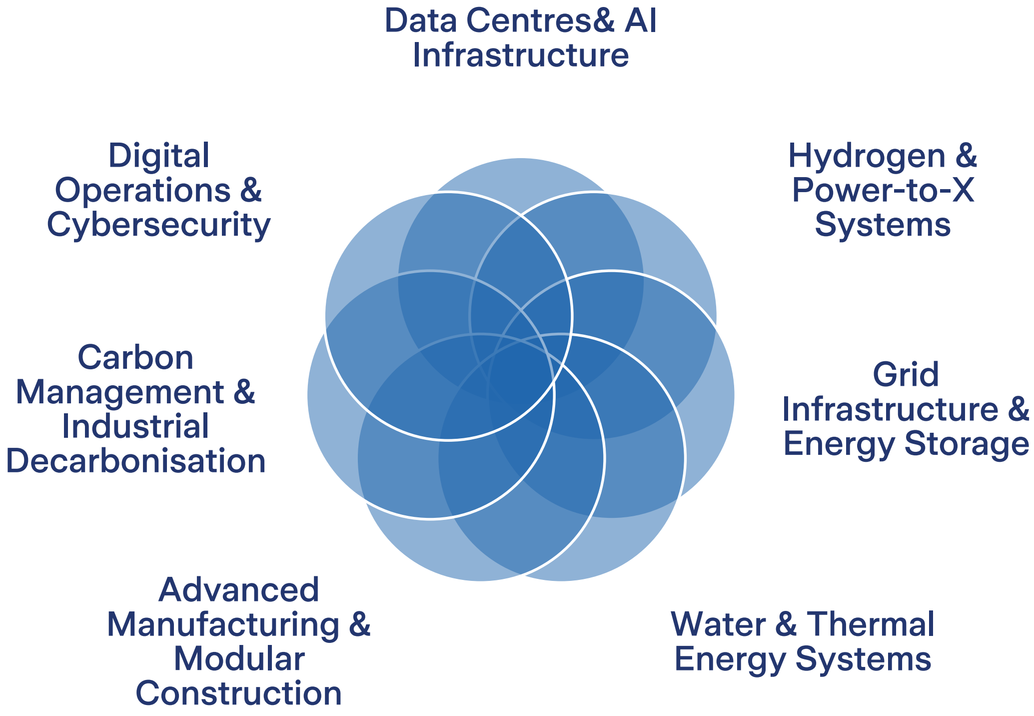

Figure 1: SMR technology use cases

Enrichment challenge and opportunity

Uranium fuel powering SMRs are sourced from a geographically diversified market, stored on site, and largely insulated from short-term geopolitical disruption. As a result, SMRs offer a structurally different risk profile to oil and gas linked generation contributing to greater energy independence and sovereignty. This expands its technology capabilities, illustrated by Figure 1.

Design-specific proliferation risks in SMRs primarily arise from the use of higher-enriched uranium (5-205 U-235), which increases the attractiveness of both fresh and spent fuel for diversion. That being said, the concentration of uranium production is spread across four countries which jointly account for over three-quarters of global uranium production. A critical and ongoing aim is to diversify uranium supply and enrichment services to create a commercially viable nuclear sector.

Modular and scalable

The modularity of SMRs during design and construction mean that major components can be assembled in specialised facilities or factories before site transportation. This improves quality control and shortens construction times to reduce overall costs. What's unique about SMRs (as opposed to large nuclear reactors), is that designers plan for modular, serial production to achieve economies of series, a similar approach in the aerospace industry. An incremental deployment reduces financial risk and gives end-users flexible solutions from the scalability offered (World Nuclear Association, 2026).

Efficient and cost-competitive

SMRs cultivate more flexible and decentralised energy production as they can be deployed across a variety of environments, benefitting remote regions that lack access to energy infrastructure by distributing energy on local and national levels. Additionally, this extent of energy independence influences cost-competitiveness due to the reduced reliance on imported fuels and dependence on global markets during volatile periods impacting energy sources. It also encourages the need to innovate sustainable energy financing and insurance solutions on an institutional and governmental scale, in which a First of a Kind (FOAK) risk approach is needed support this transition.

Key SMR risks

Technology maturity and design risk

While the EU has identified multiple projects and set early-2030s deployment targets, the absence of clear design prioritisation risks diluting resources across too many technologies, preventing supply chain maturity and cost reduction.

Technology maturity is a key barrier to commercial viability. As SMRs are relatively new nuclear technology, UK development and deployment efforts are constrained by limited government funding and an insufficient supply of engineering resources. Moreover, it must go through an extremely lengthy (several year) approval process requiring millions of pounds to satisfy the Generic Design Assessment (GDA).

While features such as sealed reactor cores and long operating cycles are intended to enhance safety and reduce on-site handling, they also limit inspection and verification, creating potential blind spots for regulators. This undermines traditional safeguards of the International Atomic Energy Agency (IAEA), particularly in detecting material diversion over extended periods (CATF, 2025).

Safety, security, and safeguards by design on SMRs (EU)

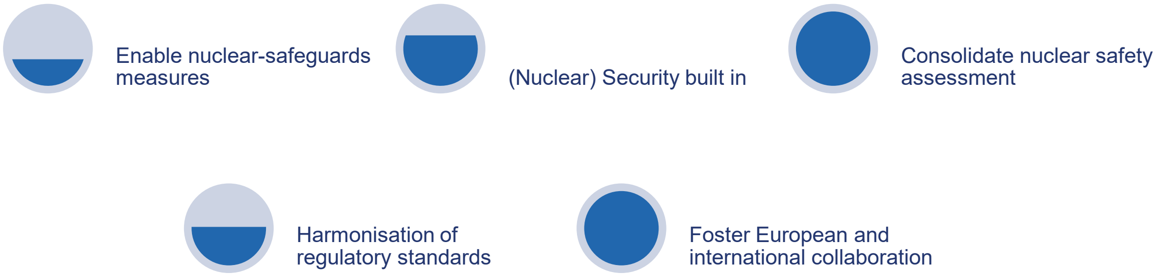

Figure 2: EU, 2025

This is also why the Joint Research Centre's (JRC) focus on the safety, security, safeguards and licensing of SMRs (Figure 2), promoting the harmonisation of regulatory standards and fosters European and international collaboration (European Commission, 2025).

Moreover, licensing fragmentation across Member States result in duplicated assessments, design divergence, and higher costs. These factors create prolonged development timelines, increased capital risk, and reduced scalability. These challenges are compounded by uneven international governance and supplier-state practices, where differing standards between major exporters (e.g. stricter US controls vs more flexible bilateral agreements from others) can result in inconsistent safeguard enforcement.

Standardised designs that SMRs benefit from are challenged by different regulatory environments. For example, the UK follows the ALARA (As Low As Reasonably Achievable) process. ALARA provides guidance for radiation safety, where three basic protective measures are time, distance, and shielding. However, the majority of other countries follow the prescriptive US – Nuclear Regulatory Commission (NRC) model, with France following a hybrid one. The NRC is a design approval process focusing on fair regulation of the nuclear industry, and in turn, nuclear regulation should be transacted as openly and candidly as possible to maintain and enhance the public's confidence (NRC, 2026). The NRC process is fairly lengthy, with the fastest review process in SMR history taking 41 months (NuScale) (Hawai'i State Energy Office, 2025).

The EU's broad project pipeline risks spreading resources too thin, slowing cost reduction and supply chain maturity. SMR remain constrained by limited funding, engineering capacity, and lengthy, high-cost approvals, with safety design features introducing new inspection challenges. Crucially, SMR progress is driven more by policy than technology readiness, making deployments highly sensitive to shifting government commitments, with underperformance risking long-term setbacks in confidence, investment, and design evolution.

In summary, regulatory fragmentation prevents mutual recognition of certifications, its absence weakens the ability to deploy standardised, pre-approved components, leading to on-site verification delays and eroding cost advantages.

Supply chain risk in the energy transition

While SMRs enhance energy diversification, their supply chain remains concentrated and unevenly developed (Figure 3), with activity clustered in North America, Europe, and East Asia, and limited presence elsewhere. This creates risks around geographic concentration, with heavy reliance on Chinese and Russian technologies, and limited supply chain redundancy. Of the 52 reactors that have started construction worldwide since 2017, 25 of them are of Chinese design and 23 Russian.

SMR deployments is also dependent on advanced manufacturing hubs and constrained fuel supply, particularly High-Assay Low-Enriched Uranium (HALEU), reinforcing exposure to bottlenecks. Balancing deployment with resilience is critical: prolonged early-stage development, combined with supply constraints exposes projects to an increase in delays, costs, and technical risks, which ultimately slows down large-scale deployment.

Most importantly, the challenge of prioritisation and the balance between supply chain efficiency and supply chain resilience occurs when manufacturers, operators, and executives focus on lowering risk exposure while maintaining financial performance. Prolonged early-stage development leads to higher levels of startup and project delays and technical engineering faults ultimately preventing mass production and rollout of the technology at scale.

Global Map of SMR Supply Chain Progress

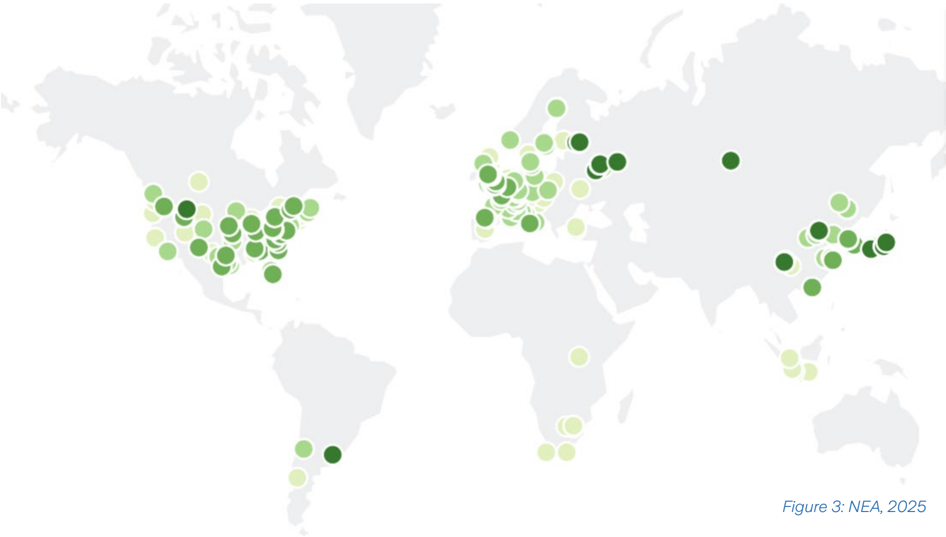

Figure 3: NEA, 2025

Number of small modular reactors in selected regions in the Announced Pledges Scenario, 2025-2050

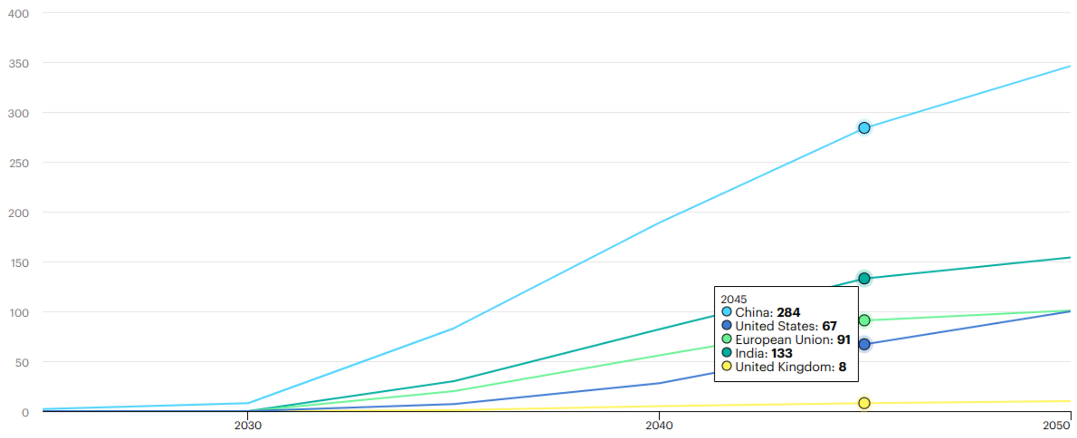

Figure 4 IEA, 2026

National commitment to the energy transition via SMRs

Figure 4 reflects the distribution of Announced Pledges Scenario (APS), an agenda pushing global decarbonisation efforts. We can see the varying rates of commitment to nuclear and that SMR maturity is largely policy-driven, not purely by cost competitiveness and technological readiness. The sensitivity to policy cycles are unique to SMRs and nuclear technology. It also makes SMRs a riskier investment as any underperformance of those deployed exposes mid- or later-stage design flaws, potentially losing significant amounts of state-level funding. As a result, it impacts industry-wide progress more significantly than other energy assets which are typically funded by private or institutional investors.

On top of that, geographical nuances reinforce regional priorities towards development and innovation. The prescriptive regulatory framework in the US is adaptive yet slow, whereas the UK and China are driven by a strong risk management culture to balance swifter approvals with appropriate safety standards.

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Are SMRs investable infrastructure?

Global projections indicate that SMRs could represent a market of approximately $670bn by 2050, delivering around 120GW of installed capacity. China, the US, and the EU together account for the majority of near-to-mid-term deployment ambition. Since 2023, 100% of Chinese and Russian nuclear energy investments are state-owned enterprises, with around 52% which are commercial investments in advanced economies (IEA, 2026).

SMRs continue to sustain a relatively immature financing profile globally, underscoring both momentum and structural imbalance in their evolution as investable infrastructure. Total disclosed funding is heavily concentrated in equity-scale investment ($6.59bn) and matching public grants ($5.51bn), together accounting for the majority of capital deployed. This indicates that early SMR development remains state-supported and sponsor-led, rather than market-driven.

In contrast, more traditional infrastructure financing channels, particularly debt ($0.85bn) and commercial contributions ($0.06bn), are significantly underrepresented. It signals that lenders and private capital markets are not yet fully comfortable underwriting construction and operational risks at scale. A generally lower publicly traded capital participation of $0.97bn further reinforces that SMRs have not yet transitioned into a liquid, widely investable asset class (NEA, 2026).

SMR regulation is complex because current EU State Aid approvals often exceed 2 years, delaying final investment decisions and creating significant uncertainty for investors and particularly problematic given SMRs' multi-unit deployment model. Existing mechanisms such as Contracts for Difference (CfDs) fail to address construction and multi-revenue risks, prompting the need for alternative structures like Regulated Asset Base (RAB) and cooperative models, which better distribute risk and improve financing viability (CATF, 2025).

Example project pipeline costs and challenges

Figure 5 shows an indicative cumulative cash flow (USD/MW) profile for an SMR project over 70 years. We can see that SMRs are not like typical infrastructure assets, but they can become infrastructure-like investments only after construction risk is heavily mitigated.

During the construction phase, there is a negative cash flow reaching approximately -5,000 with a heavy reliance on public equity (light blue) and commercial equity (dark blue). Therefore, this phase is characterised by high uncertainties e.g. delays, cost overruns, no revenue generation. Commercial lenders which provide debt are mainly absent due to high levels of risk and performance uncertainty reflecting the venture-like investment profile of SMRs, reliant on public capital for deployment.

The transition phase occurs at the breakeven point of large new builds at year 30 as more debt (light green) emerges and cash flow remains positive (25,000 peak). This suggests a fundamental shift in risk profile where operational risk replaces construction risk. During operation, SMRs gain more predictability and proves longer asset life which aligns with the core characteristics sought by infrastructure investors e.g, pension funds, sovereign wealth funds, long-term debt providers.

Overall, SMRs currently face challenges to transition from theoretical infrastructure assets to bankable investments at scale without strong public sector involvement, risk-sharing mechanisms (through insurability assessments), and policy coordination.

Indicative cumulative cash flow profile of an SMR power plant assuming cost parity with a conventional large-scale nuclear plant (USD/MW)

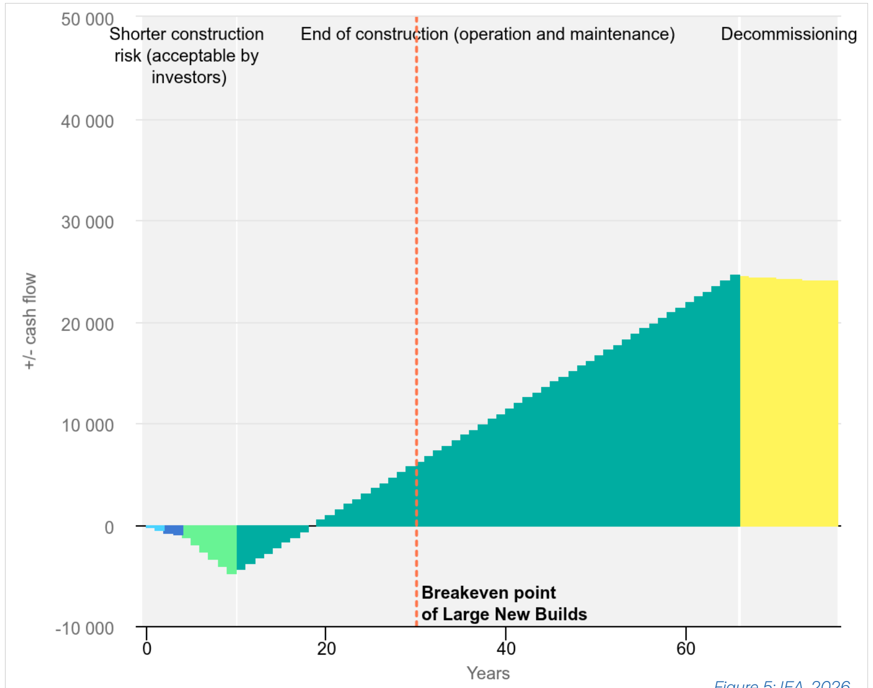

Figure 5: IEA, 2026

Translating insurability into better financing and operational performance

While 129 SMR designs exist, only a small number (11 under construction and 7 operational) have progressed to stages where insurable risk can be meaningfully assessed (NEA, 2026). This indicates that most of the sector remains early-stage and data-limited, constraining insurer's ability to price risk and deploy capacity leading to conservative underwriting if any at all. Despite these insurance and investment risks, there are an emergence of specialist nuclear insurance companies (e.g. Northcourt and Nuclear Risk Insurers) focusing solely on these complex and FOAK assets, strengthening commercial resilience. Key components of nuclear energy business insurance designed to address specific risks are Property, Liability, Decommissioning, and Business Interruption (BI).

An insurer's perspective on SMRs and wider nuclear power

Complex technology necessitates a complex risk assessment

The innovative nature of SMR technology introduces distinct risk profiles that require specialised insurance approaches. Countries like Germany, Italy, and Lithuania have also reported decommissioning expenses that surpass international expectations, emphasising the need for precise risk assessment and adequate insurance coverage. Additionally, liability coverage must adapt to the evolving nature of nuclear technology, where it's necessary for insurers to stay ahead of international treaties, national regulations, and emerging safety standards.

High construction cost bring high BI impact

Upfront capital costs and extended construction timelines deter many investors, but it also creates significant BI exposure during both construction and operation. Delays in construction, commissioning, or grid connection can translate into substantial lost revenue and prolonged debt servicing without income. Because SMRs rely on achieving cost parity through replication and timely delivery, even small delays across multiple units, compound into systemic BI risk. Therefore, insurers are cautious and conservative, often requiring robust Delay in Start-Up (DSU) coverage which increasing premiums. This is also why there is a lack of appropriate construction insurance where developers take on risks that are uninsured or underinsured.

Supply chain and non-conformities

Limited number of qualified suppliers and the continuous introduction of new SMR designs elevate construction and operational risk for insurers. They will require rigorous quality assurance, supplier vetting, and traceability systems as prerequisites for overage. Furthermore, licensing barriers and challenges directly translate into systemic supply chain risks for SMRs by undermining standardisation, scalability, and supplier confidence.

Existing regulatory frameworks are designed for large, site-built reactors, limiting innovation and force suppliers to meet rigid, often non-harmonised requirements, resulting in supplier concentration, reduced flexibility, and longer lead times.

In depth knowledge needed to assess operational risks and consequences

Given that it's necessary for the insurance industry to be able to respond to the unique risk profiles presented by SMR technology, the integration of the sectors risk teams early in the development is critical. In reality this will require a detailed risk review of each project and utilised technology during the design, development, and pre-construction phases; with the aim of identifying the mitigation for known loss events and subsequent project delays.

The risk review approach will need to pivot away from the proven operational experience towards a data analysis approach through the OEM (Original Equipment Manufacturer) design and testing of these FOAK technologies. Collaboration between OEMs and the Insurance sector engineers will require a level of engagement that transforms how traditional early-phase engagement is harnessed.

Public perception and governments short term planning

Nuclear power experiences public opposition due to high-level radioactive waste that could threaten public health and safety. The industry therefore needs a proactive approach to risk management, facilitated by insurers conducting ongoing assessments and retaining detailed documentation to adapt to evolving risks. Another important role for insurers is to ensure that coverage remains relevant and effective in an industry characterised by rapid technological advancements and regulatory changes, providing market-ready products and services across nuclear technology.

A Final Thought

SMRs represent a significant opportunity to secure low-carbon power through standardised modular construction, scalable deployment, improved operational efficiency, and innovations in fuel enrichment. FOAK technology exposes different risks and challenges including, low TRLs influenced by design maturity, supply chain constraints, uncertain deployment rates, and complex and lengthy licensing processes. Ultimately, Zurich Resilience Solutions see that the insurability of SMRs will increasingly depend on the industry's ability to demonstrate reliable asset performance, regulatory cohesiveness, robust governance, and supply chain resilience. These factors will result in higher levels of bankability and drive the demand for SMRs, as a resilient infrastructure asset, which play a crucial role in the energy transition.

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