A new nuclear world: how small modular reactors (SMRs) can power industry

LUCID CATALYST

November 2025

The context of this report

Urenco, a global leader in uranium enrichment for the nuclear sector, commissioned LucidCatalyst to conduct an independent assessment of the small modular reactor (SMR) market opportunity in Europe and North America. As the nuclear industry evolves toward smaller, more flexible reactor designs, understanding the scale and nature of industrial demand for these technologies is critical for strategic planning across the nuclear fuel cycle. This study examines how SMRs could serve energy-intensive industrial sectors that face mounting pressure to secure reliable, cost-competitive energy while meeting decarbonization commitments. The research provides comprehensive market sizing, analyses sector-specific deployment opportunities, and identifies the key drivers that will shape market development. This analysis is intended to enhance understanding of emerging nuclear markets for industry stakeholders, policymakers, and investors, supporting more informed decision-making as the SMR market matures.

CONTENTS

1 Executive summary

1.1 The industrial energy opportunity: 700 GW by 2050

This study analyzed the potential for small modular reactors (SMRs) to serve the energy needs of 11 key industrial sectors across North America and Europe. These sectors, representing more than 80% of total industrial energy demand in these regions, will require 17,000 TWh of clean, reliable energy annually by 2050.

The study found that SMRs are a strong technical match for the energy needs of these industries, and could supply up to approximately 15,000 TWh or 2,200 GW of their demand.

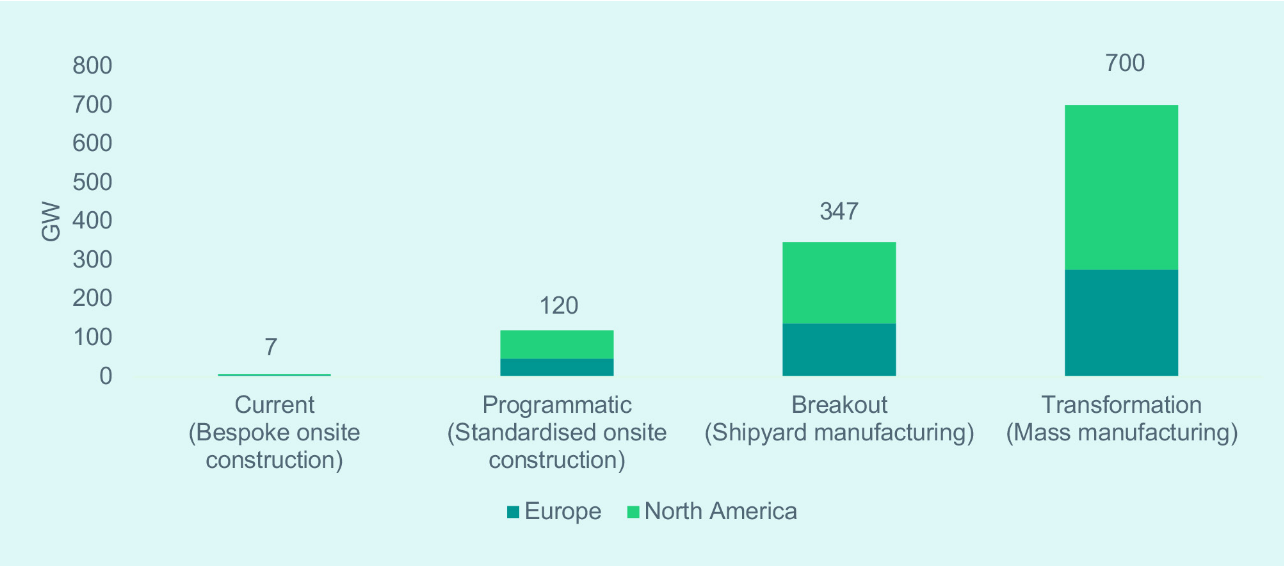
The study also found that manufacturing innovation is key to unlocking the full potential of the SMR market. Improvements to current construction methods (the "Programmatic" supply scenario) could achieve 120 GW by 2050. However, evolving to full mass manufacturing (the "Transformation" supply scenario) could enable nearly 700 GW deployment, representing a $0.5–1.5 trillion investment opportunity (Figure 1).

This 700 GW of accessible SMR market represents nearly double the current global nuclear capacity, and would expand nuclear capacity beyond the projected goal to triple conventional deployment by 2050. The top five SMR accessible markets, representing more than 75% of the 700 GW opportunity, are synthetic aviation fuels (203 GW), coal plant repowering (110 GW), synthetic maritime fuels (90 GW), data centers (75 GW), and chemicals (55 GW) (Figure 2). Sectors such as food & beverage (43 GW), iron & steel (33 GW), upstream oil & gas (33 GW), and district energy (33 GW) also represent sizable opportunities, with district energy being particularly relevant in Europe.

Data centers, chemicals, and coal repowering (i.e., coal-to-nuclear transition) are expected to drive near-term demand, with synthetic aviation fuels representing the largest long-term opportunity. Without SMRs, these industrial sectors may face constrained growth or be forced to default to carbon-intensive alternatives due to the lack of clean, reliable energy.

Despite this large potential market, only 7 GW would be deployed by 2050 under current deployment trends. This is because the current nuclear delivery model, with custom-built projects, unpredictable costs, and decade-long timelines, cannot meet industrial business requirements. Industrial energy customers need fixed-price contracts, rapid deployment, guaranteed delivery schedules, and

Figure 1: Accessible SMR market by supply scenario and region, Announced Pledges Scenario, 2050



proven operational performance. In North America, competing with low-cost, abundant natural gas will also require supportive policies and dramatic cost reductions through standardization and manufacturing innovation. While Europe's higher energy prices create more favorable economics, the regulatory differences between member states constrain large-scale deployment. Serving the 700 GW potential market will require the transformation of the nuclear delivery model from bespoke construction projects to programmatic construction or manufacturing-based delivery. This transformation increases the effective demand for, and the ability to supply, nuclear projects.

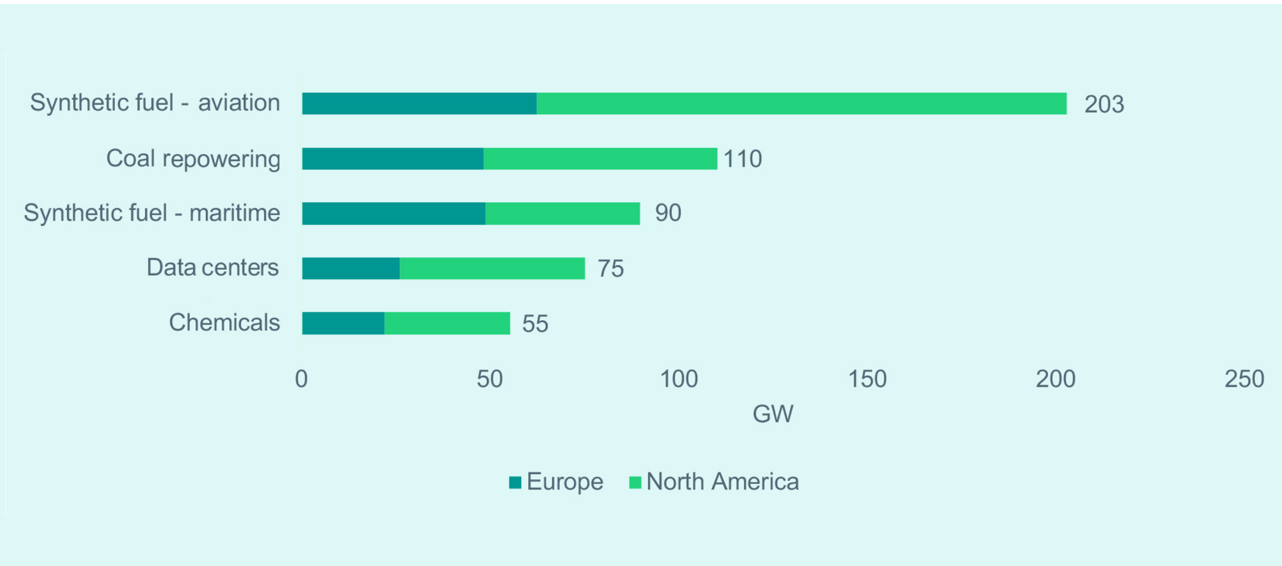
Simultaneous improvement across these **Six Critical Market Drivers** can enable the evolution of nuclear delivery models and expand market penetration for SMRs:

1. Delivery innovation through product-based manufacturing
2. Regulatory evolution toward product-based licensing
3. Economic viability through policy support
4. Site availability through pre-qualification programs
5. Capital access from mainstream financing
6. Developer ecosystem maturation with proven delivery track records

Four Supply Scenarios describe how improvements across these Market Drivers can progressively enable SMRs to meet industrial requirements and serve larger markets:

- **Current Scenario (7 GW by 2050):** Reflects limited deployment based on current supply capabilities. With deployment below 1 GW/year, custom-built projects with costs around $125/MWh cannot meet industrial business requirements, resulting in minimal market penetration
- **Programmatic Scenario (120 GW by 2050):** Achieves moderate growth through sustained government support and enhanced project management. While maintaining construction-based delivery, standardized designs and processes, and government financing support improve deployment to 5–10 GW/year. Although programmatic delivery can effectively reduce cost and schedule risk, the resulting cost ($90–125/MWh) and schedule may not be competitive enough to enable substantial penetration of the industrial energy market, limiting broader market access

Figure 2: Top five SMR accessible markets by region, Transformation and Announced Pledges Scenarios, 2050



- **Breakout Scenario (347 GW by 2050):** Achieves scalable, predictable, and low-cost delivery through shipyard manufacturing. This scenario leverages existing reactor designs and existing world-class shipyard manufacturing capabilities. This combination of current capabilities and technologies enables near-term deployment of standardized power plant products that can meet business requirements and cost thresholds of industrial energy users. The low costs achieved ($60–90/MWh) enable serving 347 GW of industrial demand by 2050
- **Transformation Scenario (700 GW by 2050):** Full re-engineering of nuclear technology into a mass-manufactured product, representing approximately 2,300 reactors of 300 MW capacity, where the entire project delivery process is designed for manufacture and assembly (DfMA). This approach enables: product-based licensing replacing site-by-site approvals; supply chains producing standardized components at scale; factory assembly lines delivering complete nuclear modules; deployment timelines measured in months, not years; and costs in the $40–60/MWh range that make nuclear energy competitive with natural gas

In addition, for each Supply Scenario, four Demand Scenarios are evaluated, reflecting different policy environments and levels of customer value recognition for nuclear energy. These scenarios assess how varying long-term gas prices ("Energy Cost" scenario), energy security premiums ("Security" scenario), and different degrees of policy support and decarbonization commitment ("Announced Pledges" and "Net Zero" scenarios) affect the size of the accessible SMR market.

The shift from Current to Programmatic would represent a significant achievement: a 16-fold increase in deployment (from less than 30 reactors to nearly 400 reactors of 300 MW each) through government support, improved project management, financing, and contracting structures. The real opportunity, however, lies in manufacturing innovation. The shift from Programmatic to Breakout represents the critical inflection point where shipyard delivery fundamentally transforms market access. The shift from Breakout to Transformation represents the difference between shipyard series production and true mass manufacturing; the difference of roughly a hundred to thousands of units per year globally. These two supply scenarios can be deployed in existing and planned industrial facilities, avoiding the need for extensive new transmission infrastructure.

North America is positioned to lead this transformation with supportive policies, regulatory modernization, and active industrial demand already emerging from data centers and chemical facilities. Despite more attractive economics, Europe faces regulatory fragmentation. Enabling standardized deployment will require improved regulatory coordination and mutual recognition of licensing approvals across member states, allowing the same reactor designs to be deployed without redundant approval processes.

With nearly 700 GW representing almost a third of industrial energy needs, SMRs offer the scale necessary to maintain industrial competitiveness while achieving climate goals. The convergence of artificial intelligence driving unprecedented energy demand and enabling new delivery models, alongside policy momentum and nuclear innovation creates a unique moment in energy history.

The opportunity is massive. The pathway is clear. The transformation is achievable. The time to act is now.

2 The industrial energy challenge: from risk to opportunity

Industrials sectors, including the technology sector, are under increasing pressure from rising energy demand. At the same time, electricity is becoming scarcer and more volatile, and deadlines for decarbonization commitments are approaching. Small modular reactors (SMRs)[1] are emerging as a promising solution with the potential to reconcile industry's strategic objectives of energy security, sustainability, and growth. While the opportunity has the potential to transform the entire nuclear industry, it comes with uncertainty. This calls for a proactive approach, anticipatory planning, and a thorough understanding of the main drivers shaping the SMR market to effectively map and monitor future growth.

This report serves the following key stakeholder groups seeking to understand SMR market dynamics and engage in strategic planning:

- **Policymakers** can identify national SMR market opportunities, signal strategic priorities, and design targeted policies to address critical development bottlenecks
- **Energy users** can better understand how SMRs align with their technical requirements and assess the commercial viability timeline for nuclear solutions
- **Investors and financiers** can evaluate SMR market potential and associated risks to make informed capital allocation decisions and build investment confidence
- **The nuclear industry** can understand customer needs, design solutions for industrial requirements, and strategically time their supply chain investments

2.1 Forces shaping industrial energy risks

Industrial energy has transformed from a future concern to an immediate challenge. Three forces are converging: (1) energy security and extreme price volatility, (2) deteriorating reliability, and (3) accelerating decarbonization requirements. These forces have created new imperatives for energy-intensive industries worldwide. This convergence threatens industrial competitiveness and is driving a fundamental shift in decision-making around new infrastructure that will operate for decades.

Energy Security and Price Volatility: The 2022–2023 European energy disruption exposed industrial operations' vulnerability to extreme price volatility. Natural gas prices spiked from €20 per megawatt-hour to over €200 in some instances,[2] an increase that rendered entire industries uneconomic overnight. BASF, the chemical giant that had operated continuously for over a century, permanently closed ammonia production facilities.[3] Aluminum smelters across Europe, which require continuous power to prevent metal from solidifying in production lines, faced impossible choices and many never reopened.[4] In total, European industrial production dropped by 12–21% in energy-intensive sectors, with much of this production permanently relocated to regions with lower energy costs.[5] In North America, particularly in the US, hyperscalers are facing difficulties securing power to support their massive growth due to grid constraints and long connection queues.[6]

Reliability Deterioration: The April 2025 Spain-Portugal blackout affected 50 million people and 15 gigawatts of generation; 60% of demand vanished in twelve seconds.[7] The immediate impacts were severe: five deaths from failed medical equipment and carbon monoxide poisoning from emergency generators,[8] economic losses reaching €2–4 billion,[9] 116 trains stranded with 35,000 passengers, airports forced to close, and hospitals cancelling surgeries.[10,11,12] Industrial facilities suffered equipment damage from sudden power loss, with some production lines requiring a week or more to restart.[13]

Decarbonization Pressure: Carbon pricing and climate commitments are creating new competitive pressures for industrial operations. The EU's Carbon Border Adjustment Mechanism, expanding carbon taxes, and customers' Scope 3 emissions requirements have made environmental costs a direct factor in industrial competitiveness. Industries face the challenge of reducing emissions while competing against regions with lower-cost, high-carbon energy sources, requiring strategic approaches to maintain competitiveness while meeting decarbonization goals.

Industrial demand for clean, reliable, affordable energy creates a large market opportunity in North America and Europe, but only for solutions that can simultaneously deliver energy security with price stability, reliability, and decarbonization.

Current alternatives fall short as variable renewables like wind and solar power cannot provide continuous high-temperature heat for industrial processes or a continuous supply of power for data centers. Battery storage is impractical for long-duration support of such energy-intensive operations. For example, modern aluminium smelters typically require between 500–1,000 MW of continuous power. Providing just four hours of backup at this scale with lithium-ion batteries would require roughly 500–1,000 Tesla Megapacks, at an estimated turnkey cost of US $0.7–1.5 billion.[14]

European markets remain exposed to price volatility of imported fossil fuels and face decarbonization requirements, which makes energy sources like natural gas less feasible. In North America, and particularly in the US, while the considerations around cost and carbon are different, growing power demand, combined with limited grid access and increasing wait times for gas turbines up to seven years[15] is pushing customers to diversify their firm capacity options towards nuclear power.

As a result, the convergence of these forces will shape the price consumers are willing to pay for energy, directly impacting the SMR market. Four Energy Demand Scenarios are proposed in this study to model how these conditions affect the size of the accessible SMR market. These scenarios are based on long-term gas prices ("Energy Cost"), energy security premiums ("Security"), and varying degrees of policy support and decarbonization commitment ("Announced Pledges" and "Net Zero") (see Section 4.5).

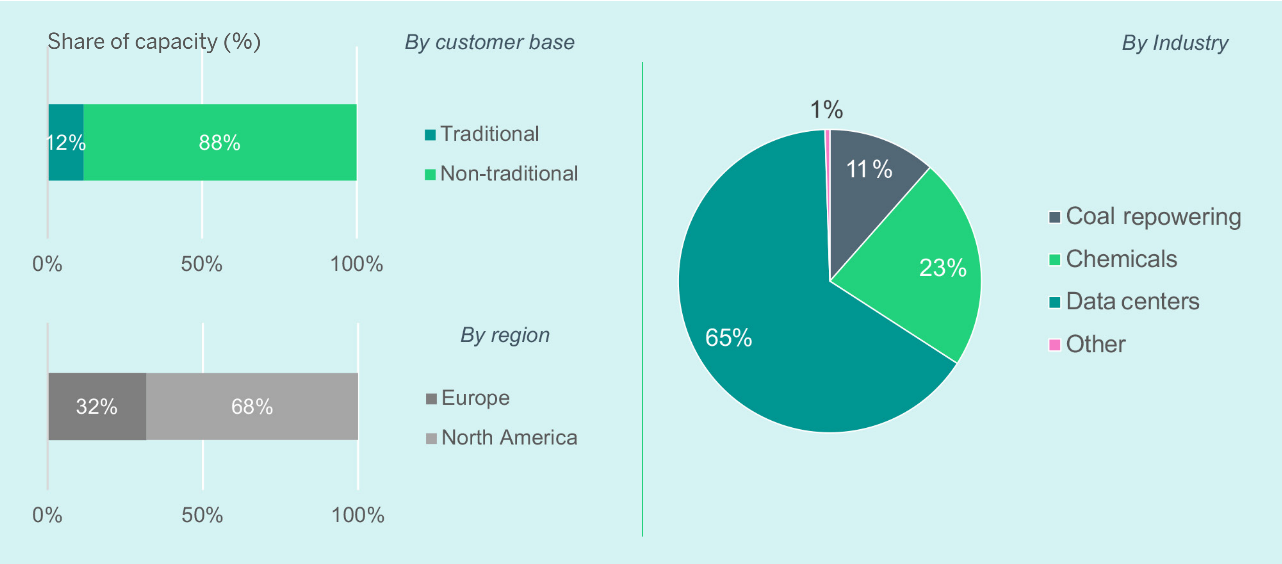
With industrial energy infrastructure typically operating for 40–50 years, current decisions will shape competitiveness until 2070. Current infrastructure reaching end-of-life requires replacement, while rapidly expanding sectors such as data centers and sustainable aviation fuels create additional demand for energy solutions that are secure, reliable, and low-carbon.

2.2 The rise of industrial markets for SMRs

SMR industrial markets are already showing early signs of activation. Our analysis has identified more than 40 GW of SMR projects currently in the pipeline across North America and Europe. The SMR project pipeline has been determined by aggregating the capacity of publicly announced projects in the regions of interest as of August 2025, regardless of their level of confidence.[16] The pipeline is not suitable to be used with the SMR deployment scenarios analyzed in this study because the pipeline does not represent the actual capacity to be deployed, which requires accounting for economics, supply conditions, and broader market drivers, as further detailed in Section 4. However, it does provide an indication of market momentum for industrial applications and acts as an indicator for real-world market activity.

In the Western world, more than 60% of projects in the SMR pipeline are in North America, with the remainder in Europe. Notably, around 80% of SMR projects are being driven by non-traditional customers, primarily large industrial energy users, indicating a significant shift in the nuclear energy customer base. The leading sectors driving demand are data centers, the chemical industry, and coal repowering, followed by smaller growth in district energy, food and beverage, military applications, and oil and gas refining (Figure 3).

Figure 3: Analysis of current SMR project pipeline, North America & Europe, 2025



Note: The customer base and industry breakdown do not include ~5 GW of projects that are either non-commercial prototypes or projects for which the industry is not specified. The industry category "Other" includes projects for military applications, district energy, food & beverage and refining oil & gas.

In the 40 GW pipeline identified in this study, not all projects have the same level of confidence. Around 50% of this pipeline (20 GW) corresponds to projects that are actively progressing and show strong development signals (Figure 4). These trends are consistent with the International Energy Agency's (IEA) Stated Policies Scenario (STEPS) projections, which suggest around 19 GW of SMRs in advanced economies by 2050.[17] These results are encouraging and confirm that the SMR potential to meet industrial energy needs is both substantiated and actively developing.

Figure 4: SMR pipeline with strong development signals (~20 GW)

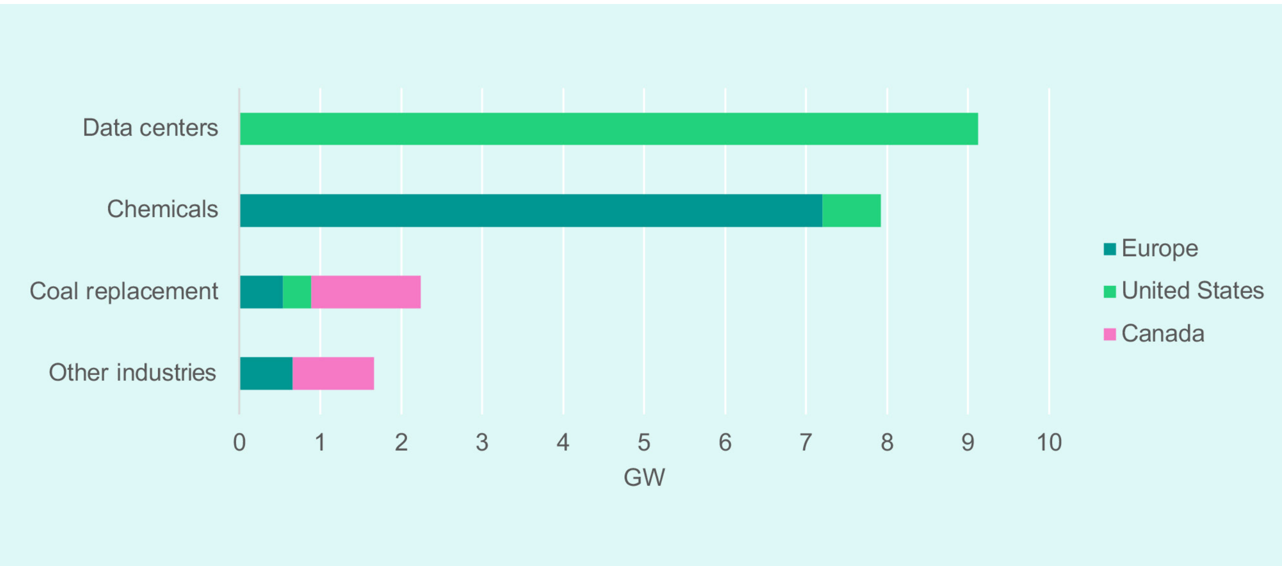


Figure 4 continued: SMR pipeline with strong development signals (~20 GW)

Region	Industry	Project Developer	Vendor	Capacity (GW)
US	Data centers	Amazon	X-energy	5
US	Data centers	Standard Power	NuScale	1.8
US	Data centers	Equinix	Oklo	0.5
US	Data centers	Google	Kairos	0.5
US	Data centers	Amazon/Energy Northwest	X-energy	0.3
US	Data centers	Texas A&M	Various[18]	0.01–1
US	Chemicals	Tata Chemicals	BWXT	0.4
US	Chemicals	Dow Chemical	X-energy	0.3
US	Coal repowering	Pacificorp	TerraPower	0.35
Canada	Coal repowering	OPG	GE-Hitachi	1.2
Canada	Coal repowering	NB Power	ARC	0.15
Canada	Other industries	Port of Belledune	ARC	1
Europe	Chemicals	OSGE	GE-Hitachi	7.2
Europe	Coal repowering	RoPower (Nuclearelectrica)	NuScale	0.46
Europe	Coal repowering	Last Energy UK	Last Energy	0.1
Europe	Other industries	KGHM	NuScale	0.46
Europe	Other industries	Cristal Union	Jimmy	0.2

2.3 A massive opportunity

Our analysis has identified 11 key industrial sectors with strong potential for SMR adoption (Section 7.1 Appendix A). Together, these sectors could account for approximately **17,000 TWh of annual industrial energy** demand across North America (~11,000 TWh) and Europe (~6,000 TWh) by 2050 (Figure 5 and Figure 6).

2.4 A need for proactive planning and new market analysis approaches

Meeting industrial energy needs with SMRs could represent several hundred gigawatts of capacity, translating into trillions of dollars in missed opportunity if the nuclear supply chain fails to deliver. At the same time, uncertainties are high, making SMR market forecasting a complex

Figure 5: Total energy demand in selected industries, Announced Pledges Scenario, 2025–2050, North America

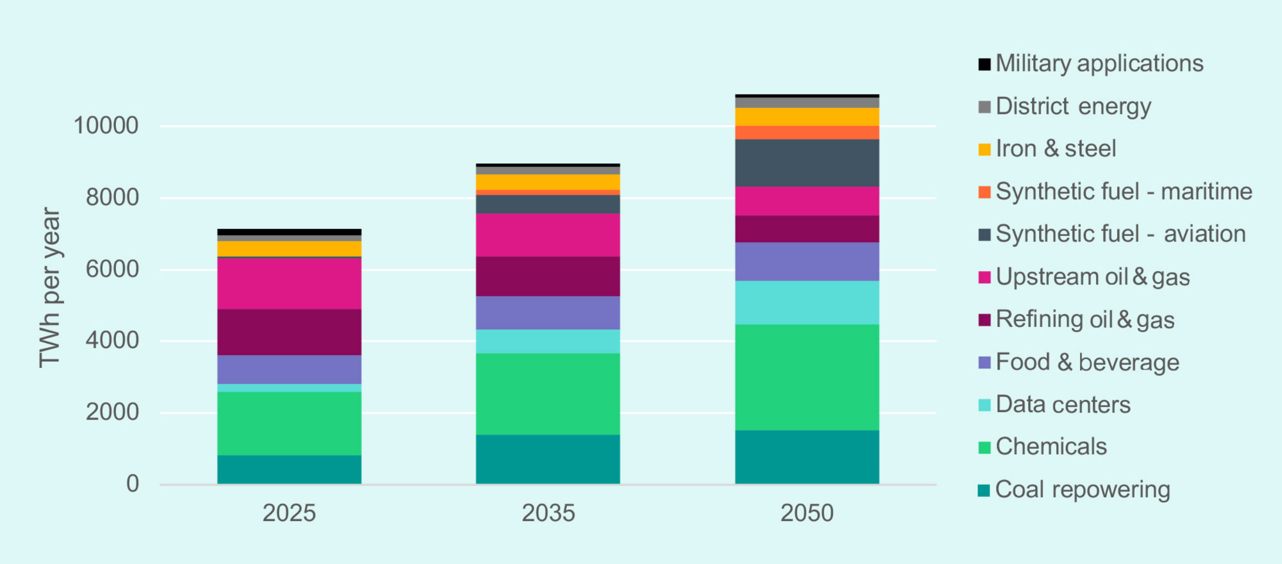
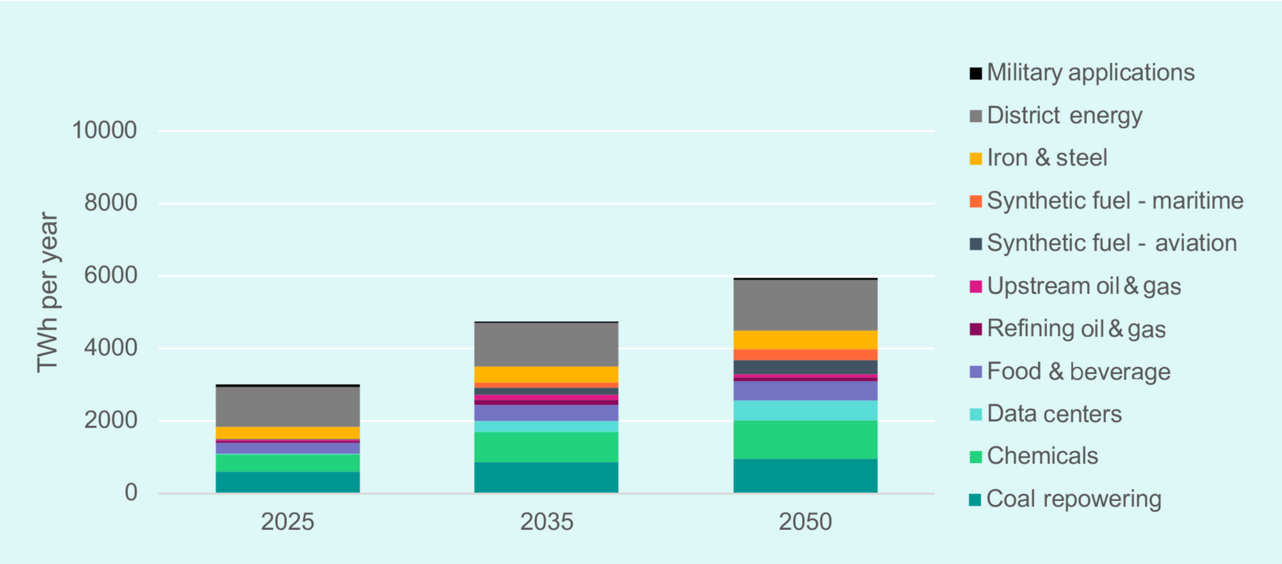


Figure 6: Total energy demand in selected industries, Announced Pledges Scenario, 2025–2050, Europe



endeavour.[19] This creates an urgent need for proactive planning and innovative market analysis methods.

This report provides an analytical framework grounded in market realities that accounts for both supply and demand dynamics and offers concrete evidence of how the SMR market could evolve toward higher deployment scenarios. Readers will find estimates of the accessible SMR market in specific industrial sectors as well as the underlying market drivers, enabling proactive planning through tracking of key metrics and trends.

3 Understanding SMR technical potential to meet industrial energy demand

Understanding which industries can be served by SMRs, and to what extent, is fundamental to assessing SMR market potential. Not all industrial energy needs can be met by nuclear technology, and particularly SMRs. Some processes require temperatures beyond current SMR capabilities, while others may have technical requirements incompatible with the technical features offered by SMRs.

This chapter first examines the main technical requirements of the 11 key industrial sectors, then evaluates SMR compatibility with these requirements, and finally quantifies the technical potential for SMR deployment based on temperature matching and integration with existing industrial operations.

The analysis reveals a substantial opportunity for SMRs: of the 17,000 TWh of annual industrial energy demand across North America (Figure 5) and Europe (Figure 6) by 2050, **approximately 15,000 TWh could technically be served by SMRs, equivalent to approximately 2,200 GW of SMR capacity.** However, this value should be interpreted as a theoretical upper bound rather than the actual accessible market for SMRs, the latter being determined by real market conditions including supply and demand dynamics.

3.1 Key industries and their technical requirements

Industry selection and categorization

This study analyzes the 11 key industrial sectors across North America and Europe to identify opportunities for SMR deployment. These sectors—data centers, chemicals, coal repowering, refining oil & gas, iron & steel, synthetic fuels (aviation and maritime), upstream oil & gas, food & beverage, district energy, and military applications—were selected through a structured evaluation process described in Section 7.1 Appendix A. **Together, these sectors represent more than of 80% of total industrial energy demand in these regions.**

Furthermore, the sectoral analysis revealed that **not all sectors have the same potential in terms of market size and adoption timelines** (Figure 7).

Figure 7: The 11 key industrial sectors with strong potential for SMR adoption

Catalysts (first movers with high growth)	1. Data centers 2. Upstream oil & gas 3. Military applications
High Confidence (early movers with high demand)	4. Chemicals 5. District energy 6. Refining oil & gas 7. Food & beverage
High Impact (later movers with high demand)	8. Coal repowering 9. Synthetic fuel for aviation 10. Synthetic fuel for maritime 11. Iron & steel

1. **Catalyst** sectors include data centers, upstream oil & gas and military applications. These sectors are advancing rapidly due to limited viable alternatives, robust growth potential, and capacity to absorb first-of-a-kind cost premiums or leverage existing infrastructure for cost reduction. These first movers can help establish supply chain capabilities and build industry confidence. While they may have a high impact, with high demand (e.g. upstream oil & gas), they are within the catalyst sector because they represent a significant opportunity to initiate SMR deployment as a first mover
2. **High Confidence** sectors such as chemicals, district energy, refining oil & gas, and food & beverage are also showing momentum and clear market signals. They represent much larger markets in terms of energy demand and therefore offer strong near- to medium-term potential for SMR deployment
3. **High-Impact** sectors are less likely to move in the short term because they require lower SMR costs to become competitive with current energy costs,

therefore likely to follow behind the Catalyst and High Confidence projects. However, their energy demand is so large that they could significantly shape long-term SMR market prospects. This category includes coal repowering, synthetic fuels for aviation and maritime, and iron & steel

This three-tier categorization helps sequence SMR market development: Catalyst sectors build industry capabilities and confidence, High Confidence sectors provide the scale needed to improve economics, and High Impact sectors can then be captured once competitiveness is achieved. The reality is, nevertheless, more complex, and some sectors may have outlier projects that advance in parallel to others rather than following sequential market development. This is particularly true when such projects receive specific policy support.[20]

Defining industrial technical requirements

Industrial energy demand has unique technical requirements that differ fundamentally from residential or commercial electricity consumption. While homes and offices primarily require intermittent electricity for lighting and climate control, industrial facilities need continuous, high-intensity energy inputs that directly enable production processes. These requirements determine which energy technologies can viably serve industrial markets.

The following industrial technical requirements have been identified to assess the potential of SMRs:

- **High energy density:** Industrial facilities often operate on constrained sites where space for energy infrastructure is limited. Energy solutions must deliver substantial power from compact footprints
- **Extreme reliability:** Industrial facilities typically require availability factors exceeding 95%, with critical processes demanding 99.9% reliability. Unplanned outages can cost millions in lost production, equipment damage, and restart expenses
- **Cogeneration needs:** Many industries require both heat and electricity for their production processes. Onsite cogeneration provides significant value by improving energy efficiency and therefore reducing costs
- **High-temperature process heat:** Many industrial processes require heat at specific temperatures—from 150 °C for food processing to over 750 °C for chemical reforming and steel production. This heat must be delivered consistently at precise temperatures to maintain product quality and process efficiency
- **Siting flexibility and integration:** Some industries face siting constraints (e.g., limited grid access, proximity to demand) and require generators that can be deployed in different configurations (e.g., on-grid, co-location, or behind-the-meter) and be integrated close to industrial facilities.
- **Facility size and scalability:** Industrial demand ranges from just a few megawatts to several gigawatts. Energy sources must be able to scale and match facility sizes as closely as possible.

Below, each of the key sectors is analyzed against these criteria according to the three-tier categorization described in Figure 7.

Catalyst sectors—first movers with high growth

Industries with strategic advantages and willingness to adopt new technologies:

- **Data centers** require baseload power. Uptime standards are extremely high, targeting 99.999% availability—translating to less than five minutes of unplanned downtime per year—making continuous, resilient electricity supply critical. Most data centers today have a capacity between 50–100 MWe, with the potential to achieve GW-scale in the near future
- **Upstream oil & gas** operations typically require 75–85% electricity and 15–25% heat, mostly at low to medium temperatures. These operations are often remote and demand very high uptime

(>95%) to avoid costly delays during drilling. Offshore FPSOs / platforms require between 20–150 MWe. Large onshore pads can reach up to 300–500 MW. Scalability and modularity are key for expansion

- **Military applications** typically rely on 70–80% electricity and less than 30% low-temperature heat, primarily for space heating. Systems must ensure >95% availability to maintain operational readiness. Mobility and off-grid capability are key design requirements with demand ranging between 1–5 MWe for most remote bases

High Confidence sectors—early movers with high demand

Large-scale energy consumers with SMR projects underway:

- **Chemicals** typically require ~65% heat and 35% electricity, with energy used for drying, cracking, reforming, and synthesis. These facilities operate across a broad temperature range from 50 °C to over 1,100 °C, with approximately half of their heat demand above 300 °C. Downtime tolerance is extremely low: continuous operations demand >95% uptime, as unplanned outages can lead to major safety, quality, and financial losses. The size of chemical facilities covers a wide range, with specialty or batch facilities in the range of tens of megawatts and large petrochemical hubs consuming hundreds to thousands of megawatts
- **District energy** systems primarily supply low-temperature heat (80–120 °C), with some setups also enabling district cooling via absorption chillers. Networks are already available and have relatively high downtime tolerance due to their seasonal operating patterns. Facilities tend to be small and decentralized but can reach between tens and hundreds of megawatts in large city hubs
- **Refining Oil & Gas** has a roughly equal split of energy demand between heat and electricity, with potential hydrogen production contributing to additional power needs. Critical units such as hydrocrackers and reformers operate at 300–550 °C, requiring precise thermal integration. Like chemical plants, refineries demand >95% uptime, as unscheduled outages can result in high operational losses. Refineries are large energy consumers with facilities of hundreds to thousands of megawatts
- **Food & beverage** facilities rely heavily on electricity (~70%) for motors, refrigeration, and compressors, with the remainder supplied by low-to medium-temperature heat. Typical thermal needs fall in the 150–250 °C range for processes such as pasteurization, drying, and cleaning. These sites usually operate continuously year-round, with outages posing risks of spoilage or product loss. Site size varies widely with most facilities being under 20 MWe

High Impact sectors—later movers with high demand

Sectors with large market potential with the potential to adopt SMRs:

- **Coal repowering**[21] offers substantial scale with existing grid connections and industrial site infrastructure. Nuclear deployment can utilize existing transmission and cooling infrastructure while replacing aging coal plants, providing immediate decarbonization opportunities. Most coal units for electricity generation are in the range of 350–750 MWe. A large coal plant with several units can be in the range of 1–5 GW
- **Synthetic fuel** production for aviation and maritime sectors requires large quantities of low-cost electricity for hydrogen production and may require carbon taxes to bridge the competitiveness gap with oil-based products. This emerging sector has significant future growth potential. Commercial facilities may require several hundred megawatts
- **Iron and steel** production can be carried out using blast-furnace/basic-oxygen-furnace (BF/BOF) and/or electric-arc furnace (EAF) processes. BF/BOF operations require temperatures above 1,000 °C. In contrast, modern EAF mills are highly electricity-intensive

(~95%) with minimal high-temperature heat needs. When coupled with hydrogen-based direct reduced iron (DRI), electricity demand could rise further by 2050. While EAFs can pause between charges, maintaining >95% power availability is essential to keep equipment warm and operational during continuous 24-hour cycles. Modern mills typically have capacities in the range of hundreds of megawatts

3.2 SMR capabilities to meet industrial technical requirements

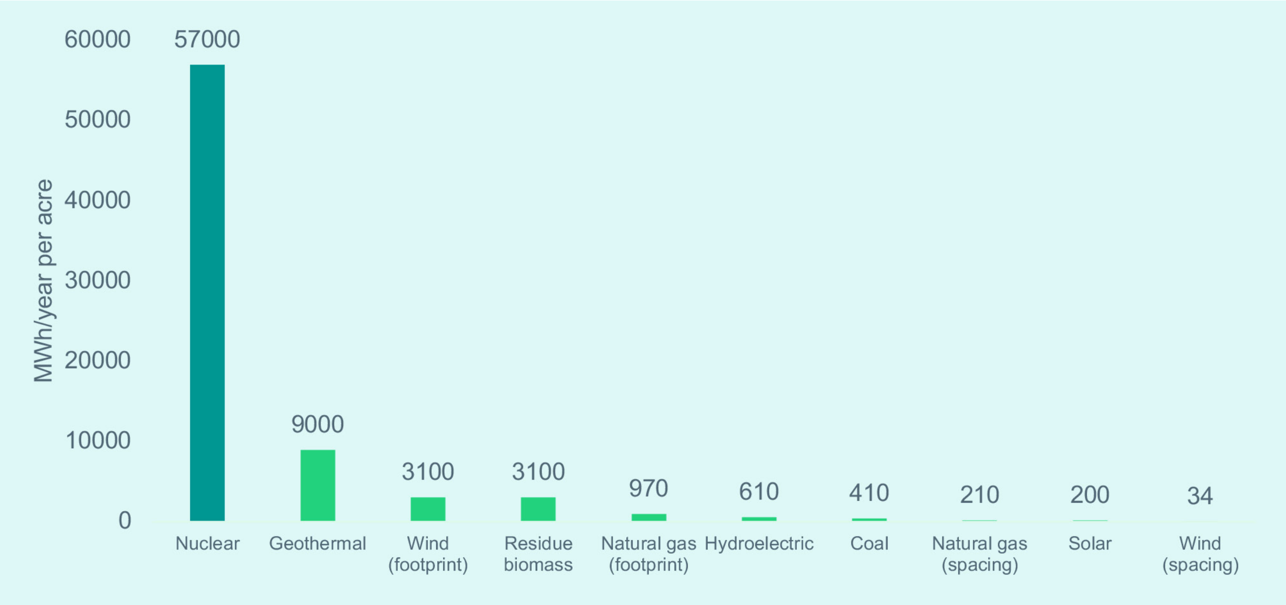
For the SMR market to develop, reactors must be designed to meet the technical requirements of their target industrial markets. Our analysis confirms that SMRs are well-positioned to satisfy most technical requirements across the 11 key sectors identified.

High energy density

The power density advantages of nuclear power are likely to be decisive for many industrial applications. For example, offshore operations such as upstream oil & gas activities face strict weight and footprint constraints. Similarly, chemical and refining facilities are typically brownfield sites with hazardous materials, requiring energy generators to fit within strict siting limitations.

Nuclear power offers exceptionally high-power density per acre: a single facility can produce up to 285 times more energy in a year than renewables, enabling deployment on constrained industrial sites where solar or wind installations are impractical (Figure 8). Furthermore, some SMRs use advanced nuclear technologies with power densities 2–3 times higher than traditional LWRs,[22] further enhancing the ability of nuclear facilities to operate within very tight industrial footprints.

Figure 8: Energy production per acre (land use efficiency of energy) for different energy sources[23]



Note: "Footprint" refers to the land that is physically occupied by the energy infrastructure, meaning the exclusive area taken up by the facilities. In contrast, "spacing" represents the full area required for the layout and necessary buffers, which includes the empty land between units. Because the calculation of MWh per acre using spacing includes these gaps, it lowers the apparent land productivity compared to footprint alone. For example, wind farms: The land footprint for wind farms is limited to the area of each turbine tower, which is very small. However, when accounting for spacing requirements between turbines, this significantly lowers the land efficiency (MWh/year per acre).

Extreme reliability

Nuclear power is a baseload, highly reliable technology, achieving capacity factors of over 90% through a weather-independent operation, compared to 25–35% for renewables (Figure 9). Some designs allow online refueling, supporting very high availability factors. This capability, combined with the multi-unit deployment enabled by SMRs, supports the extreme reliability required (>95%) in some industries. Staggered refueling and maintenance outages minimize downtime while offering the potential to sell excess electricity.[24]

Cogeneration needs

Nuclear power is already used for cogeneration applications. Large light-water reactors currently provide both electricity and district heating for municipalities and have done so for decades. In the past, there have also been pilot projects producing both electricity and heat for industrial applications, demonstrating the potential of SMRs to operate in cogeneration mode across different sectors.[26]

Cogeneration systems are more energy-efficient: nuclear systems capable of producing electricity and process heat simultaneously can achieve efficiencies above 80%, compared to 35–40% for electricity-only systems. These higher efficiencies improve overall competitiveness, potentially reducing SMR costs by up to 40%[27] and supporting greater market penetration.

High-temperature process heat

SMR designs based on advanced nuclear technologies can provide process heat of up to 750 °C (Table 1), covering most of the temperature requirements of the industries of interest (Figure 10). While core temperatures may be higher, unavoidable heat-exchange losses and current materials limitations realistically cap recoverable heat from SMRs at around 750 °C. Higher temperatures may become feasible as new nuclear-qualified materials are developed.

Light-water reactors can provide recoverable heat up to 285 °C, suitable for many industrial processes, and can meet the vast majority of heat needs in sectors such as district energy, food & beverage, and upstream oil & gas. Advanced nuclear technologies expand the range of heat demand that can be technically addressed, particularly for chemical reactions and oil refining.

Figure 9: US capacity factor by energy source, 2023[25]

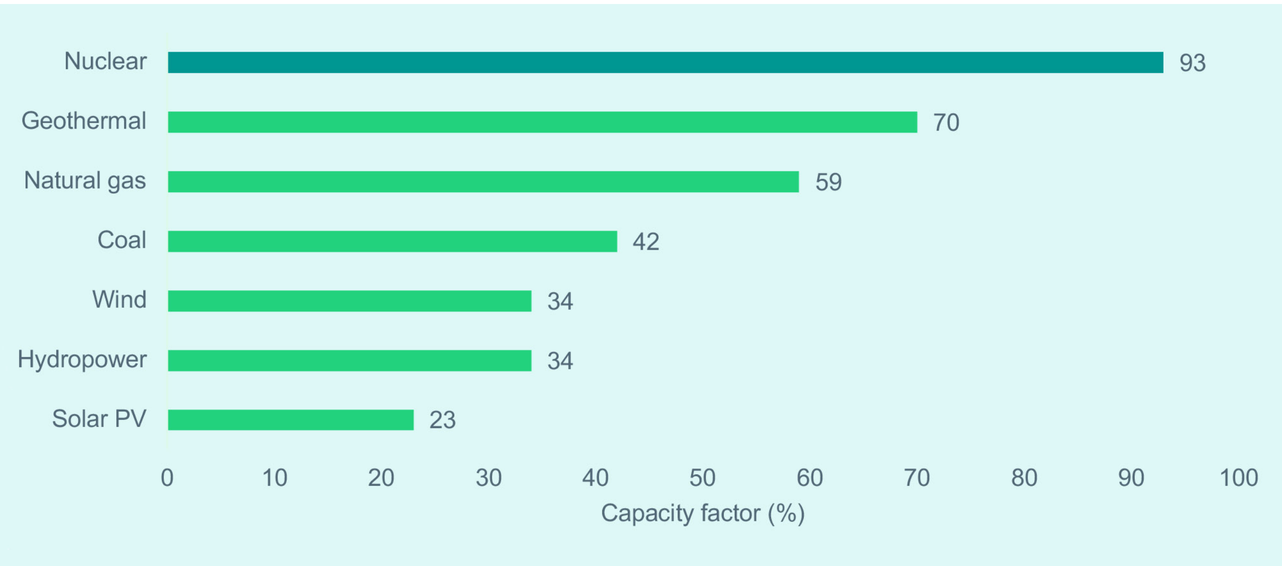
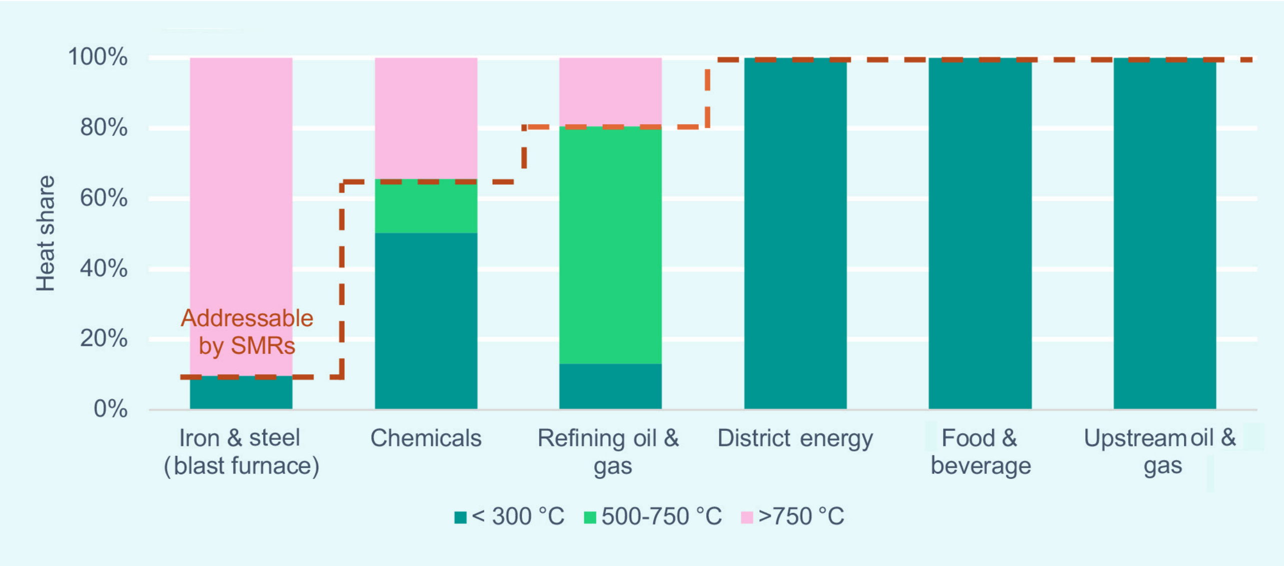


Table 1: Recoverable heat temperature by technology

Technology	Core outlet temp	Recoverable heat temp
High Temperature Reactor (HTR)	850 °C (750 °C in HTRs, assumed +100 °C with technical progress)	Steam: ~ 500–550 °C
		Other coolant: 700–750 °C
Molten Salt Reactor (MSR)	700	Steam: ~ 500–550 °C
		Other coolant: 630–650 °C
Sodium Fast Reactor (SFR)/ Lead Fast Reactor (LFR)	550	Steam: ~450–500 °C
		Other coolant: 500–520 °C
Light-water Reactor (LWR)	300	Steam: 250–275 °C

Figure 10: Heat demand breakdown by temperature band in selected industries



Note: Industries relying essentially on electricity are not included

Siting flexibility and integration

Advanced nuclear designs also offer greater siting flexibility and integration across a wide range of industrial configurations compared to traditional light-water reactors, due to the following technical and safety features:[28]

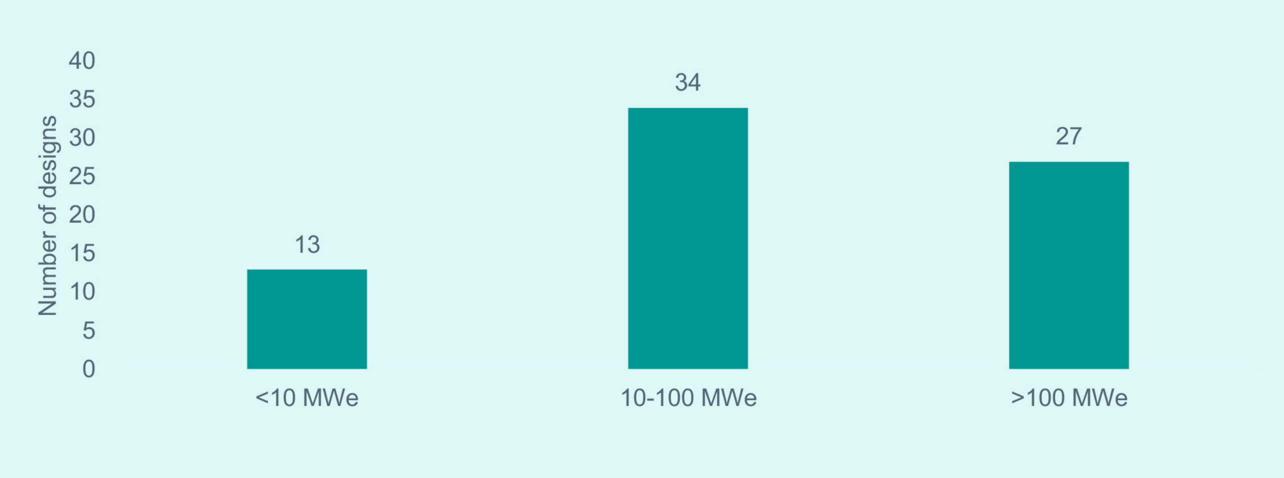
- **Operation at lower pressures:** Advanced designs use new coolants that enable operation at or near atmospheric pressure
- **Higher levels of inherent safety:** These designs leverage inherent safety features made possible by novel fuels (e.g., TRISO), lower operating pressures, and design configurations that support enhanced passive safety systems, as well as fewer and less severe failure modes
- **Reduced emergency planning requirements:** The combination of lower pressure and enhanced inherent safety has the potential to qualify some advanced nuclear designs for smaller emergency

planning zones, with radiological impacts remaining within the site boundary in the event of an accident. This could facilitate integration into brownfield sites and locations closer to end energy users

Facility size and scalability

The SMR designs under development cover a wide range of sizes, enabling alignment with the diverse scale of industrial facilities (Figure 11). A multi-unit deployment approach allows capacity to be matched more precisely combining several SMR units to serve GW-scale facilities when needed. As industrial facilities expand, additional units can be added, supporting scalability over time.

Figure 11: Number of SMR designs under active development by size range, 2025[29]



3.3 SMR technical potential

The technical potential for SMRs, the theoretical upper bound of what could be deployed, depends primarily on two factors: (1) matching industrial temperature requirements and (2) integration with existing industrial operations.

Accordingly, the technical potential for SMRs:

- **Covers all electricity and low-temperature steam needs**, which could theoretically be provided by an onsite cogeneration unit
- **Covers all process heat needs up to 750 °C**, which could be supplied by an onsite SMR with limited retrofitting of the industrial facility, replacing existing combined heat and power generators
- **Excludes non-process fuel energy needs.** These typically include fuels burned onsite for facility support and ancillary operations (e.g., space heating, emergency power, plant vehicles), excluding fuels used as feedstock or to supply heat/steam or mechanical drive for production processes. Such uses are assumed to be highly integrated within industrial facilities, making SMR replacement impractical. While SMRs could theoretically produce synthetic fuels to meet these needs, this is conservatively considered impractical compared to other alternatives (e.g., electrification)

Our analysis reveals that **SMRs can address more than 80% of the total energy demand across the selected 11 industrial sectors.** This high technical compatibility stems from two factors:

1. **Electricity dominates most sectors' energy needs and its importance is growing**, particularly for synthetic fuel production processes
2. **Most industrial heat requirements fall below 750 °C**, well within the temperature capabilities of current and advanced SMR designs

This strong technical alignment positions SMRs as an ideal clean energy solution for a wide range of industrial applications (Figure 12).

The portion of energy demand that is not technically addressable by SMRs consists primarily of heat above 750 °C. This high-temperature requirement is found mainly in the iron & steel and chemical sectors, and to a lesser extent in oil & gas refining.

The technical potential of SMRs can also evolve over time. In the iron & steel, chemicals, and oil & gas refining sectors, it could increase with greater electrification of existing production processes, including advances in high-temperature heat electrification and the use of onsite electricity to produce hydrogen feedstock. For example, the chemical and oil & gas refining industries use hydrogen as a feedstock, which could be produced onsite using SMRs. Similarly, the iron & steel sector may shift toward electric arc furnaces and direct reduced iron (DRI) processes using hydrogen.

Producing this hydrogen with SMRs brings opportunities to expand their technical potential and applicability in these industries.

Additionally, the results show that **heat represents 30–45% of the total technical potential for SMRs** in the selected sectors (Figure 13 and Figure 14).

In North America, most of this heat demand comes from the chemical sector and refining oil & gas. Under demand scenarios that push for decarbonization (such as the Announced Pledges scenario, see Section 4.5), the role of refining oil & gas becomes less prominent, leading to a reduction in heat demand, while chemical sector demand still rises.[30] In Europe, chemicals and district energy play the dominant role in overall energy demand. District energy demand in Europe is three to four times larger than in North America, which explains its higher share in the region's energy mix. In absolute terms, the technical potential for heat is similar in North America and Europe. However, heat plays a more prominent role in Europe's industrial energy profile.

Lastly, the fact that **electricity is used in most sectors, confirms the industrial need for cogeneration** and indicates that nuclear-based cogeneration could be a valuable solution across a wide range of sectors.

Figure 12: Estimated SMR technical potential share by industry

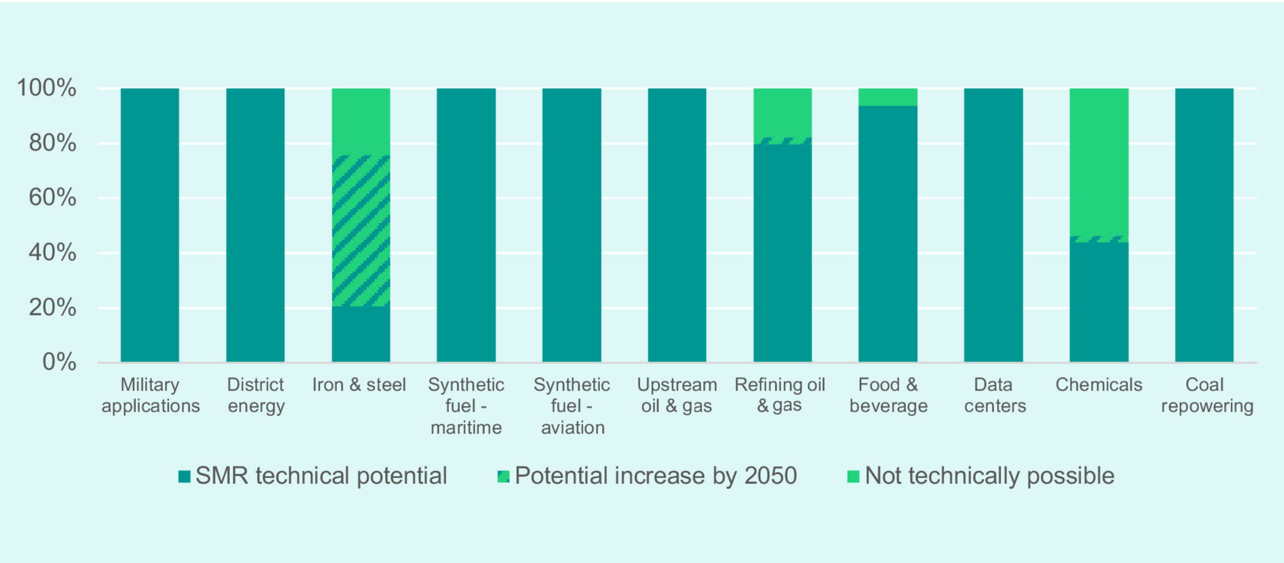


Figure 13: SMR technical potential in selected industries and carrier, North America, 2050

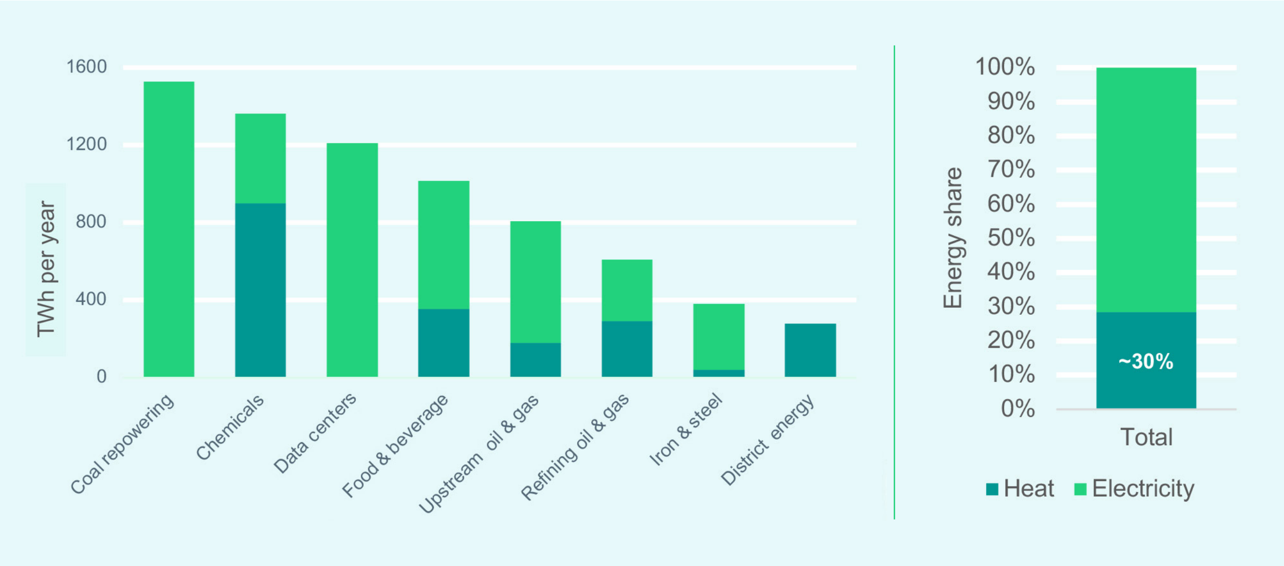
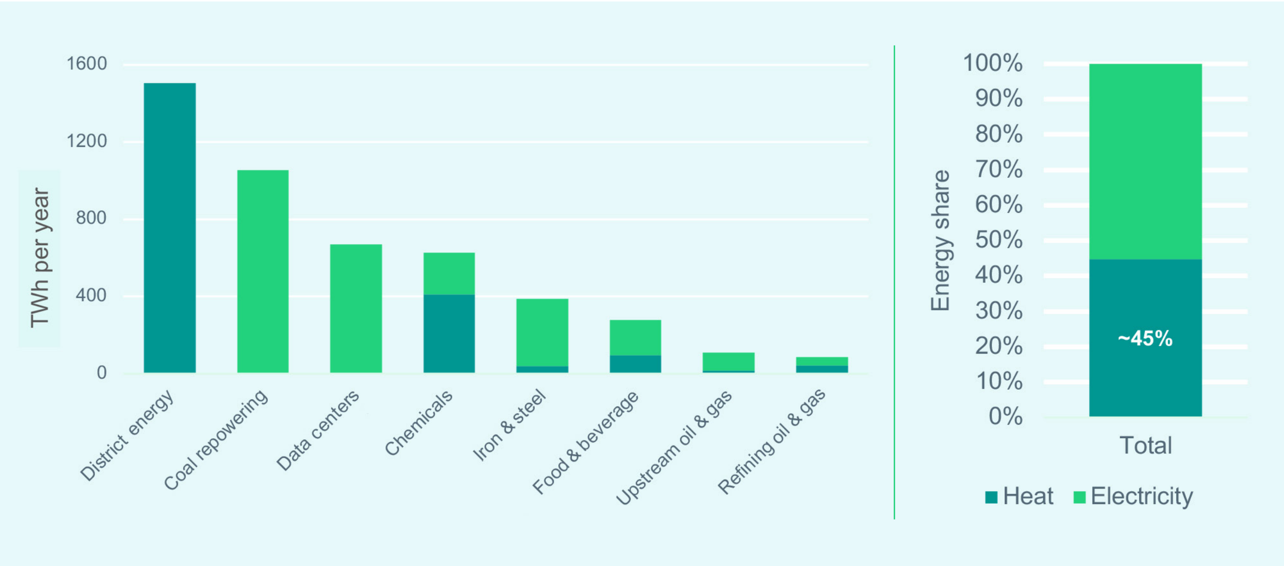


Figure 14: SMR technical potential in selected industries and carrier, Europe, 2050



Projecting technical potential across North America and Europe reveals substantial opportunities in both regions. **Of the 17,000 TWh total industrial energy demand across North America and Europe** (Figure 5 and Figure 6), **approximately 15,000 TWh – 9,500 TWh in North America and 5,500 TWh in Europe** (Figure 15 and Figure 16), **could be served by SMRs, requiring roughly 2,200 GW**[31] **of deployed capacity** (Table 2). While this represents the theoretical upper bound, the actual accessible market will depend on real market conditions based on demand and supply dynamics.

Figure 15: Technical potential by industry, Announced Pledges Scenario, 2025–2050, North America

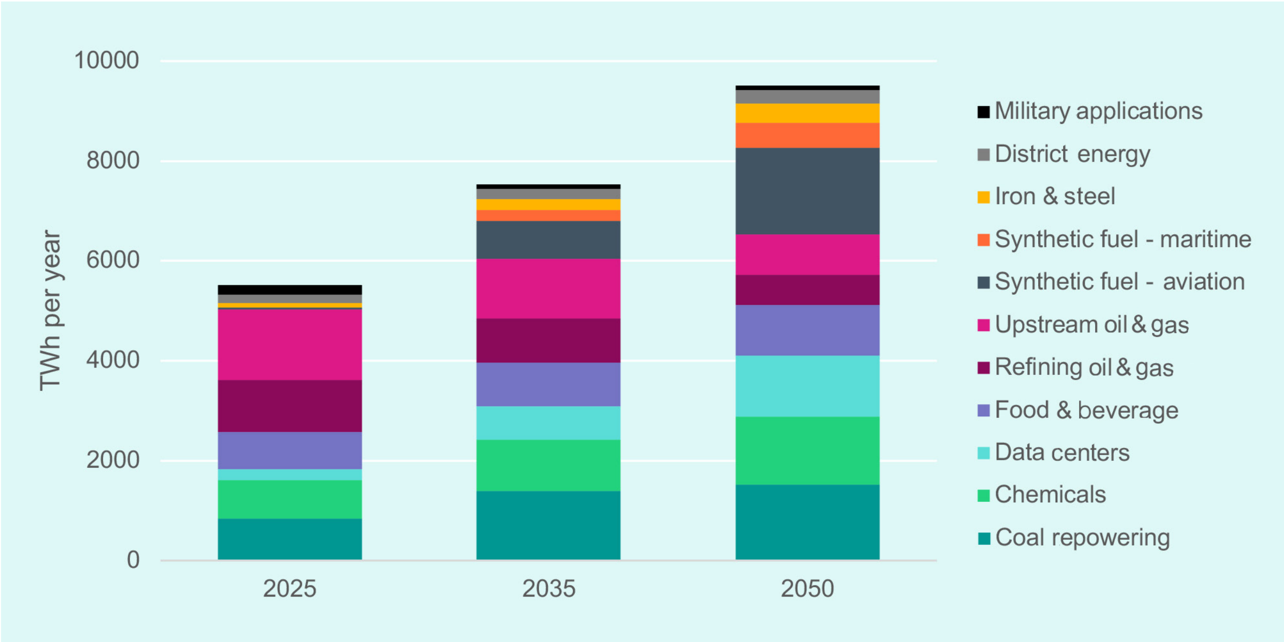


Figure 16: Technical potential by industry, Announced Pledges Scenario, 2025–2050, Europe

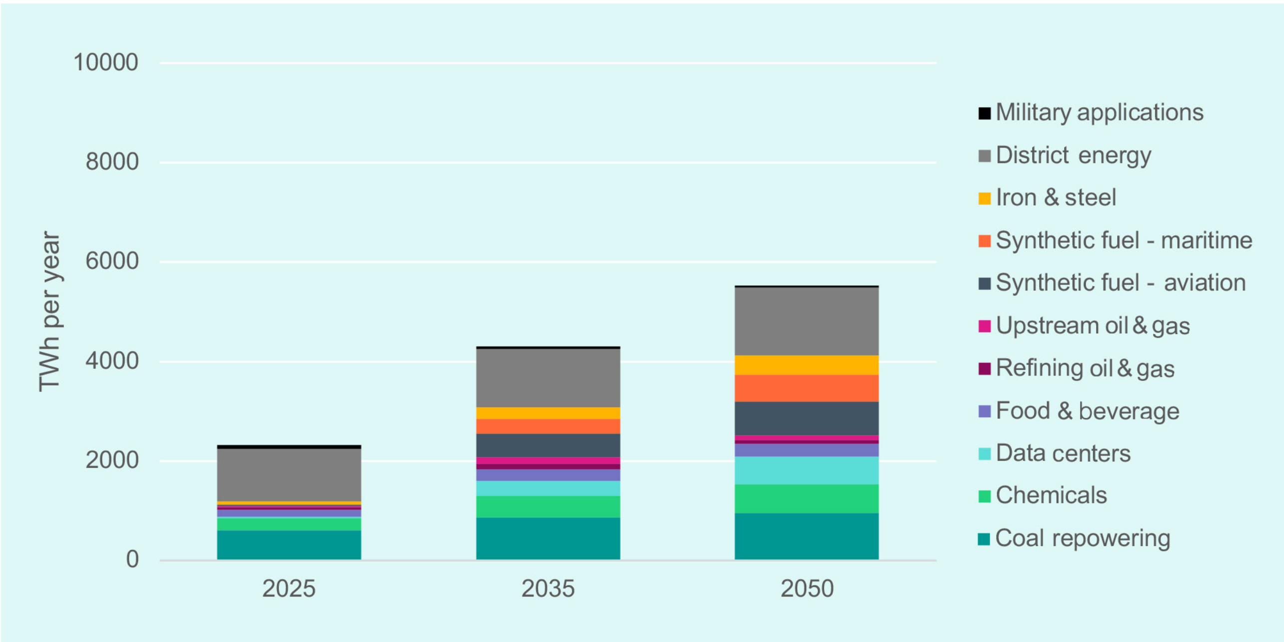


Table 2: SMR technical potential and investment opportunity in North America and Europe, Announced Pledges Scenario, 2050

Region	Estimated Technical Potential (SMR-suitable demand)	Estimated Technical Potential (Required SMR capacity)*
North America	9,515 TWh	~1,400 GW
Europe	5,527 TWh	~800 GW
Combined Market	**15,042 TWh**	**~2,200 GW**

*Accounts for conversion losses for synthetic fuels production and actual capacity that needs to be deployed

4 Estimating SMR market access

The previous chapter identified **a technical potential of 2,200 GW for SMRs to serve industrial energy needs** across the combined markets of North America and Europe. However, real market deployment depends on economic viability, regulatory frameworks, and delivery capabilities and innovations and could take different directions depending on how a set of critical market drivers evolve.

This chapter presents our framework for mapping the potential directions the SMR market could take based on fundamental supply and demand dynamics. The framework demonstrates how specific improvements in market conditions could unlock larger opportunities: **from around 7 GW under current deployment trends to up to 700 GW by 2050 under a full transformation of nuclear delivery models, representing a $0.5–1.5 trillion investment opportunity**.

4.1 A framework to map future SMR market access

The proposed framework to estimate future SMR market access is structured as follows:

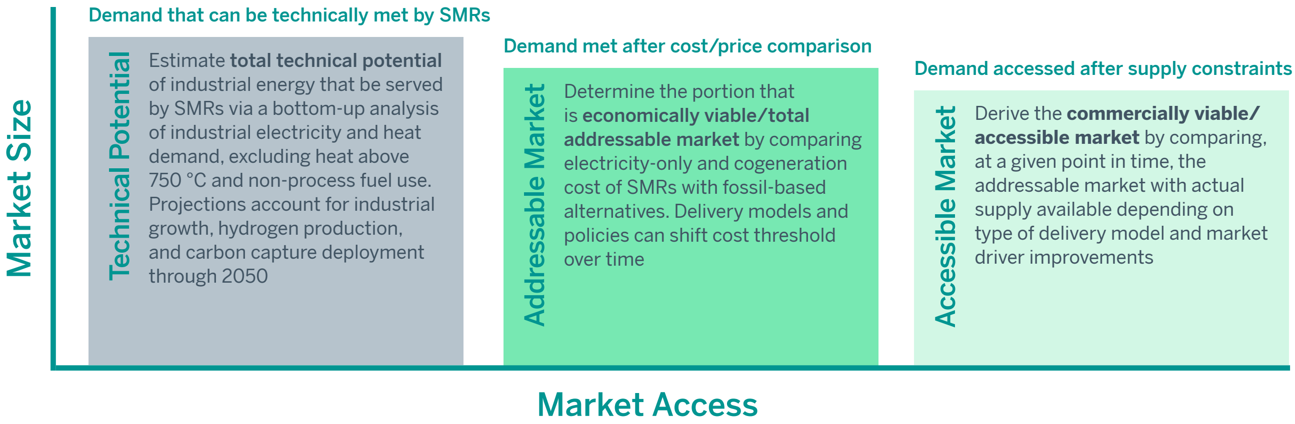
- **From technical potential to market access:** The technical potential is narrowed down to the accessible SMR market by accounting for actual supply and demand dynamics
- **High-level evaluation of supply and demand dynamics:** As a first, high-level step, supply and demand dynamics for SMR deployment are reduced to a cost-price comparison, with costs driven by delivery models and supplier delivery costs, and prices shaped by energy costs, security premiums, and policies
- **Six market drivers shaping deployment:** Cost and price are not the only factors determining SMR market access. Six Critical Market Drivers[31] are identified to evaluate how improvement in market realities and supply constraints translate into market access
- **SMR market access scenarios:** These cost-price dimensions and Six Critical Market Drivers, are used to derive a scenario matrix that maps out potential directions the accessible SMR market could take, depending on improvements in market conditions

4.2 From technical potential to market access

Our analysis is based on a three-step approach to translating technical potential into realistic SMR deployment levels (Figure 17):

1. **Technical Potential:** Bottom-up analysis which sets the maximum theoretical market that SMRs could serve in technical terms. The technical potential covers all industrial electricity and process heat demand below 750 °C, excluding non-process fuel use.[32] Projections account for industrial growth, hydrogen production, and carbon capture deployment through 2050. It is estimated at 2,200 GW across North America and Europe (Section 3.3)
2. **Addressable Market:** The technical potential is then subject to economic screening against fossil-based, technology alternatives. Electricity-only and cogeneration costs of SMRs are compared with combined cycle gas turbines (for electricity-only applications), combined heat and power units (for cogeneration), and specific cost thresholds for hydrogen and synfuels production. Energy price trends, security premiums and policy frameworks that appropriately value clean firm power shift these economic boundaries over time
3. **Accessible Market:** Lastly, the accessible market is determined by comparing the addressable market with the actual supply available based on a specific delivery model. This represents the SMR supply that can actually be built given real-world constraints

Figure 17: From SMR technical potential to accessible market reality



4.3 High-level evaluation of supply and demand dynamics

As a first step, supply and demand dynamics can be reduced to a commercial transaction: SMR deployment occurs when the supplier's cost falls below the buyer's acceptable price. Once this threshold is crossed, a commercial transaction is triggered and the market grows.

Costs and prices shaping SMR market growth can evolve in many different directions, but emerging trends already provide clues about market direction. These trends reflect ongoing investments and enacted policies. While their ultimate success remains uncertain, they could define clear pathways for market development.

Supplier's cost evolution

Supplier costs are assumed to be primarily driven by the type of nuclear delivery model (Figure 18). A delivery model can be defined as the way a nuclear plant is designed, licensed, and built. Today, three main approaches are being explored by SMR vendors, **which could potentially enable a ~70%[33] cost reduction assuming a transition from current onsite EPC to mass manufacturing:**

- **Onsite EPC (Engineering, Procurement, and Construction):** This is the traditional model for nuclear power, now being adapted for SMRs. It is proven but slow, capital-intensive, and exposed to cost overruns. Current examples include the Xe-100 reactors from X-energy (for Dow Chemical and Amazon AWS) and GE Hitachi's BWRX-300 (Darlington, OSGE, TVA Clinch River). Efficiency improvements are possible by applying lessons learned, leveraging larger order books, and increasing design and construction standardization[34]
- **Shipyard Manufacturing:** Modular reactor components are built in shipyards or offshore facilities, leveraging heavy industrial infrastructure already proven for submarines and aircraft carriers for military applications. This approach offers significant cost and schedule advantages through modularization and pre-shop fabrication, though regulatory and logistical hurdles remain. Some companies are adapting current designs to shipyard construction, while others are developing marine-based reactor applications from the outset[35,36]
- **Mass Manufacturing:** The smaller size of SMRs allows greater use of factory production lines, where reactors are mass produced, built in factories, and shipped for onsite assembly. This approach promises faster deployment, scalability, and improved quality control but remains in the early stages of commercialization. Several vendors are already undertaking investments in mass-manufacturing capabilities, including Aalo Atomics (Aalo-X), Copenhagen Atomics (Waste Burner), and BWXT (Project Pele)[37]

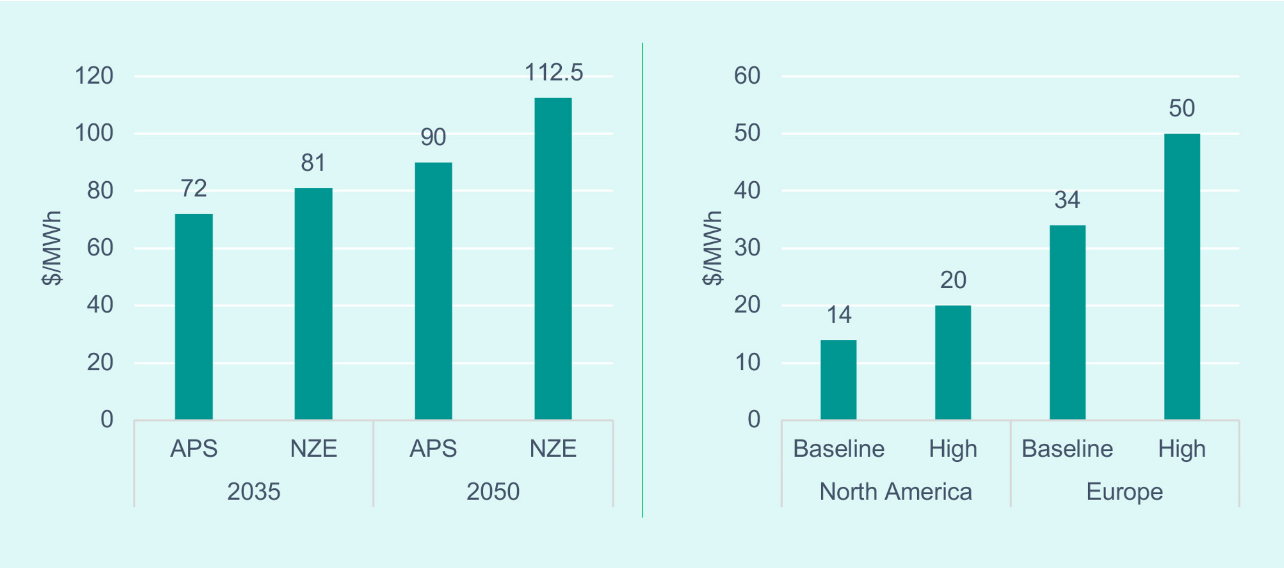
Figure 18: SMR costs under different project supply scenarios[38]

Buyers' acceptable price evolution

Buyers' acceptable price is determined from the perspective of large energy users, based on dimensions that directly affect profitability and, ultimately, shareholder value. These dimensions can be expressed as price metrics derived from commodity projections and relevant policy scenarios (Figure 19):

- **Energy Cost:** For many large energy users, energy expenses account for 20–85% of total operating costs, depending on the industry[39]
- **Security Premium:** Selected sectors have extreme reliability requirements (Section 3.1) and are willing to pay a premium above energy costs. Major data center providers already demonstrate willingness to pay over $100/MWh for reliable, clean solutions.[40] This premium can be even higher in remote or off-grid locations where alternatives are limited
- **Clean Energy Value:** Corporate sustainability commitments and regulatory requirements for clean energy are creating demand pull for zero-emission baseload power. Industries and governments are also placing greater value on clean, firm power attributes (e.g., dispatchability, onsite fuel availability), which increases the acceptable price to be paid for nuclear power

Figure 19: Policy support price premium in advanced economies by year and scenario (left) and gas prices in North America and Europe by 2050 (right)[41]



Note: APS = Announced Pledges Scenario, NZE = Net Zero by 2050. The policy support price premium is, by definition, added on top of fuel prices to account for the impact of policies on SMR demand.

4.4 Six critical market drivers shaping deployment

SMR deployment is influenced by both cost and price, but they are not the only factors. For instance, it can be heavily influenced by factors such as regulatory frameworks, availability of sites, access to capital, and a skilled workforce. SMR market development therefore requires coordinated progress across the following six critical market drivers.

By addressing these drivers systematically and simultaneously, nuclear power can meet industrial requirements and maximize market access:

1. **Delivery innovation:** Switching from the current approach of bespoke, one-off projects to standardized products deployed at scale. This is made possible by shifting from onsite construction to controlled factory environments, which are less prone to time and cost overruns and enable deployment at much larger scales. The product and manufacturing lines are designed concurrently leveraging design-for-manufacturing and assembly principles to achieve the necessary cost, speed, and scale requirements. This is the case for shipyards and mass manufacturing facilities which are being explored today by SMR vendors

2. **Regulatory evolution:** Switching from current, lengthy site-by-site licensing to product-based licensing would facilitate series production. The shift from treating each nuclear plant as a unique project to certifying standardized products fundamentally changes the economics and timeline of deployment. This is the case in the maritime industry with type approval approaches

3. **Economic viability:** Switching from expensive projects requiring massive government support to affordable products that can compete against fossil-based alternatives. The combination of cost reductions enabled by innovative delivery models (e.g., shipyard and mass manufacturing) with market frameworks that appropriately value 24/7 reliability, energy security, and zero emissions, improves the competitiveness of nuclear power and maximizes market access

4. **Site availability:** Moving from a handful of sites to having hundreds of pre-qualified sites enables rapid scaling once other conditions are met. National site qualification programs can identify and prepare locations suitable for standardized nuclear deployment, eliminating years from project timelines
5. **Capital access:** Moving from a specialized nuclear financing framework to mainstream financing approaches maximizes the access of private capital. Today, nuclear projects rely heavily on government-backed financing with limited involvement of the private sector. However, when nuclear projects become predictable, repeatable products rather than one-off megaprojects, the perceived risks (and therefore the cost of capital) can be significantly reduced, enabling access to the same capital markets that finance other industrial equipment
6. **Developer ecosystem:** Moving from a few integrated utilities with a limited pool of projects to a fully mature industrial ecosystem with project developers deploying standardized products across multiples sites and industries. A mature ecosystem includes not only reactor vendors but also integrated supply chains, skilled workforces, and experienced project developers who can align incentives, apply best project management practices, and improve performance by capitalizing on the lessons learned from large order books leveraging the latest digital tools

In our modelling, these drivers are captured through specific price-cost conditions (Section 4.3) and a supply funnel model built around different delivery models (i.e., onsite construction, shipyard production, mass manufacturing). Improvements in these drivers determine the final shape of the supply funnel by influencing the number of projects starting each year, their probability of success, their durations, and the allowed deployment ramp rates and capacity constraints. How the improvements across these six critical drivers could lead to different accessible market trajectories through 2050, is further detailed in Section 5.2.

4.5 SMR market access scenarios

Our analysis incorporates 16 scenarios, structured around a 4x4 matrix by crossing project supply (cost) and energy-demand (price) conditions described in Section 4.3. Each cell of the matrix also encapsulates specific improvements in the six critical drivers. Together, these scenarios define the space of possibilities within which the accessible SMR market can evolve. They are built on emerging delivery models and aligned with established energy transition pathways, particularly the IEA's Announced Pledges Scenario (APS) and Net Zero by 2050 (NZE) for demand projections.[42]

Project supply scenarios

Project supply scenarios are built upon emerging delivery models and associated cost projections. The main assumptions of the supply scenarios are summarized in Table 3:

- **Current Scenario (deployment < 1 GW/year by region):** Reflects today's nuclear industry onsite EPC delivery model in advanced economies, with very limited learning across new constructions. Over the last 25 years less than 10 GW of new nuclear capacity has been added representing deployment rates < 1 GW/year. Costs are assumed to remain constant at $125/MWh with projects taking 10+ years to be delivered
- **Programmatic Scenario (deployment 5–10 GW/year by region):** Achieves moderate growth through sustained government support programs and higher standardization of designs and delivery processes. Deployment increases up 5–10 GW/year in line with historical maximum deployment rates in the regions of interest. Costs go below $100/MWh but remain high, and projects are delivered in 5–7 years
- **Breakout Scenario (deployment 10–15 GW/year by region):** Represents the critical inflection point where shipyard-based delivery fundamentally transforms nuclear market access by reducing cost up to 50% from Current Scenario and delivering projects within 2–3 years. It is assumed that an average nuclear-qualified shipyard can produce around 10 barges per year each being able to carry four reactor units of 300 MWe[43,44]

Table 3: Project Supply Scenarios main assumptions

Project Supply Scenario	Delivery model	Estimate projected Cost	Delivery time	Deployment rates*
Current	Bespoke onsite construction	$125/MWh, hold constant through 2050	+10 years	< 1 GW/year
Programmatic	Standardized onsite construction	90–125/MWh	5–7 years	5–10 GW/year
Breakout	Shipyard manufacturing	$60–90/MWh	2–3 years	10–15 GW/year
Transformation	Mass manufacturing	$40–70/MWh	2–3 years or less	20–25 GW/year

*Actual deployment is determined with the supply funnel model reflecting market drivers improvements

This is an annual throughput between 10–15 GW/year per facility. A total of two manufacturing facilities are assumed to be operational in each region of interest by 2050, starting from 2030. Costs can reach $60/MWh with projects being delivered in 2–3 years

- **Transformation Scenario (deployment 20–25 GW/year by region):** Represents full ecosystem maturity where mass manufacturing becomes the primary delivery method thanks to the widespread adoption of design-for-manufacturing and assembly (DfMA) approaches in the design of nuclear systems. Compared to Breakout Scenario, higher scale and lower costs maximise SMR market adoption. A mass-manufacturing facility is estimated to produce around 500 units of 50 MWe annually leading to deployment levels between 20–25 GW/year. A total of two manufacturing facilities are assumed to be operational in each region of interest by 2050, starting from 2030. Cost can drop to $40/MWh with projects being delivered in 2–3 years or less

Energy demand scenarios

Energy demand scenarios are built on potential energy costs, energy security, and policy considerations that directly shape the acceptable price energy users are willing to pay for SMRs. The main assumptions underlying these scenarios are summarized in Table 4:

- **Energy Cost Scenario (gas price between $14–34/MWh):** Baseline competition with natural gas at $14–34/MWh sets the fundamental economic threshold. Rising gas prices in the long-term could improve the relative competitiveness of nuclear

Table 4: Energy demand scenarios main assumptions

Project Supply Scenario	Gas price	Policy support price premium
Energy Cost	$14–34/MWh	Assumed none in North America, +$45/MWh in Europe based on EU–ETS[45]
Energy Security	$20–50/MWh	Assumed none in North America, +$45/MWh in Europe based on EU–ETS
Announced Pledges	$14–34/MWh	+ $72–90/MWh to gas prices, all regions
Net Zero by 2050	$14–34/MWh	+ $81–112/MWh to gas prices, all regions

Energy Security Scenario (gas prices between $20–50/MWh): Industrial facilities experiencing production downtime or high gas price volatility may pay 50% premiums over existing gas prices (+$5–15/MWh) for guaranteed baseload power, depending on infrastructure criticality.

- **Announced Pledges Scenario (policy support adding $72–90/MWh to gas prices):** Under the Announced Pledges Scenario (APS) countries and energy users meet their clean energy pledges and/or fully implement existing policies that place additional value to the system attributes (i.e., low-emissions, dispatchability, onsite fuel) of nuclear power
- **Net Zero by 2050 (policy support adding $81–112/MWh to gas prices):** Similar motivations than in APS but countries and energy users intensify their efforts to achieve net zero by 2050 with the Paris Agreement 1.5 °C target and/or place even more to the system attributes of nuclear power

Interpreting policy support

Each country has at its disposal a variety of policy instruments to bridge the competitiveness gap between SMRs and fossil-based alternatives. These instruments can be designed to value nuclear power's attributes, including low emissions, dispatchability, fuel diversity, and overall system value. Policies may aim either to reduce generation costs (e.g., targeted financing support, direct subsidies, tax credits) and/or to increase revenues (e.g., market reforms, capacity mechanisms, above-market PPAs, carbon pricing). The "policy support price premium" on gas prices across APS and NZE scenarios reflects the wide range of policy instruments that may be available to countries considering such policies.

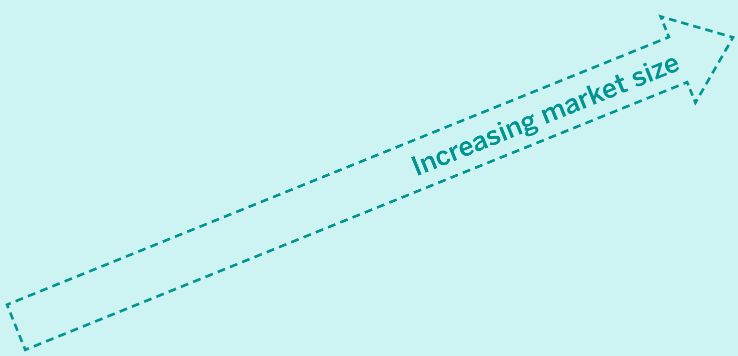
Mapping potential SMR market futures

Our modelling approach creates 16 potential SMR market futures resulting from crossing project supply and energy demand scenarios (Figure 20). Each scenario represents different levels of supply and demand conditions, captured through specific improvements in supply delivery costs and acceptable price from energy users.

The scenarios are not sequential stages but parallel development pathways that could emerge simultaneously, depending on the pace of supply and demand improvements. This means it is possible to achieve maximum SMR market access starting today if mass manufacturing becomes a proven, licensable solution, supported by policies that properly value nuclear power. By modelling these scenarios quantitatively, we can assess the specific market impacts of different strategic approaches to SMR market development.

Figure 20: Mapping potential SMR market future by crossing supply and demand scenarios

			Project Supply Scenarios			
			Current Bespoke onsite EPC model <1 GW/year/region SMR costs = $125/MWh	**Programmatic** Standardized onsite EPC model 5–10 GW/year/region SMR costs = $125–90/MWh	**Breakout** Shipyard manufacturing 10–15 GW/year/region SMR costs = $60–90/MWh	**Transformation** Mass manufacturing 20–25 GW/year/region SMR costs = $40–60/MWh
Energy Demand Scenarios	**Net Zero by 2050 (NZE)** Existing pledges and policies intensified	+$81–112/MWh to gas prices				
	Announced Pledges (APS) Existing pledges and policies are met	+$72–90/MWh to gas prices				
	Energy Security Premium paid for energy independence	Gas price = $20–50/MWh				
	Energy Cost Long-term energy prices	Gas price = $14–34/MWh				



4.6 Market sizing results and analysis

The quantitative results demonstrate the dramatic impact of coordinated supply and demand improvements on accessible nuclear markets. These findings quantify the market potential currently locked behind supply constraints and reveal how specific improvements can unlock larger market opportunities: **7 GW based on current deployment trends to up to 700 GW by 2050 under full delivery transformation**.

Accessible SMR market heatmaps

Our modelling reveals extraordinary market scaling potential across 16 scenarios over time combining supply and demand improvements, demonstrating how the implementation of new delivery models, combined with policy support and increasing willingness to pay from energy users, could unlock vast nuclear deployment opportunities (Table 5 and Table 6).

The Current Scenario modeling assumes that most projects will start construction by 2027, consistent with the expected final investment decision timeline for some projects.[46] Projects are also assumed to take more than seven years, resulting in no deployment before 2035. However, the study also recognises potential deployment by 2030 under the Stated Policies Scenario of the International Energy Agency,[47] which is reflected as the high end in the accessible marker range of the Current Scenario in Table 5 and Table 6.

Table 5: Accessible market heatmap, North America, 2035–2050

2035 (in GWe)	Current	Programmatic	Breakout	Transformation
Net Zero by 2050	Up to 2.0	8.7	30.0	48.8
Announced Pledges	Up to 2.0	8.7	30.0	48.7
Energy Security	Up to 2.0	8.7	26.1	26.1
Energy cost	Up to 2.0	8.7	26.1	26.1

2050 (in GWe)	Current	Programmatic	Breakout	Transformation
Net Zero by 2050	3.3	73.5	210.0	423.6
Announced Pledges	3.3	73.5	210.0	423.6
Energy Security	3.3	26.1	26.1	26.1
Energy cost	3.3	26.1	26.1	26.1

Large Market
Small Market

Table 6: Accessible market heatmap, Europe, 2035–2050

2035 (in GWe)	Current	Programmatic	Breakout	Transformation
Net Zero by 2050	Up to 1.1	4.4	11.2	11.7
Announced Pledges	Up to 1.1	4.4	11.1	11.7
Energy Security	Up to 1.1	5.4	11.1	11.8
Energy cost	Up to 1.1	5.4	11.3	11.8

2050 (in GWe)	Current	Programmatic	Breakout	Transformation
Net Zero by 2050	4.1	44.3	135.9	274.0
Announced Pledges	4.1	46.6	137.5	276.7
Energy Security	4.8	46.7	140.2	282.6
Energy cost	4.8	45.8	143.2	282.6

Regional opportunities

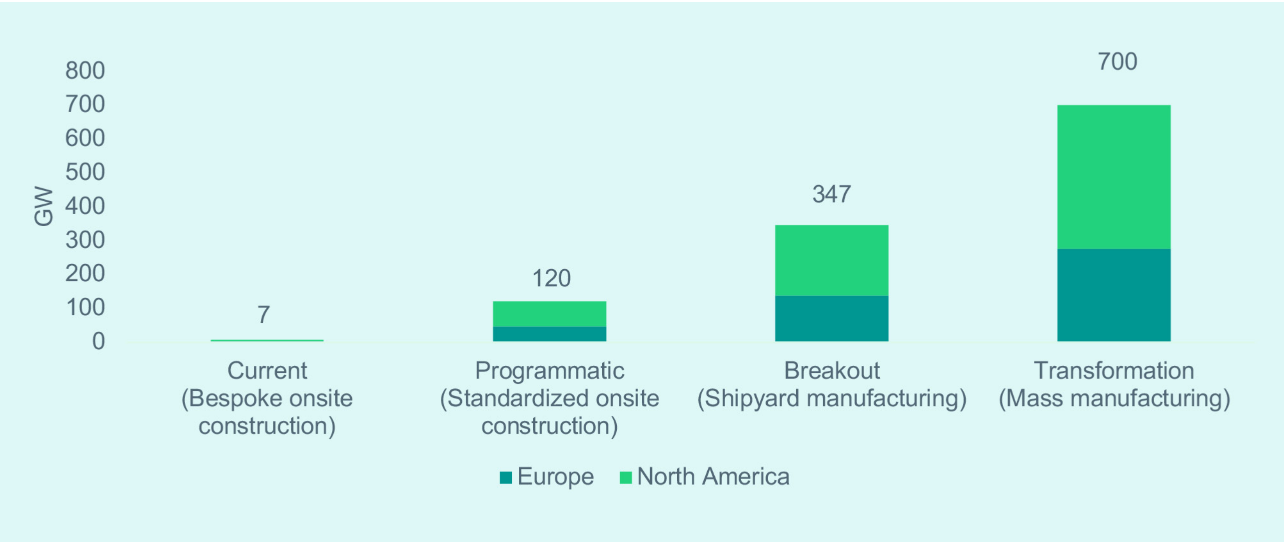
Taking the APS Scenario as a reference, regional accessible market evolution across the Current, Programmatic, Breakout and Transformation scenarios reveals massive scaling of SMRs (Figure 21).

North America: 424 GW opportunity

North America represents the larger absolute opportunity with 424 GW of potential deployment by 2050 under the Transformation scenario.

The region is positioned to lead with:

Figure 21: Accessible SMR market by supply scenario and region, Announced Pledges Scenario, 2050



- Broad bipartisan support for nuclear as an essential source of baseload power and legislation to support expanded use of nuclear to meet growing energy demand
- Regulatory modernisation supporting more predictable and efficient regulatory reviews for advanced reactors[48] under the ADVANCE act, as well as fixed deadlines for evaluation and approval of licenses laid out in the Executive Order on reform of the Nuclear Regulatory Commission (NRC)
- Large and active industrial demand driven primarily by data centers
- Regulatory collaboration between the NRC and the Canadian Nuclear Safety Commission (CNSC), including joint technical reviews of Terrestrial Energy's IMSR400 and GE Hitachi's BWRX-300 in Darlington, Ontario, which is expected to be the first BWRX-300 in North America
- Bipartisan efforts to address growing energy demand and considerations of grid reliability and energy security, which makes nuclear an attractive energy source. Supply chain development and near-term demonstration programs, such as the ARDP demonstration projects (over $3 billion for the Natrium and Xe-100 reactors), other funding support for next generation reactors, and policy initiatives to accelerate the deployment of new reactors, including the Idaho National Laboratory's NRIC DOME initiative at the EBR-II site and the selection of 11 projects to fast-track SMR test reactors

The primary challenge remains competing with abundant natural gas priced at $14–20/MWh. Achieving competitiveness requires both dramatic cost reductions through manufacturing innovation and power market framework that appropriately value key attributes of nuclear power (e.g. reliability, fuel diversity) at both federal and state level.

Europe: ~276 GW opportunity

Europe offers ~276 GW of deployment potential with better near-term economics due to structurally higher energy prices ($34–50/MWh for gas combined with EU-ETS carbon pricing).

The region benefits from:

- Strong climate commitments with binding 2030 and 2050 targets
- Existing nuclear expertise in France, UK, and Eastern Europe
- District energy networks providing additional cogeneration opportunities
- Energy security concerns driving diversification from gas imports
- Established power market valuing clean energy and long-term price stability, for instance through EU-ETS carbon pricing and the use of power purchase agreements and contract for differences

These conditions make SMRs attractive even with limited policy support, as reflected in the Energy Cost and Energy Security scenarios. However, strong decarbonization commitments in the region can reduce the addressable market, particularly in the oil and gas sector and maritime, thereby lowering the accessible market in the APS and NZE scenarios. In these scenarios, oil and gas sector demand peaks by 2030 (or earlier), mainly due to the electrification of transport. This also has a negative effect on market demand as industries adapt. For example, if less oil is required, fewer oil tankers are needed to transport it, and energy demand in oil extraction and refining decreases, thereby impacting demand across both the oil and gas industry and the maritime sector.

Regulatory fragmentation across 27 member states limits deployment efficiency. Achieving scale requires either higher EU-level regulatory efficiency[49] and mutual recognition of previous licensing work regulatory on same designs[50] enabling standardized deployment. Despite these challenges, Europe represents the second priority market where early deployment could proceed more easily due to favorable economics even under less aggressive scenarios.

Combined, **these regions represent a $0.5–1.5 trillion investment opportunity**,[51] with deployment timing and scale directly linked to market driver evolution and scenario realization in each region.

Sectoral opportunities under transformation

The 700 GW market encompasses diverse industrial sectors, each with distinct requirements and adoption timelines. Understanding these differences helps prioritize development efforts and identify early markets that can catalyze SMR deployment in each of the scenarios.

Top five sectors representing more than 75% of SMR market access

1. **Synthetic aviation fuels: 203 GW**

   The largest single opportunity emerges from aviation's need for carbon-neutral drop-in fuels (Figure 22). Airlines face limited decarbonization options. Batteries are too heavy for long-haul flights. Direct use of pure hydrogen as fuel requires completely redesigned aircraft and new airport infrastructure. This leaves synthetic fuels, which are typically made by combining hydrogen (as a feedstock) with carbon to produce synthetic kerosene, as the primary pathway. This route works with today's engines and fuel systems, so airlines can decarbonize without fleet replacement and building new infrastructure. Producing these fuels requires massive amounts of clean electricity for electrolytic hydrogen production and synthesis processes, with SMRs providing the continuous baseload power required. This long-term opportunity accelerates post-2035 as regulations tighten, production technologies mature and SMR cost are low enough for affordable hydrogen production

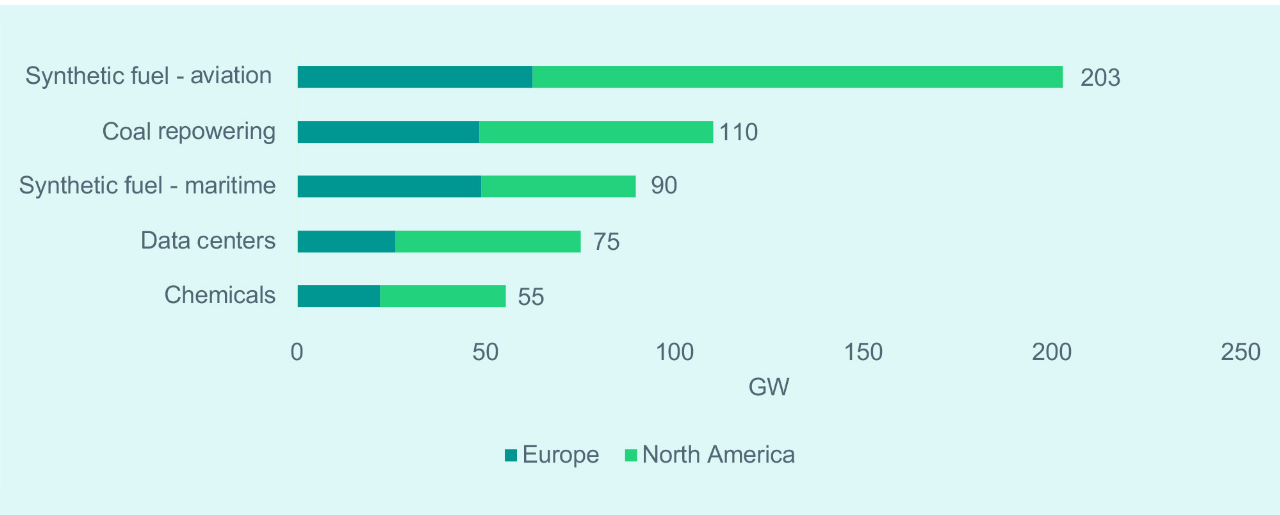
2. **Coal repowering (plant replacements): 110 GW**

   Coal plant sites offer attractive deployment opportunities, with existing grid connections, cooling water access, trained workforces, and community acceptance of industrial facilities. These advantages not only facilitate adoption but can also reduce SMR investment costs by up to 35%.[52] Repowering coal with SMRs also maintains grid stability while eliminating emissions and preserving local employment. This near-term opportunity, with first demonstration projects already underway (Figure 4), can begin under Current and Programmatic conditions, making it critical for establishing early commercial success and demonstrating viability at scale

3. **Synthetic maritime fuels: 90 GW**

   The shipping industry faces International Maritime Organization (IMO) mandates to achieve net zero emissions by 2050, with

Figure 22: Top five SMR accessible markets by region, Transformation and Announced Pledges Scenarios, 2050



interim targets of at least a 20% reduction by 2030.[53] This creates strong demand for clean fuel production at port facilities. Like aviation, shipping requires energy-dense, drop-in fuels to enable trans-oceanic transport. SMRs can provide the continuous, low-carbon energy needed for large-scale ammonia or methanol production, with deployment expected to accelerate between 2035 and 2050 as regulatory pressure intensifies and SMR costs decline

In parallel, direct nuclear propulsion for vessels could also emerge earlier, depending on the modernization and harmonization of legal and regulatory frameworks for nuclear ships. However, this market is estimated to be roughly three times smaller than the synthetic fuel route, reaching about 30 GW by 2050 (See appendix 7.3)

4. **Data centers: 75 GW**

   Data centers represent the fastest-growing near-term demand (Figure 22), fueled by exponentially increasing AI computing needs that require extreme reliability (over 99.99% uptime). These facilities already pay premium prices – often above $100/MWh – for highly reliable power, and several have begun signing agreements for SMR deployment.[54] Combined with their concentrated energy demand and rapid growth toward GW-scale facilities, data centers are well positioned to act as early adopters and drive the initial scale-up of SMRs

5. **Chemicals: 55 GW**

   The chemical industry requires both electricity and high-temperature process heat (up to 750 °C), which SMRs can provide, making combined heat and power applications particularly valuable. High-value chemical products can absorb premium energy costs while also benefiting from lower SMR costs through cogeneration efficiencies. Moreover, the industry's familiarity with complex processes and safety management facilitates nuclear adoption. This sector represents the second-largest near-term opportunity after data centers, with several major chemical companies already exploring SMR deployment (Figure 4)

The remaining six sectors represent 20% SMR market access

6. **Food & beverage: 43 GW**

   The food & beverage industry's energy needs are dominated by low-temperature heat (< 300 °C), which can be served by incumbent light-water reactor technologies. The industry is characterized by small, decentralized facilities, which may pose challenges for large LWR units and instead favor microreactors. Market access will also be influenced by competition with heat pumps, particularly for smaller facilities

7. **Iron & steel: 33 GW**

   Iron & steel is a difficult market to access due to the very high temperatures (> 1,000 °C) required for blast furnaces. However, as the industry transitions toward electric arc furnaces (EAF), opportunities for SMR adoption increase. If SMR costs decline sufficiently, onsite hydrogen production for direct reduced iron (DRI) processes could further expand the potential market significantly

8. **Upstream oil & gas: 33 GW**

   Upstream oil & gas operations, both onshore and offshore, are attractive markets as they are often off-grid and willing to pay higher premiums, making them suitable for early SMR deployment. Most energy needs are electricity, with the notable exception of Canadian oil sands, which use steam-assisted gravity drainage (SAGD). The size of this European market is constrained under decarbonization pressures, where oil & gas production is expected to decline. In September 2025, major oil & gas players launched the Industrial Advanced Nuclear™ Consortium (IANC)[55] to leverage their integration and project delivery expertise to define the requirements for the application of nuclear technology, signalling industry interest on SMRs

9. **District energy: 33 GW**

   District energy benefits from existing operational experience with large LWRs, as the low temperatures involved make nuclear heat an obvious fit. The market is approximately 3–4 times larger in Europe than in North America, with advanced pilot projects such as Helsinki's VTT/Steady Energy small modular district heating reactor, which is targeting deployment in the early 2030s.[56] As with food & beverage, adoption may be challenged by the prevalence of small, decentralized facilities and competition with heat pumps. However, nuclear could be an economically attractive option for large district energy hubs, especially under high electricity prices[57]

10. **Refining oil & gas: 13 GW**

    Refineries require large amounts of electricity, high-temperature heat, and extreme reliability-conditions well suited to SMR cogeneration capabilities. Demand is expected to decline, particularly in Europe, as mobility electrification reduces liquid fuel demand. Nonetheless, continued demand for petrochemicals will sustain significant energy needs, leaving a niche but strategic opportunity for SMR adoption.

11. **Military applications: 12 GW**

    Military applications were a catalyst for nuclear deployment in the past and could play the same role again. This sector is driven primarily by strategic and national security considerations rather than pure economics, which translates into a higher willingness to pay. Opportunities include direct government procurement and potentially shorter licensing pathways, both of which could accelerate SMR demand in the near term

Potential Market Evolution Timeline

Near-term drivers (2025–2035)

Data centers, military applications and upstream oil & gas are poised to drive initial SMR demand. These sectors combine immediate energy needs with the ability to absorb early-adopter premiums. Coal repowering and chemical could also move in parallel with targeted policy support, as evidenced in the United States.[21] These sectors may also benefit from specific cost advantages such as capital cost savings from repurposing infrastructure in coal repowering, and cogeneration efficiencies in chemicals, while facing pressing decarbonization requirements that may increase willingness to pay. Early commercial successes in these sectors can demonstrate viability and attract broader industrial interest, creating the reference projects needed for mainstream adoption.

Long-term growth (2035–2050)

Synthetic fuel production for aviation and maritime represents the largest growth opportunity as these hard-to-abate sectors require scalable decarbonization solutions. With manufacturing efficiency driving costs to $40–60/MWh and markets properly valuing clean firm power, the full 700 GW opportunity becomes accessible. By this period, SMRs have the potential to transition from alternative energy to standard industrial energy solution.

Measuring the level of policy support needed to unlock the opportunity

Our analysis finds that **policy support, in the range of $14–60/MWh, combined with improvements in delivery, could bridge the current competitiveness gap** between nuclear power and fossil fuels and unlock significant opportunities (Figure 23).

This level of policy support needed to unlock the 700 GW opportunity is comparable to other recent instruments for clean technologies, underscoring that extension of existing policy ambition to "all clean technologies in a technology-neutral manner", with proper remuneration for the system value that nuclear power provides (Figure 24) is needed. Policy actions that enable the Breakthrough and Transformation scenarios, to deliver nuclear energy at the lowest cost, would also be beneficial.

Figure 23: Comparison of combined cycle gas turbine cost as function of carbon price with different SMR delivery costs

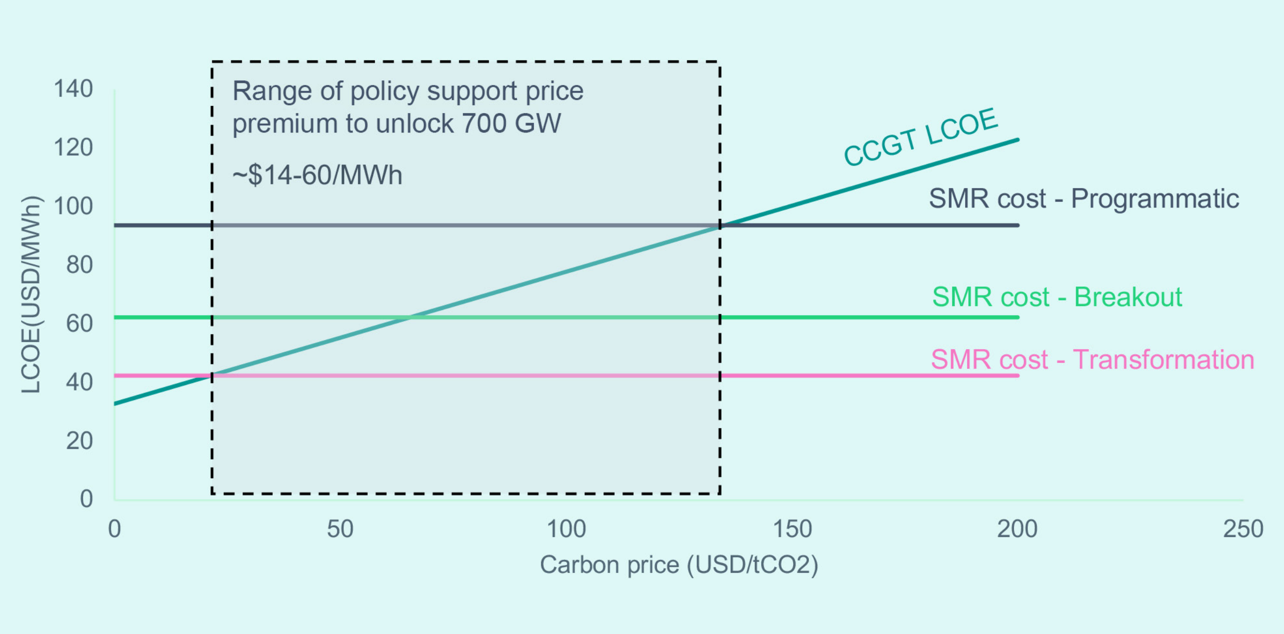


Figure 24: Comparison of policy instruments and their economic impact/price[58]

The level of policy support is not fixed and can be adjusted as improvements in nuclear delivery are achieved. As technologies mature, delivery becomes shorter and more predictable, and SMRs reach acceptable price thresholds for industrial users, policy support can gradually phase down; similar to other industrial policies that provide initial backing for strategic technologies until they become commercially competitive.

5 Bridging the gap: from today's 7 GW to tomorrow's 700 GW

The previous chapters identified a potential accessible market of nearly 700 GW by 2050 under full delivery transformation. This chapter explains how coordinated progress across the six Critical Drivers can bridge the gap between today's limited deployment (Current Scenario) and tomorrow's massive opportunity (Transformation Scenario).

5.1 Designing for industrial requirements

A foundational condition for market adoption is that products must be designed to meet customer requirements. Customer requirements drive the product design process and not the other way around.[59] In the case of SMRs, while SMRs show strong potential to meet industrial technical requirements (Section 3.2), they often fall short in addressing industrial business requirements (Table 7).

This mismatch between what industrial customers require and what nuclear currently delivers helps explain why deployment is projected to achieve 7 GW under current delivery trends, despite nearly 700 GW of potential under full transformation.

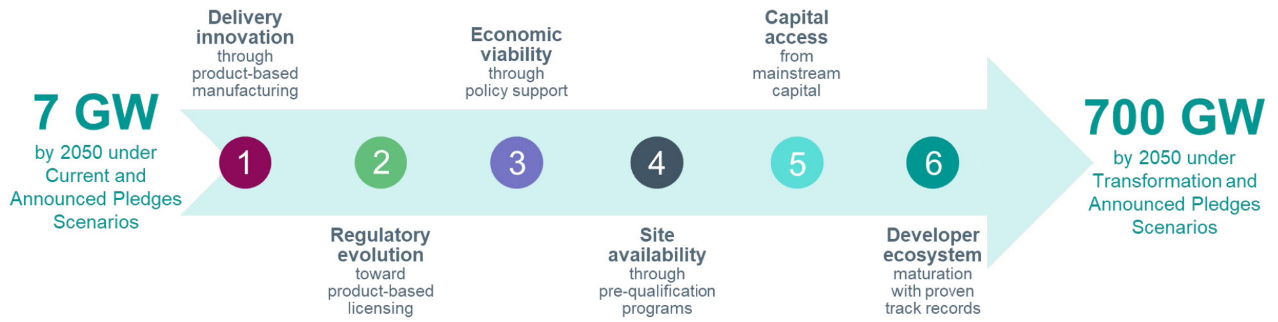
5.2 The pathway for market transformation

This gap, however, represents opportunity rather than limitation. The pathway from today's 7 GW to tomorrow's 700 GW is clear: systematic and simultaneous transformation across the six Critical Drivers that can evolve nuclear from custom construction projects to manufactured energy products fully aligned with industrial requirements (Figure 25).

Table 7: SMRs must be designed to meet both energy users technical and business requirements

Current nuclear delivery	Industrial customers require
Massive upfront capital requirements	Low upfront capital, with preference for operating expenses
10+ year deployment timelines	Solutions aligned with 2–3 year industrial planning cycles or less
Onsite delivery with cost-plus contracts	Manufacturing-like procurement and fixed-price contracts
Custom, first-of-a-kind designs supported by shallow supply chains	Proven, standardized solutions adapted for industrial scale
Customer-borne nuclear licensing risk and operational responsibilities	Energy-as-a-service: no operational involvement or asset liability
Site-specific licensing requirements	Easily deployable across diverse industrial sites
Nuclear-specific safety standards designed for utilities	Industrial safety standards

Figure 25: Six critical drivers activation to bridge the gap from 7 GW to 700 GW of SMRs



Driver 1: Delivery innovation through product-based manufacturing

Manufacturing-based delivery fundamentally changes nuclear economics and deployment timelines:

- **Reduces capital costs** by 70% (see Figure 18) through factory production
- **Compresses delivery** timelines from 10+ years to 2–3 years or less[60]
- **Enables fixed-price contracts** industrial customers require
- **Creates predictable deployment schedules** for planning certainty
- **Enables higher throughput** and delivery scale

Driver 2: Regulatory evolution toward product-based licensing

Product-based licensing enables series production by providing shorter, more predictable regulatory timelines and deployment schedules, thereby reducing overall perceived regulatory risk:

- **Risk-informed, performance-based licensing** provides flexibility by focusing regulatory effort where it adds the most value
- **Type certification for standardized designs**[61] eliminates the need for site-specific reviews
- **Higher International regulatory efficiency and mutual recognition** of previous licensing work on same designs enables broader, cross-border deployment
- Digitally enabled licensing processes, on both regulator and licensee sides, can reduce paperwork and accelerate timelines

Driver 3: Economic viability through policy support

Policy support helps bridge competitiveness gap and justify manufacturing investments:

- **Technology neutral power market frameworks** that properly value nuclear power's key attributes (e.g. low emissions, dispatchability, fuel diversity) and provide long-term price stability
- **National-level procurement** to create initial demand
- **Infrastructure funding** to support first deployments and test new delivery models

Governments can also provide non-monetary infrastructure support, such as aligning regulatory frameworks with national priorities and launching workforce programs. In parallel, cost reductions enabled by delivery innovations improve the competitiveness of nuclear power, allowing some policies to be phased down over time.

Driver 4: Site availability through pre-qualification programs

Site pre-qualification accelerates deployment and unlocks scale by identifying and preparing sites to be "nuclear-ready," providing greater visibility for project developers:

- **National land** designated for SMR deployment
- **Coal plant sites** pre-approved for nuclear conversion
- **Energy corridors and industrial clusters** with a nuclear-ready infrastructure checklist pre-qualified
- **Streamlined environmental reviews** and permitting for pre-qualified sites, with a reduced scope for site-specific assessments

Driver 5: Capital access from mainstream financing

Mainstream financing reduces costs and helps attract capital for scale:

- **Government-backed nuclear financing frameworks** support early deployments by de-risking first projects
- **Manufacturing-based delivery models reduce project risk**, enabling wider access to private capital
- **Commercial banks, infrastructure funds, and pension funds join nuclear investment** once risks are reduced, securing attractive rates and crowding in additional low-cost capital

Driver 6: Developer ecosystem maturation with proven track records

A mature developer ecosystem reduces costs and enables speed and scale, creating a supply chain able to deliver around 50 GW annually:[62]

- **Multiple project developers** capable to effectively coordinate multiple projects across industrial sectors
- **Proven EPC contractors** with nuclear experience
- **Multiple qualified suppliers** for every component
- **Trained workforce pipeline** from universities
- **Digital delivery platforms** reducing project complexity and effectively capturing lessons from every project
- **Demonstrated track records** building customer confidence

5.3 Understanding the transformation journey

Each level of progress across the six Critical Drivers opens new market opportunities that can now be mapped to specific project-supply scenarios, improving understanding of what needs to be done to unlock SMR market potential (Table 8). This identifies the path forward and what is required to transform today's market conditions to new scenarios that enable larger SMR market access.

All scenarios are achievable from today:

Current to Programmatic (7 GW → 120 GW): Initial progress on regulatory standardization and government support enables a 17-fold increase. Even with construction-based delivery, coordinated policy action and improved project management unlocks significant growth. This demonstrates that progress does not require full market drivers activation; meaningful market expansion begins with incremental improvements.

Current to Breakout (7 GW → 347 GW): The critical inflection point where manufacturing innovation combines with regulatory evolution. Shipyard production, product certification, and mainstream financing work together to nearly triple market access compared to Programmatic scenario. This shows how multiple drivers reinforcing each other create step-change improvements.

Current to Transformation (7 GW → 700 GW): Full maturation across all six drivers maximizes deployment. Mass manufacturing, global supply chains, competitive ecosystems, and policy support operate in harmony. Each driver amplifies the others' impact, demonstrating the power of full transformation.

The key insight: Each improvement in the six critical drivers expands market access, with each scenario being achievable from today. While full transformation unlocks the complete 700 GW opportunity, even achieving the Programmatic scenario's 120 GW represents massive growth and valuable market penetration. The Breakout scenario's 347 GW would fundamentally establish nuclear as a mainstream industrial energy solution.

Table 8: Connecting progress in six Critical Drivers with SMR market opportunity

Scenario	Delivery Innovation	Regulatory Evolution	Economic Viability	Site Availability	Capital Access	Developer Ecosystem	Accessible Market by 2050, Announced Pledges Scenario (in GW)
Current	Onsite construction, bespoke designs. Projects take 10+ years	Existing licensing processes. Still site-specific	SMR cost $125/MWh Policy support equivalent to >$60/MWh	A handful of pre-qualified sites by region	Government-led	Few project developers supported by a shallow supply chain	7
Programmatic	Standardized designs enable modular construction, first cost reductions through repeatability. Projects take 5-7 years	More streamlined, standardized licensing processes. Still site-specific	SMR cost $90-125/MWh Policy support equivalent to $30–60/MWh	Increasing number of pre-qualified sites by leveraging national land first coal site	Government-led attracting low levels of private capital	Few project developers gaining experience and leveraging new investment in supply. University programs launched	120
Breakout	Shipyard manufacturing partnerships established and operational. Products deployed in 2–3 years	Product based licensing based on type certification frameworks. Multi–site licensing	SMR cost $60–90/MWh Policy support equivalent to $15–30/MWh	High number pre-qualified sites, coal sites and first industrial sites. Streamlined review and permitting	High levels of private capital	Several experienced project developers leveraging existing shipyard supply and supported by proven EPC contractors and digital tools	347
Transformation	Mass manufacturing facilities licensed and operational. Products deployed in 2–3 years or less	Full product-based licensing with high levels of regulatory efficiency and mutual recognition globally. Multi-site licensing	SMR cost $40–60/MWh Policy support equivalent to <$15/MWh	High number of pre-qualified sites including industrial clusters and energy corridors. Streamlined review and permitting	Full access to private capital and financing mechanisms	A fully mature, competitive global ecosystem with multiple suppliers per component, proven EPC contractors, and a sustained workforce pipeline, all highly integrated with digital tools	700

6 Conclusion: the path to 700 GW

6.1 The opportunity is clear

This study has identified a transformative opportunity: nearly 700 GW of SMR deployment potential by 2050, representing approximately 2,300 reactors of 300 MW capacity and $0.5–1.5 trillion in investment. This isn't a theoretical aspiration but an achievable market opportunity that can meet the urgent energy needs of industrial sectors across North America and Europe, including the technology sector.

The analysis reveals that SMRs are technically capable of serving over 80% of industrial energy demand, providing the continuous baseload power, high-temperature heat, compact footprint and ability to match a wide range of facility sizes that industrial operations require. From data centers demanding 99.9% reliability and siting flexibility to chemical plants and refineries requiring high temperature heat, SMRs match industrial, technical requirements across the board. Further examples include offshore platforms and military applications requiring small, mobile units, to synthetic fuel production requiring massive clean energy inputs.

6.2 The path is defined

The journey from today's 7 GW to tomorrow's 700 GW follows a clear progression through coordinated advancement of the Six Critical Drivers:

1. **Delivery innovation:** Evolution from custom construction to mass manufacturing reduces costs by 70% and compresses timelines from more than a decade to 2–3 years or less
2. **Regulatory evolution:** Shift from site-by-site licensing to product certification enables series production and shorter, more predictable deployment, thereby reducing perceived risks
3. **Economic viability:** Policy frameworks that value clean, firm energy create the market pull for nuclear deployment at scale
4. **Site availability:** Pre-qualified sites eliminate years of permitting delays and enable rapid deployment
5. **Capital access:** Mainstream financing at standard infrastructure rates transforms project economics and supports scale
6. **Developer ecosystem:** A mature, competitive supplier base with proven track records enables 50+ GW annual deployment

Small improvements in these critical drivers could expand the SMR market access significantly. Even achieving the Programmatic scenario's 120 GW represents a 17-fold increase from current trends. The Breakout scenario's 347 GW would establish nuclear as a mainstream industrial energy solution. Full transformation to 700 GW maximizes market access. All of these scenarios are achievable today with the right level of ambition.

6.3 The time is now

Industrial companies focused on 2030 decarbonization targets are making energy decisions today. This convergence of industrial need, policy support, and nuclear innovation creates unprecedented opportunity for transformation. The companies that commit now will:

- Secure competitive energy costs before carbon pricing escalates
- Lock in reliable supply before grid constraints worsen
- Position themselves as climate leaders with 24/7 clean energy
- Benefit from early-mover advantages in emerging markets like synthetic fuels

The 2025–2030 period isn't a deadline but an opportunity to capture first-mover advantages and build the foundation for decades of growth. Early success will create the operating references, proven delivery models, and supply chain maturity that accelerate broader adoption.

6.4 Action required today

For Policymakers: Establish frameworks that enable, not constrain, nuclear innovation. Product-based licensing, pre-qualified sites, and technology-neutral clean energy standards can unlock private investment and accelerate deployment.

For Industrial Customers: Engage now to shape energy solutions that meet your specific needs. Early adopters will influence technology development, secure priority delivery slots, and capture competitive advantages.

For Technology Developers: Invest in manufacturability (i.e. design for manufacturing and assembly) and standardization and work with customers to define product requirements. The market rewards predictable delivery and proven performance that meet the customer's needs, not technological complexity disconnected from market reality.

For Financial Institutions: Recognize the Transformation scenario is underway, with mass manufacturing of reactors already in development. Manufacturing-based delivery and energy-as-a-service models fundamentally change nuclear development risk profiles, creating opportunities for mainstream investment.

For Communities: Embrace the opportunity for economic revitalization. Former coal communities can become clean energy manufacturing hubs, creating sustainable employment for generations.

6.5 The transformation is achievable

The gap between today's 7 GW and tomorrow's 700 GW is bridgeable. The technology exists. The industrial demand is urgent. The policy momentum is building. The delivery models are emerging. What is required is coordinated action across the Six Critical Drivers to transform nuclear from specialized infrastructure to manufactured energy products.

This transformation will not happen overnight, but it will happen progressively. Each standardized design approved, each manufacturing partnership formed, each successful deployment completed, builds toward the goal. The path from Programmatic to Breakout to full Transformation scenario is clear.

With nearly 700 GW representing almost a third of industrial energy needs, SMRs offer the scale necessary to maintain industrial competitiveness while achieving climate goals. The convergence of artificial intelligence driving unprecedented energy demand, policy momentum, and nuclear innovation enabling new delivery models creates a unique moment in energy history.

The opportunity is massive. The pathway is clear. The transformation is achievable. The time to act is now.

7 Appendices

7.1 Appendix A: Identifying industrial sectors with strong potential for SMR adoption

The selection of key industrial sectors for SMR market analysis followed a four-step evaluation process:

1. A high-level literature review was conducted to identify target industries based on existing analyses. These include studies from government agencies, national laboratories, academia and international organisations (e.g., International Atomic Energy Agency, OECD Nuclear Energy Agency and International Energy Agency). A full list of the publications analyzed is presented in appendix 7.2
2. An industry screening based on classification systems such as the North American Industry Classification System (NAICS) was conducted. The screening criteria included energy intensity, heat requirements, and grid access practicality, ensuring that no relevant sectors were overlooked. This process resulted in a shortlist of approximately 20 industries, which closely aligned with findings from the literature review. These include: Data centers, chemicals, coal repowering, refining (oil & gas), iron & steel, aluminium, synthetic fuels, off-grid mining, district energy, maritime propulsion/ships, upstream oil & gas, food & beverage, cement, pulp & paper, glass, water desalination, mining, plastic materials & resins, remote communities, military applications, space applications, computers, electronics, and electrical equipment
3. An industry evaluation across nine criteria was performed to determine the compatibility of each of the 20 industries with SMR deployment. The criteria included market potential (energy demand, deployment timeline), strategic fit (emissions, growth trajectory), lack of alternatives (impact of lost load, heat requirements, grid constraints), affordability (current energy costs), and ease of adoption (process compatibility). An example of an industry evaluation matrix for the United States, also relevant for the broader North American region, is presented in Table 9
4. A multicriteria analysis was performed to rank and prioritize the different sectors. Three sensitivities were tested: one prioritizing demand size, another focused on the willingness to adopt SMRs (with higher weight given to short deployment timelines and ease of adoption), and a third focusing on relative energy costs. These results narrowed the list of sectors from 20 down to 11
5. The results also allow for the categorisation of industries into catalyst, high-confidence, and high-impact sectors (Figure 7), particularly by comparing the results from the demand size and willingness-to-adopt sensitivities. The analysis further revealed that the maritime sector could represent a potential market for SMRs in two ways: through synthetic fuels or through direct nuclear propulsion. This study focuses on the synthetic fuels route, as it presents lower regulatory hurdles and potentially higher demand; however, it also acknowledges the potential and recent developments in the nuclear propulsion route (appendix 7.3)

Table 9: Industry Evaluation Matrix (United States focus)

	Market potential		Strategic fit		Lack of alternatives			Affordability	Ease of adoption
	Current energy demand	Deployment timeline	Emissions	Growth trajectory	Impact of lost load	Significant heat demand that cannot be electrified	Ease of grid supply	Current energy costs	Process compatibility (incl. conversion project)
Military applications	Low	High	Low	Intermediate	High	High	High	High	High
District energy	Intermediate	Intermediate	High	Intermediate	Intermediate	Intermediate	Low	Low	High
Iron & steel	Intermediate	Low	High	Low	Low	Intermediate	Intermediate	High	Low
Synthetic fuels for maritime	High	Low	High	High	Low	High	High	High	Low
Synthetic fuels for aviation	High	Low	High	High	Low	High	High	High	Low
Upstream oil & gas	Intermediate	High	Intermediate	Intermediate	Intermediate	High	High	Intermediate	Intermediate
Refining oil & gas	High	Intermediate	High	Intermediate	Intermediate	High	Intermediate	Intermediate	Intermediate
Food & beverage	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Low	Intermediate	Intermediate
Data centers	Low	High	Intermediate	High	High	Low	Intermediate	Low	High
Chemicals	High	High	High	Intermediate	Intermediate	High	Low	Intermediate	Intermediate
Coal repowering	High	Low	High	Low	Low	Low	Low	Intermediate	High

Legend for Industry Evaluation Matrix:

Excellent fit for nuclear deployment

Moderate fit with some limitations or requirements

Significant challenges or poor fit for nuclear

Key Evaluation Criteria: Market potential, strategic fit, lack of alternatives, affordability, ease of adoption

7.2 Appendix B: Summary of key SMR market studies

As part of the approach to identify and select key markets with the strongest potential for SMR adoption a literature review was carried out. The main studies analyzed are summarized in Table 10.

Table 10: Summary of key SMR market studies

Study	Organisation	Year	Region
Energy, Electricity and Nuclear Power Estimates for the Period up to 2050 – 2024 edition	IAEA	2024	Global and by region
The Path to a New Era for Nuclear Energy	IEA	2025	Global and by region
Meeting Climate Change Targets: The Role of Nuclear Energy	OECD/NEA	2022	Global
Pathways to 2050: Role of nuclear in a low-carbon Europe	Compass Lexecon	2024	Europe
The Role of Policy and Module Manufacturing Learning in Industrial Decarbonization by Small Modular Reactors	Vanatta et. al, Nature	2024	United States
Techno-economic analysis of small modular reactors decarbonizing industrial process heat	Vanatta et. al, Joule	2023	United States
Generation and Use of Thermal Energy in the US Industrial Sector and Opportunities to Reduce its Carbon Emissions	JISEA	2016	United States
SMR Roadmap - Economics and Finance Working Group	Natural Resources Canada	2018	Canada
ENERGY TRANSITION OUTLOOK 2024	DNV	2024	Global and by region
The Energy Security Scenarios: Energy and Artificial Intelligence	Shell	2025	Global
Pathways to commercial liftoff: Advanced Nuclear	US Department of Energy	2024	United States
Advanced Reactors Global Market Outlook and Economic Assessment United States and Canada AR Economic Assessment Study	EPRI	2024	United States and Canada
Global Market Analysis of Microreactors	INL	2021	Global

7.3 Appendix C: Maritime sector - synthetic fuels vs. nuclear propulsion

There are two potential pathways for the adoption of nuclear power in the maritime sector: synthetic fuels production and direct propulsion.

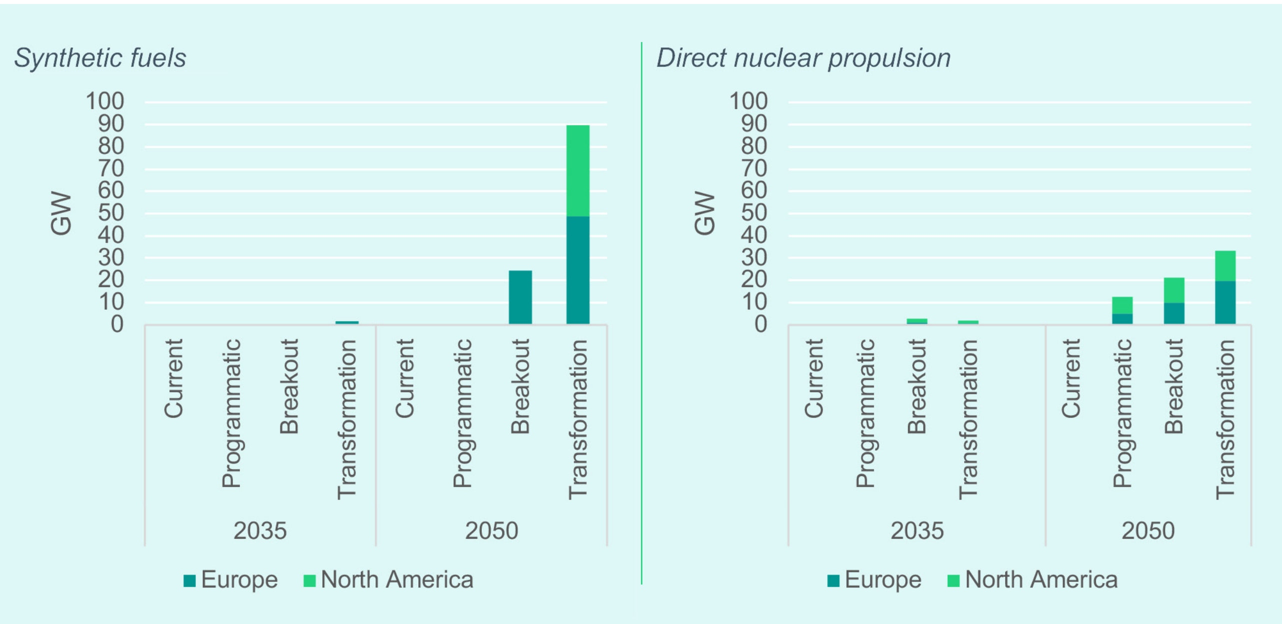
Synthetic fuel production: This pathway involves producing synthetic fuels using nuclear electricity. This route benefits from relatively minimal regulatory hurdles and becomes viable when cheap, abundant nuclear electricity is available to compensate for conversion inefficiencies. While the energy losses in converting electricity into fuel are significant, this approach allows retrofitting of existing fleets and uses established fuel supply chains. As a result, the synthetic fuels pathway becomes prominent only under high-supply, transformative SMR deployment scenarios. This is the pathway explored in the present study.

Direct nuclear propulsion: In this pathway nuclear reactors are installed onboard ships to generate electricity that power electro-mechanical engines. This method offers greater energy efficiency and improved competitiveness compared to synthetic fuels. It also emerges earlier across most SMR supply scenarios due to its technical maturity and higher competitiveness. However, because of its higher efficiency, the total accessible energy market for nuclear propulsion is approximately three times smaller than that of synthetic fuels (Figure 26).

Nuclear propulsion is a technically proven civil application, as demonstrated by past and existing civilian nuclear vessels. Historically, key examples include the Nuclear Ship (NS) Savannah (United States), NS Otto Hahn (Germany), NS Mutsu (Japan), and NS Sevmorput (Russia, former Soviet Union), which were operated between nine years up to several decades,[63] definitively demonstrating the technical feasibility of nuclear-power ships.[64]

The primary challenges, however, stem from regulatory uncertainty rather than technological limitations. Naval nuclear standards, being military-specific and designed around pressurized water reactors, are unsuitable for civilian merchant vessels operating in international waters and calling at foreign ports.

Figure 26: SMR accessible market for maritime synthetic fuels vs. direct nuclear propulsion pathways, all supply scenarios, Announced Pledges, 2035–2050



Several coordinated efforts are underway to address these regulatory gaps and accelerate nuclear shipping adoption:

- The IAEA launched Atomic Technologies Licensed for Applications at Sea (ATLAS) in 2024 to develop comprehensive safety, security, and safeguards frameworks for civil nuclear applications at sea.[65] This initiative includes outreach to major shipping nations and industry stakeholders
- At the Maritime Safety Committee meeting (MSC 110) in April 2025, the IMO formally agreed to begin revising the 1981 Code of Safety for Nuclear Merchant Ships and relevant SOLAS (safety of life at sea) provisions. The Sub-Committee on Ship Design and Construction has been tasked with developing a modern framework for civilian nuclear propulsion, with work scheduled to begin in January 2026[66]
- Formed in April 2024, Nuclear Energy Maritime Organization (NEMO) has obtained non-governmental organization (NGO) consultative status with both the IMO and IAEA. The organization aims to create an integrated ecosystem including shipbuilders, It aims to help shape regulatory updates and align class societies, insurers, and regulators for floating nuclear power and nuclear mobility[67]

In summary, while synthetic fuels have very low regulatory hurdles and could leverage existing ships, direct nuclear propulsion may also emerge due to its efficiency and competitiveness. Both routes remain under active development and will depend heavily on international collaboration, private sector initiatives, and regulatory progress to move forward.

8 Endnotes

1 In this report, SMRs are defined as nuclear reactors that integrate higher levels of modularization, standardization, and factory fabrication, with modules that can be transported and assembled on site. This approach has the potential to reduce delivery time and cost through economies of series. SMRs encompass both existing light-water reactor (LWR) Gen III technologies and Gen IV designs that use more innovative coolants and fuel arrangements. These include high-temperature reactors (HTRs), sodium fast reactors (SFRs), lead-cooled fast reactors (LFRs), molten salt reactors (MSRs), and fluoride salt-cooled high-temperature reactors (FHRs). In terms of size, all reactors below 450 MWe are covered, including microreactors with power levels below 10 MWe.

2 European Commission (2025). "Report From the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions."

3 Clean Energy Wire (February 2023). "Chemicals producer BASF to axe jobs at energy intensive production sites in Germany."

4 European Aluminium (May 20, 2022). "Response to REPowerEU." European Aluminium.

5 A. Lopez, A. Corbeau (March 2024). "Anatomy of the European Industrial Gas Demand Drop." Center on Global Energy Policy, Columbia University.

6 In the United States, electricity consumption is expected to grow by 130% by 2030. Electricity grids are under strain, with connection queues for new data centers lasting up to seven years in high-demand regions such as Northern Virginia. By 2030, an estimated 20% of projects could face delays (IEA, 2025). To address this, regions like PJM have launched a fast-track process to set rules for interconnecting data centers and other large loads (Utility Dive, 2025).

7 Associated Press (2025) "Spain says April blackout was caused by grid failures and poor planning, not a cyberattack." CNN World.

8 The Guardian (April 29, 2025). "Spain and Portugal returning to normal as experts investigate cause of blackout."

9 Reuters (April 29, 2025). "Spain's power generation nearly back to normal after Monday blackout, says grid operator." Reuters.

10 Associated Press (April 29, 2025). "Spain-Portugal power outage: fatalities reported in Spain linked to generators and medical equipment failures." AP News.

11 The Guardian (April 30, 2025). "'No one knew what to do': power cuts bring chaos, connection and revaluation of digital dependency." The Guardian.

12 Railway Supply (April 29, 2025). "Rail passengers evacuated after power outage in Spain." Railway Supply.

13 Spain's main business lobby CEOE estimated the outage would shave €1.6 billion ($1.82 billion), or 0.1%, off gross domestic product, noting it could take oil refineries a week or more to resume their operations fully, and that some industrial ovens had been damaged (Reuters, April 29, 2025).

14 An aluminum smelter draws 500–1,000 MW continuously; covering a four-hour outage therefore needs 2,000–4,000 MWh of storage. A Tesla Megapack in its four-hour configuration stores 3.9 MWh and lists for about US $1.04 million, and total installed costs are assumed 40 % higher to account for EPC, foundations, and grid integration.

15 Large-frame gas turbine lead times are typically ~5 years and can reach ~7, while smaller turbines are ~2–3 years; a follow-up piece notes OEM capacity expansions are unlikely to "drastically reduce" these waits (Utility Dive, 2025).

16 LucidCatalyst analysis based on public data on available projects without taking into account their level of confidence. This estimate is consistent with the numbers from Wood Mackenzie (May 2025) projecting an SMR project pipeline of 47 GW, most of it in North America.

17 International Energy Agency (January 2025), "The Path to a New Era for Nuclear Energy."

18 Texas A&M has selected four vendors: Kairos Power, Terrestrial Energy, Aalo Atomics and Natura Resources.

19 Several overlapping conditions bring uncertainty into SMR market developments: dozens of new reactor technologies being proposed simultaneously (127 SMR under development according to the last edition of the NEA SMR Dashboard) with varying level of maturity, different untested deployment models, rapidly evolving regulatory frameworks and government policies, and the emergence of entirely new industrial customer segments.

20 Projects such as the Xe-100 with Dow in the chemical sector and TerraPower's Natrium coal repowering project with PacifiCorp are examples of project outliers. Coal repowering and chemicals are not considered "catalysts." In fact, low gas prices and competition in the chemical sector may limit this sector's ability to pay the initial nuclear premium despite potential economics stemming from repurposing existing infrastructure and cogeneration. However, these projects are moving forward thanks to the multibillion-dollar 50/50 cost share provided by DOE's Advanced Reactor Demonstration Program (X-energy, ARDP).

21 Coal repowering consists of retrofitting a decommissioned coal site to accommodate new generators. This approach benefits from reusing parts of the existing infrastructure, including components, grid connections, and water access, to accelerate deployment. Repowering coal plants with nuclear can also be referred to as coal-to-nuclear transitions (DOE, coal-to-nuclear transitions).

22 IAEA, Aris Database, Characteristics, Power Density (Accessed in August 2025).

23 U.S. Department of Energy (September, 2024), "Pathways to Commercial Liftoff: Advanced Nuclear."

24 For example, Dow indicates that company is evaluating options for the sale of any excess power from the Seadrift Xe-100 project in Texas (Utility Dive, 2025).

25 Ibid.

26 OECD Nuclear Energy Agency (2022), "Beyond Electricity: The Economics of Nuclear Cogeneration."

27 Derived assuming a 50/50 cogeneration split and valuing heat and electricity equally per MWh while keeping total costs unchanged. Applying a non-electrical product credit method consistent with OECD/NEA (2022) – which credits the value of sold heat against total costs and allocates the remainder to electricity – this is equivalent to valuing heat at $16/MWhth (or approximately $4/MMBtu of natural gas with no CO_2 price).

28 OECD Nuclear Energy Agency (2021), "Small Modular Reactors: Challenges and Opportunities."

29 LucidCatalyst analysis based on data from OECD Nuclear Energy Agency (July, 2025), "The NEA Small Modular Reactor Dashboard: Third Edition."

30 The oil and gas sector is strongly linked to the chemical sector, as it provides key feedstocks for petrochemicals and plastics. While oil and gas production is expected to decline under APS due to the electrification of the transport sector, the chemical sector is projected to grow, driven by a rising global population. This growth is supported by a larger share of oil and gas being directed toward petrochemicals, as well as the increasing role of plastic recycling, low-carbon hydrogen, and bio-based feedstocks; factors that help reduce the coupling between the two sectors, as projected by International Energy Agency's World Energy Outlook 2024.

31 For simplicity, the 'Critical Market Drivers' are also referred to as the 'Six Critical Drivers' or simply 'drivers' during the course of this report.

32 Non-process fuel is defined as fuels burned onsite for facility support and ancillary operations (e.g., space heating, emergency power, and plant vehicles), excluding fuels used as feedstock or to supply heat/steam or mechanical drive for production processes. They are assumed to be highly integrated within industrial facilities. While SMRs could theoretically be used to produce synthetic fuels to meet these needs, it is conservatively considered impractical compared to other alternatives (e.g. electrification).

33 According to NREL ATB (2024) data, moving from a levelised cost of electricity of $125/MWh under current delivery models to $40/MWh with mass production translates into a 68% cost reduction potential.

34 U.S. Department of Energy (September, 2024), "Pathways to Commercial Liftoff: Advanced Nuclear."

35 For example, Prodigy Clean Energy is adapting existing SMR and microreactor designs into shipyard-fabricated, transportable nuclear power plants; purpose-built marine structures that house a vendor's reactor ("bring your own reactor") rather than simple "barges with reactors." They're working with Lloyd's Register toward lifecycle requirements and Canadian deployment timelines around the early 2030s.

36 Blue Energy is another example of a company that aims to build complete nuclear power plants at existing shipyards, modularizing and standardising around current reactor designs to cut cost and build time; the company emerged from stealth with a $45 million Series A in 2024.

37 Several SMR developers are advancing not only demonstrations but also dedicated manufacturing models. Aalo-X (Aalo Atomics) is pursuing a factory-based modular assembly ("kit reactor" approach), targeting first criticality by 2027; a full-scale non-nuclear prototype has already been completed in Texas to validate manufacturability. Copenhagen Atomics follows a factory-first strategy, planning mass production of containerized molten salt reactors, with a test reactor expected by 2027 and power units in the early 2030s. They are already producing non-nuclear loops and full-scale prototypes to validate design and scaling. Similarly, BWXT's Project Pele, backed by the U.S. Department of Defense, is progressing toward the first prototype deployment of a mobile microreactor in the late 2020s, supported by BWXT's established manufacturing base and experience in nuclear fuel and component fabrication.

38 LucidCatalyst analysis based on data from NREL 2024 Annual Technology Baseline (ATB)

39 For example, in hyperscale data centers, electricity typically represents around 20% of total operating costs. In energy-intensive chemical processes (e.g., ammonia and petrochemicals), the combined costs of fuel, power, and feedstock can account for up to 85% of total production costs. In coal plants, 60-70% of operating costs are attributable to fuel alone. Similarly, refineries have energy expenditures typically representing 50% of cash operating costs.

40 In Nevada, Google's Clean Transition Tariff with NV Energy to procure around-the-clock geothermal from Fervo has been reported at $107/MWh to NV Energy. Equinix onsite fuel cells (Bloom Energy) have been reported at 8-13¢/kWh (i.e., up to $130/MWh) in real deployments.

41 For APS, the policy support price premium is calculated assuming a carbon price between \$160–200/tCO_2 in advanced economies and a gas carbon intensity of 450 gCO_2eq/kWh, consistent with IEA World Energy Outlook 2024 assumptions. Similarly, for NZE, the policy support price premium is calculated assuming a carbon price between \$180-250/tCO_2 in advanced economies and a gas carbon intensity of 450 gCO_2eq/kWh, consistent with IEA World Energy Outlook 2024 assumptions.

42 International Energy Agency (October 2024) World Energy Outlook 2024.

43 Samsung Heavy Industries' Geoje Shipyard launches approximately 30 ships per year.

44 LucidCatalyst (December 2021) Rethinking Deployment Scenarios for Advanced Reactors: Scalable Nuclear Energy for Zero-Carbon Synthetic Fuels and Products.

45 The +$45/MWh is calculated assuming a carbon price of $100/tCO_2$ and a gas carbon footprint of 450 gCO_2-eq/kWh.

46 In fact, some investors may wait for greater certainty on regulatory approval before taking a final investment decision. For example, the final investment decision for Dow's Seadrift Xe-100 project is not expected before 2028 (Utility Dive, 2025).

47 International Energy Agency (January 2025) "The Path to a New Era for Nuclear Energy."

48 10 CFR Part 53 is a proposed NRC licensing framework that aims to be risk-informed, performance-based, and technology-inclusive for advanced reactors. It would be a voluntary alternative to Parts 50 and 52, which were developed around large light-water reactors and the combined license process. The proposed rule was published on October 31, 2024, and the rulemaking is ongoing, with a statutory deadline at the end of 2027. Because Part 53 is not yet final and has no licensing precedents, developers face uncertainty about interpretation and schedule compared with established Part 50 and Part 52 pathways.

49 Instead of aiming for full regulatory harmonisation – which may encounter practical hurdles – some regulatory bodies are working together in areas where equivalencies or common positions are possible. In such cases, once regulatory work is performed in one country, compliance in those specific areas can also be recognised by others. This approach to regulatory efficiency is being explored in initiatives such as EDF's NUWARD™ joint regulatory review, the IAEA Nuclear Harmonization and Standardization Initiative (NSHI), and the OECD Nuclear Energy Agency's Multinational Design Evaluation Programme (MDEP).

50 Mutual recognition refers to regulatory bodies accepting or leveraging safety assessments, design certifications, or licensing work already performed by peer regulators in other countries for similar reactor designs. Instead of repeating a full review from scratch, national regulators can build on previously validated technical analyses, test results, or design approvals, focusing only on country-specific adaptations (e.g., siting, grid integration, emergency planning).

51 This value has been estimated assuming $2000/kWe overnight capital cost in line with the most aspirational cost projections from NREL 2024 Annual Technology Baseline (ATB).

52 Bipartisan Policy Center (March 2023), "Can Advanced Nuclear Repower Coal Country?."

53 International Maritime Organisation (2023), "2023 IMO Strategy on Reduction of GHG Emissions from Ships."

54 Amazon has invested in X-energy, anchoring a $500 million Series C-1 financing round aimed at deploying up to 5 GW of Xe-100 SMRs in the United States by 2039, beginning with an initial four-unit, 320 MW installation with Energy Northwest and potential expansion to 960 MW. Google has signed a PPA with Kairos Power targeting up to 500 MW of deployment by 2035. Google is also providing early-stage capital to Elementl Power, a technology-agnostic advanced nuclear project developer, to prepare three U.S. sites for advanced nuclear reactors.

55 IANC is a vendor-neutral consortium launched by The Open Group to accelerate deployment of advanced nuclear heat and power for industrial users. Founding members include Chevron, ConocoPhillips, ExxonMobil, Freeport-McMoRan, Nucor, Rio Tinto, and Shell. Stated objectives include standardizing interfaces and terminology, adopting risk-appropriate design practices, and creating open frameworks and business guidelines that aggregate industrial demand, compile use cases and user requirements, and develop technical standards and process guides. The intended outcome is lower cost, reduced regulatory and schedule risk, and dependable, decarbonized heat and power for industry.

56 Steady Energy, a spin-out from Finland's VTT, is developing the LDR-50 (50 MWth, ~150 °C) small modular reactor dedicated to district

heating. Finland's regulator STUK completed a positive preliminary concept assessment in June 2025. The company plans to start constructing a non-nuclear pilot plant in late 2025 in Helsinki's former Salmisaari coal plant, designed to physically test LDR-50 heat and safety systems. The company has secured preliminary agreements for up to 15 reactors in Finland. Its target is the first commercial deployment by around 2030 (World Nuclear News, June 2025).

57 Pursiheimo, E., et al. (2022). "Investments in Nuclear Heating in Helsinki Metropolitan Area During Volatile Energy Markets."

58 EU-ETS values correspond to carbon price forecasts ranging between \$70–100/tCO_2 by 2030. REC pricing trends are based on 2024 values from Berkeley Lab for the NEPOOL and PJM markets, though trends may vary by state in the U.S. The 30% ITC impact is estimated by DOE for SMR capital costs of \$5,000–10,000/kWe.

59 As Steve Jobs famously said: "You've got to start with the customer experience and work backwards to the technology. You can't start with the technology and then figure out where to sell it."

60 Most SMR designs aim for delivery times of 2-3 years for Nth-of-a-kind units. In analogous mass-manufacturing industries like shipping and aerospace, final assembly can be measured in weeks or months, but order-to-delivery for new aircraft, engines and ships typically run longer due to backlogs and supply chain constraints.

61 In the maritime sector, type certification is a regulatory process by which a vessel design is reviewed and approved by a classification society or flag state authority as meeting established safety and performance standards. Once a ship type is certified, identical vessels can be constructed and deployed without requiring a full design review for each individual unit. This approach reduces licensing time and cost, facilitates fleet-scale deployment, and ensures uniform compliance with international conventions such as SOLAS (Safety of Life at Sea) and MARPOL (Marine Pollution). Applying a similar type certification approach to SMRs could allow standardised nuclear reactor designs to be licensed once, and then replicated across multiple sites and jurisdictions with minimal additional regulatory burden.

62 Assuming that 700 GW are deployed between 2035 and 2050 under full market driver activation, this leads to a developer ecosystem supplying around 50 GW/year.

63 As of 2024, the NS Sevmorput — launched in 1988 — was still in active service, making it a 36-year-old nuclear-powered cargo vessel.

64 Freire, L. O., & de Andrade, D. A. (2015). Historic survey on nuclear merchant ships. Nuclear Engineering and Design, 293, 176–186. https://doi.org/10.1016/j.nucengdes.2015.07.031.

65 Lloyd's Register (March 2025). Framing the future of maritime nuclear technology.

66 Safety4Sea (June 2025). IMO agrees to revision of regulations for nuclear-powered ships.

67 NEMO (April 2024) "New Industry Association for Nuclear Maritime Launched."

List of figures

List of tables

urenco.com

lucidcatalyst.com