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Strategy for the development and deployment of Small Modular Reactors (SMRs) in Europe

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1. Conclusions and recommendations

Strategic context and objectives

1.1. The European Economic and Social Committee (EESC) recognises the value of a strategy for the development and deployment of Small Modular Reactors (SMRs) in Europe. The title of the initiative clearly identifies two phases that this opinion must address: the development of an SMR range and the deployment of this range, with the EESC's focus being on economic optimisation and strategic autonomy, and transparency concerning the health and safety of workers, the public and the environment. At the same time, the EESC acknowledges that the SMR business model has yet to be proven in practice, with an uncertain timeline and cost of deployment.

1.2. In accordance with Article 194 of the TFEU, which enshrines Member States' sovereignty over their energy mix, and the Net-Zero Industry Act (2024), nuclear energy is recognised as a strategic net-zero technology and is essential for achieving some of the Member States' decarbonisation goals and could significantly contribute to a massive and rapid phase out of fossil fuels in the EU. The EESC's latest opinion on the Nuclear Illustrative Programme [TEN/856] reaffirms technological neutrality regarding the means of producing low-carbon electricity.

Demand Mapping and Market Aggregation

1.3. To promptly undertake a comprehensive needs-based analysis of SMR requirements. Potential end-uses for SMRs can already be identified, including:

— energy-intensive industries with high secondary energy and heat requirements;

— non-interconnected or sparsely interconnected territories;

— maritime transport;

— district heating networks, subject to potentially prohibitive public acceptability constraints.

1.4. With a view to establishing contractual arrangements in the form of Power Purchase Agreements (PPAs), heat purchase agreements and other long-term offtake mechanisms, the EESC recommends encouraging large (energy-intensive) industrial firms and, more broadly, major public and private consumers to join forces to aggregate demand. This would facilitate capital mobilisation, risk sharing and the integration of value chains.

1.5. The EESC advocates structured demand aggregation in the EU SMR strategy. Promoting multi-stakeholder consortia (vendors, supply chain actors, potential off-takers and Member States) would help mitigate risk and boost bankability.

The EESC recommends establishing a European SMR Demand and Offtake Register to map needs across industry, heating and remote regions. By tracking project maturity – from initial expression of interest to site-specific consortia – the EU could shift from abstract goals to a concrete project pipeline with transparent risk allocation.

The Core Framework for the SMR Strategy

1.6. The European strategy for SMRs should be based on three fundamental pillars:

— an analysis of relevant SMR use cases (industry, district heating networks, grid integration, etc.);

— the systematic matching of end uses (electricity, heat or combined heat and power) with the most appropriate technological pathways (third-generation pressurised water reactors or fourth-generation molten salt reactors and fast reactors);

— guidance on funding SMR investments that does not disproportionately burden the public sector and ensures a fair allocation of risks and responsibilities between public authorities and private investors.

1.7. Based on these criteria – namely demand requirements, potential technological solutions, the securing of a European supply chain and the standardisation of products and licensing – Member States must converge toward a very limited range of SMR solutions, provided that technological diversity is preserved where necessary to reduce systemic risk and avoid lock-in, likely no more than four or five in total.

Industrial Standardisation and Nuclear Safety Frameworks

1.8. The European strategy for SMRs should be based on standardisation requirements by product family, provided that the highest safety standards are upheld. These requirements should aim to reduce capital and financing needs and align with the logic of series production. They should also facilitate the necessary licensing procedures through greater cooperation among national nuclear safety authorities. SMR standardisation will be the key to a vital time-to-market response, optimising the CAPEX required for SMR construction and the OPEX for these low-carbon power generation assets. This standardisation should be carried out while maintaining the priority for nuclear safety, rigorous independent regulatory overview and clear responsibility of operators for all liabilities and (radioactive) waste streams. EU-level regulatory oversight must be strengthened to ensure consistent safety and environmental protection.

Supply Chain Resilience, R&D and Strategic Autonomy

1.9. Europe should, as a matter of urgency, secure the entire nuclear fuel cycle for both SMRs and AMRs. This includes access to uranium resources, conversion and enrichment services, fuel fabrication, transport and storage infrastructure, spent fuel management, reprocessing capabilities and final disposal solutions. Particular attention should be given to future requirements for advanced fuels such as LEU, HALEU, MOX and thorium-based fuels, where strategic dependencies on non-European suppliers could create vulnerabilities.

1.10. The EESC notes that different SMR and AMR technologies require different fuel cycles. Consequently, decisions regarding reactor technologies should be accompanied by a corresponding assessment of fuel supply, fabrication, transport, storage, recycling and waste-management requirements. A coherent European fuel-cycle strategy would strengthen strategic autonomy, enhance security of supply and reduce external dependencies while supporting the deployment of SMRs and AMRs.

1.11. The Union should facilitate immediate investment in Research and Development (R&D), while ensuring the safeguarding of the associated Intellectual Property (IP).

1.12. The EU currently spends between EUR 250 and EUR 300 billion annually on fossil fuel imports, probably a lot more as a result of the conflict between the USA and Iran. This massive outflow of capital undermines our strategic autonomy. By transitioning from volatile fossil fuels (OPEX) to homegrown low-carbon energy sources (CAPEX) through renewable and SMR deployment, Europe can re-channel these resources into its own industrial fabric, ensuring both price stability for our industry and long-term energy security. In line with the IAA and the 'Made in Europe' initiative, and given the need to address our vulnerabilities and support European industry, it is important that the SMR and AMR value chain ensures the necessary security of electricity supply whilst also promoting the creation of skilled jobs in Europe.

1.13. Public authorities must therefore invest in more local, autonomous and sovereign solutions, considering these expenditures on raw materials and goods sourced outside of Europe. The requirements for skilled jobs and strategic autonomy are thus aligned with economic and trade balance considerations.

Employment, Skills and the Social Contract

1.14. The strategy for these SMR value chains should prioritise the promotion of the jobs that are required, including reskilling workers from fossil fuel sectors and ensuring a just transition for the deployment of this energy source, which may provide industrial, economic and environmental opportunities. Financial support for these sectors must therefore entail a social contract for the creation of high-quality jobs. Acceptability must be built on transparency and long-term viability. A wide-ranging consultation involving all stakeholders, including civil society, must be organised, following the example of the consultation carried out for Newcleo's nuclear projects in France. Public oversight of operating facilities should be guaranteed through independent monitoring, regular disclosure of safety and environmental performance data, and accessible mechanisms for citizens and local communities to raise concerns.

Power Grid Integration and Long-Term Energy System Planning

1.15. To align the European SMR strategy with the consumption and electrification outlook, particularly for industrial applications, as set out in the power system planning ambitions proposed by the Commission. Indeed, the EESC, in its opinion TEN/863, supported the planning of electricity grid developments but also emphasised the importance of correlating grid requirements with the capabilities and constraints of low-carbon power generation assets and industrial transformation. An SMR strategy consistent with long-term power system planning is a prerequisite for optimising investments. This principle also applies to strategies for variable renewable energy sources or hydropower. The SMR strategy must serve the broader objectives of mitigating vulnerabilities and decarbonising the economy. Consequently, Member States must ensure the massive electrification of our economy alongside the phase-out of fossil fuels. They must therefore guarantee a growing electricity production by 2050, relying on a resilient and flexible energy mix combining

variable renewable energy, dispatchable low-carbon generation, storage and cross-border interconnections, with system stability ensured through both synchronous and non-synchronous technologies delivering the necessary grid services. Furthermore, all necessary agility must be maintained to adapt to potential challenges to initial assumptions, particularly regarding emerging technologies still under development.

Financing Roadmaps, Funding Instruments and Risk Allocation

1.16. To immediately initiate a financing roadmap with a fair share of the risk uptake and burden between private investors and the public sector, including strict cost-control mechanisms, transparency and risk-sharing with private investors, by leveraging existing instruments, such as:

— Euratom and Horizon Europe to support R&D and design work, as recommended by the EESC in its opinion TEN/864 [18 Mar 2026].

— The design of an SMR requires a significant investment. The CRE's [France] Forward Planning Committee estimates that the design of an SMR alone will cost one billion or more euros. GE-HITACHI estimates that its BWRX-300 model will require at least 40 billion euros to finalise the design and build the first units in the series.

— The Innovation Fund to ensure the deployment of the first demonstrators in the early 2030s, based on essential First-of-a-Kind (FOAK) projects. FOAK projects must be subject to evaluation of cost, risks and environmental impacts.

— The Net-Zero Industry Act (NZIA), which must ultimately support these strategic technologies for the EU through appropriate financing incentives, as well as streamlined licensing and permitting, while continuing to comply with existing nuclear safety, environmental protection, transparency and competition legislation, and guaranteeing nuclear safety by robust and independent nuclear regulatory procedures.

— The EIB and IPCEIs (Important Projects of Common European Interest) to enable public sector commitment to the development of these technologies during this initial launch phase.

— Implementing nuclear waste legislation to prevent undue burdens being shifted to future generations, including long-term waste management financing.

— Realistic and balanced Contracts for Difference (CfDs) that also allow risk-taking from the private investor under the oversight of competent authorities.

1.17. Nuclear projects have historically struggled with access to commercial and multilateral finance, and a nuclear-specific institution could finance not only reactors but also further supply-chain facilities, fuel production, etc. The EESC notes that nuclear finance may require dedicated multilateral and blended-finance tools, particularly for FOAK SMR projects and the supporting infrastructure. Emerging concepts such as the International Bank for Nuclear Infrastructure (IBNI), together with the renewed engagement of multilateral development banks and the IAEA, demonstrate the need for nuclear-specific financial expertise, completion-risk mitigation, guarantees and long-term revenue-stabilisation mechanisms. The EESC therefore recommends that the Commission monitor and, where appropriate, engage with emerging nuclear-finance initiatives.

Geopolitics and Strategic International Cooperation

1.18. The EESC underlines that SMRs are not only an internal EU industrial-policy issue but also a field of strategic international cooperation. Cooperation with like-minded partners should cover licensing experience, safeguards, fuel-cycle security, supply-chain resilience, export-control coordination, governance procedures and brownfield coal-to-nuclear conversion. The EU should draw lessons from practical initiatives such as the US-EU Project Phoenix, while ensuring that cooperation with non-EU technology holders supports European supply-chain participation, local skills and IP retention.

2. **General comments**

2.1. The PINC quantifies the massive investment requirements for decarbonisation. In its opinion TEN/856, the EESC translates this 'macro-economics' into operational ambition:

— Technology neutrality

— Upholding high levels of transparency and safety for the environment and health

— Aggregation of demand

— Financing with reduced project risk

— Control of vulnerabilities

— Industrial value chain

— Skills and 'just transition'

The TEN/856 / PINC opinion also forms the basis of the European Industrial Alliance on SMRs which was launched in 2024.

2.2. SMRs and AMRs (Generation IV SMRs) represent complementary solutions to high-capacity reactors for providing power and/or heat. In particular, SMRs can be integrated into the grid as replacements for legacy thermal power plants; unlike large-scale reactors, they do not necessitate heavy investments in grid infrastructure.

2.3. The success of an SMR strategy hinges on the achievement of four key objectives:

(I) Design standardisation;

(II) Simplified deployment processes;

(III) Modularity in the construction of reactor components;

(IV) Achieving economies of series.

2.4. The SMR strategy could be successful, but significant private CAPEX would need to be mobilised first. Profitability depends on achieving economies of scale through the deployment of standardised solutions. Consequently, the market is at least on a European scale, if not global.

2.5. The EESC recommends that the European Commission and the European Industrial Alliance on SMRs prepare, publish and regularly update a European SMR supply-chain gap map. This should identify the critical capabilities required for SMR deployment across the full value chain, including reactor components, modular manufacturing capacity, nuclear-grade materials, heavy components, pumps and valves, instrumentation and control systems, fuel-cycle services, testing and demonstration facilities, quality assurance and control, transport and logistics, waste-management capabilities and specialised skills.

2.6. The gap map should distinguish between capabilities that already exist in Europe, capabilities that need scaling up and capabilities where Europe risks strategic dependence on non-EU suppliers. It should also assess lead times, licensing, certification and qualification bottlenecks, exposure to export controls, dual-use restrictions, raw-material risks and the specific needs of different SMR technology families.

2.7. The EESC underlines that the European Industrial Alliance on SMRs should ensure balanced representation of the full spectrum of SMR and AMR technologies.

Key challenges

2.8. The modularity inherent in the SMR manufacturing process could reduce the capital costs required for building these low-carbon power and heat generation assets. Reduction of up to 50-60 % can be expected in on-site construction time, but this is subject to significant uncertainty.

2.9. The series effect resulting from the lower power output of these reactors could lead to unit price reductions. Furthermore, the learning curve effect enables faster convergence toward optimal SMR design. Costs generally fall by 10-15 % between the first unit (FOAK) and the fifth, after which they stabilise. Ultimately, productivity gains can reach 25 % compared with a single-unit project, which depend on large-scale deployment, something which has not yet been demonstrated.

2.10. The combined effects of modular construction and standardisation can shorten construction timelines, thereby reducing the cost of capital. The fact that historical evidence suggests that nuclear projects often face delays and cost overruns should be considered.

2.11. Factory-based manufacturing of SMR modules can significantly reduce costs associated with non-quality, with a reduction of 70-80 % in rework and manufacturing defects compared to on-site assembly.

2.12. SMRs will not become competitive automatically because they are smaller. Their economic case depends on treating reactors increasingly as standardised industrial products rather than bespoke civil-engineering megaprojects. The EESC therefore recommends that EU-supported SMR projects apply design-for-manufacture-and-assembly principles, maintain standardised digital design documentation throughout construction, use configuration-control systems, and adopt contracting models that allocate risk in a way that rewards timely and repeatable delivery.

2.13. Hybrid thermal and power solutions offer additional flexibility for power modulation. Beyond modularity and the series effect, SMRs with combined heat and power production provide greater versatility in utilising energy produced by nuclear fission. By recovering this heat for industrial use or district heating, the overall efficiency of the plant can rise from 33 % (electricity alone) up to around 80 %.

2.14. Certain advanced SMR and AMR technologies, notably high-temperature gas-cooled reactor design, can reach temperatures exceeding 500 °C and may therefore be suitable for some higher-temperature industrial applications.

2.15. The reduced size and compactness of SMRs may facilitate local integration. Consequently, in specific contexts and locations, with safety and regulatory conditions carefully evaluated, they may gain public acceptance for supplying district heating networks, as seen in Helsinki (Finland), which recently issued a tender for a thermal SMR dedicated to the city's heating network, and which would be located in places that would ensure the highest level of safety and security.

2.16. Most SMR concepts incorporate passive safety systems, meaning they are less reliant on external electricity sources.

2.17. Greater regulatory cooperation at European level, including possible alignment or mutual recognition of national licensing decisions for standardised SMR designs, could help reduce SMR deployment timelines across Europe. To take this a step further, it is conceivable that this licensing work could be carried out at European level.

2.18. 4th generation SMRs, with their broad spectrum for burning actinides and fissile atoms, may reduce the volume of long-lived radioactive waste, while increasing the amount of waste with a shorter lifespan. They also offer a potential opportunity to overcome fuel access constraints, given the vast fuel potential already present on European soil (estimated at over 1 000 years).

2.19. Europe possesses some of the world's most advanced capabilities for producing fuels for 4th generation SMRs.

2.20. Licensing requirements aligned with the highest safety standards provide a vital safeguard. They should be proportionate to the risks of each design, whilst ensuring that safety levels are on a par with those required for current conventional nuclear reactors.

2.21. Local SMR construction has the potential to become an important building block for European reindustrialisation.

2.22. Standardisation and series effects are expected to facilitate the development of the supply chain, ensuring maximum efficiency.

2.23. SMR-dedicated technologies, together with renewables, could help make the transition away from fossil fuels. In Europe, this could significantly reduce imports of the current (approximately) EUR 250 to EUR 300 billion worth of fossil fuels annually.

2.24. The climate, economic and sovereignty objectives inherent in SMR solutions can inspire young Europeans to pursue initial and vocational training in the SMR industry.

2.25. SMRs enable the conversion of fossil fuel-based sites to low-carbon energy sources at the same location. This allows for the preservation of infrastructure and the transformation of jobs in regions with historic industrial sites, representing a significant socio-economic advantage that should be leveraged.

2.26. Practical lessons can be provided by Project Phoenix, as well as by similar coal-to-nuclear initiatives. Such initiatives can help identify suitable brownfield sites, assess regulatory and infrastructure readiness, preserve local employment through retraining, and structure early public dialogue. The EESC underlines, however, that feasibility studies should not be confused with investment readiness assessments: FOAK SMR projects will still require robust licensing pathways, transparent cost assumptions, credible offtake arrangements and risk-sharing mechanisms.

2.27. SMR-based solutions are attracting interest from some countries seeking to decarbonise their economies without opting for large-scale nuclear reactors (>1 000 MW), which face numerous site constraints.

2.28. The Net-Zero Industry Act (NZIA) has identified SMRs as 'Strategic Net-Zero Technologies' supporting Europe's decarbonisation objectives and contributing to energy sovereignty.

2.29. Questions regarding dissemination must also be raised in relation to both the plant itself and the fuel cycle. The EU's support for the development of SMRs and AMRs must be underpinned by a highly restrictive policy on the locations where these technologies might be deployed. The focus is on EU territory and, potentially, its most reliable partners. Issues of nuclear security, including risks from potential malevolent attack (sabotage, terrorist attack, acts of war), must also be taken into account.

Brussels, 15 July 2026.

The President
of the European Economic and Social Committee
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