The (zero-emission) prize at the end of the (long) race

by Alexa Ivy

Nuclear-powered vessels have a long history in naval and icebreaker applications, though atom-freighters did not leave the demonstration-project period of 1962-72 (with one still working since the late 1980s exception). That said, the emergence of the 4th generation small modular reactors (SMR) is opening the way for using this emission-free technology also in commercial shipping. But any race towards a nuclear-powered commercial maritime future will require a marathon-like rather than a sprint commitment.

In September 2025, ABB signed a memorandum of understanding with Blykalla, a Swedish nuclear energy company, to support and accelerate the deployment of small modular lead-cooled reactors to the maritime industry. The agreement builds on the terms of a 2024 deal between the two, which targets developing SMR technology to support Sweden's clean energy requirements.

Blykalla's Swedish Advanced Lead Reactor (SEALER) is a highly compact, passively safe reactor with inherent safety features ensuring stability even without external control. SEALER is also one of the three reactors identified in the Nuclear Propulsion for Merchant Ships I (NuProShip I) project, which aims to adapt a gen-IV SMR to the requirements of maritime vessels – in particular, larger ships. "With our compact reactor design, we see a unique opportunity to lead the way in maritime nuclear propulsion – a solution uniquely positioned to meet the sector's demand for clean energy," commented Jacob Stedman, CEO at Blykalla. "Realising this vision will require an ecosystem of committed partners, and this collaboration is a critical building block."

ABB's expertise in system integration as well as in power distribution, control, and automation technologies will be key to ensuring the successful deployment of the SMR as a shipboard solution. Once put on a vessel, an SMR would require little or no refuelling at all. "We look forward to advancing the viability of SMRs in maritime applications. Next-generation SMRs will enable innovative ship designs that can help to reduce emissions compared to vessels powered by carbon-based fuels," said Samuli Hänninen, Segment Manager, Icebreaking ships, ABB Marine & Ports.

Nuclear intervention

The expansion of the agreement's terms is certainly timely. This October, the International Maritime Organization (IMO) is set to adopt the Net-Zero Framework to make it legally binding to reduce ship greenhouse gas emissions to net-zero by 2050 (with entry into force due in 2027).

Many in the maritime industry are expressing doubts over the availability of alternatives to heavy fuel oil and liquefied natural gas so far proposed. Stakeholders hold different views on the extent to which biofuels, methanol, ammonia, batteries, and fuel cells can get the 'net zero' job done, considering the size of the affected ship fleet, with some suggesting that – even in the best-case scenario – "all of the above" will be needed.

In early 2024, the European Commission announced the launch of the European Industrial Alliance on SMRs, which aims to facilitate and speed up the development, demonstration, and deployment of SMRs in Europe by the early 2030s. The case for nuclear ship propulsion was also distilled by the EU's closest neighbour when Torbjørn Lie, OSM Thome's Business Development Manager, earlier this year introduced Norway's Green Shipping Program's Advanced Nuclear in Maritime Report. He commented, "In the pilot, the aspect of insurance has been particularly interesting to learn more about, including the challenges, possible solutions, and seeing that the Norwegian marine insurance industry is an active and inquisitive party that wants to contribute to the success of the maritime industry's green ambitions." Skuld's Decarbonisation and Transition Risk Lead, Matias Bøe Olsen, added accordingly, "Nuclear is an interesting zero-emission option that can meet IMO ambitions for 2050, support energy demand, and be a viable technological possibility. As insurance excludes nuclear fuels and lacks international conventions to change this,

we welcome insight and a new debate on the topic. The pilot project allows us to get a basic insight into the risks associated with nuclear fuel. We have to mature as an industry to allow the industry to discuss nuclear as one of the many options for reducing emissions." With appropriate investments and regulatory support, nuclear propulsion would contribute strongly to maritime decarbonisation, "especially since 85% of the one billion tonnes of carbon emissions we are supposed to eliminate by 2050 comes from deep sea ships of above 5.0-megawatts," Lie added.

Patience will be instrumental to realise the full potential of nuclear ship propulsion, according to Markus Virtasalo, Solution Manager, Electric Solutions, ABB Marine & Ports. "From ABB's perspective, we have been empowered to make an early start on nuclear ship propulsion, which puts us in a strong position to accommodate any surprises that we'll meet along the way. But the prize is a reliable source of ship power that generates zero emissions – even at high vessel speed – works independently of any external decarbonisation device or fuel supply chain issue, and needs little or no refuelling at all. That is certainly a marathon worth running!"

Getting those regulations in shipshape

Stamina for the long game will also be needed to align with the timeline of regulators as they reframe maritime legislation to accommodate nuclear-powered ship propulsion.

Formally, the IMO adopted the Convention on the Liability of Operators of Nuclear Ships in 1962 (the year when States Marine Lines started operating NS Savannah), but the instrument was never ratified. Even though the Code of Safety for Nuclear Merchant Ships was adopted by the IMO Resolution A.491.XII in 1981 into the Safety of Life at Sea Convention, there is currently no marine liability convention applicable to commercial vessels using nuclear power for propulsion.

In June this year, IMO's Maritime Safety Committee (MSC110) agreed to begin updating legacy regulations governing nuclear-powered ships, tasking the Sub-Committee on Ship Design and Construction to start work on a framework to bring nuclear propulsion into the mix to achieve net-zero emissions by (around) 2050. Critically, the updated Code of Safety for Nuclear Merchant Ships will look beyond pressurised water reactor (PWR) systems with direct steam cycle propulsion to incorporate the 4th generation nuclear technology innovations.

Soon after, in July 2025, the IMO gave NGO status to the Nuclear Energy Maritime Organization (NEMO), in what must be seen as a rapid acceptance of a grouping established only last year. NEMO – whose members include, among others, shipowners, shipyards, classification societies, insurers, legal companies, and port authorities – focuses on developing the fine detail of regulatory frameworks for SMRs and floating nuclear power systems to bring to the IMO recommendations for port calls.

Other regulators are proving comparably receptive: the International Atomic Energy Agency is developing ATLAS (Atomic Technologies Licensed for Applications at Sea), a set of regulatory structures for nuclear propulsion and floating nuclear power facilities. Class (Lloyd's Register, ABS, RINA, and DNV) are also making strong efforts to support the nuclear option. Last year, for example, Maersk joined a nuclear-powered container ship feasibility study, working with Lloyd's Register and Core Power. In September 2025, Samsung Heavy Industries and the Korea Atomic Energy Research Institute, in co-op with ABS and the Flag of Liberia, jointly developed a concept for an SMR-powered LNG carrier design. Elsewhere, an SMR-powered 15,000-TEU container ship design from South Korea's HD Korea Shipbuilding & Offshore Engineering has already secured approval in principle from ABS (with a HAZMAT study also underway with DNV).

Festina lente

Today, the concept design work carried out by ABB Marine & Ports includes engineering the systems needed to convert thermal energy to electricity and propulsion. "From the naval architect's perspective, work to interface a nuclear reactor with a versatile 'steam-electric' power plant and to integrate it with electric motor-driven shaft lines or Azipod propulsion involves familiar thought processes, and practical knowledge of the flexibility of steam-electric power as a suitable solution across diverse vessel types," said Hänninen. He furthers, "Currently, it is possible to work on generic system solutions, leaving reactor-specific interface work until later."

Pre-dating the recent Blykalla announcement, ABB's work on nuclear power has already included concepts like a shuttle tanker and a container vessel. While the timeline for market readiness of the maritime SMR remains elusive, it is closely monitored, and plans are updated accordingly. Blykalla foresees its first nuclear reactor reaching criticality in the early 2030s.

Nuclear propulsion went truly mainstream at this year's London International Shipping Week, as the headline topic at four seminars and a frequent discussion point for financiers, owners, consultants, insurers, reinsurers, and others at general fuel events. Virtasalo is taking a pragmatic position towards the recent increase in interest in maritime nuclear. "Now is a good moment to assess main goals and principles as we approach overall system design, while applicable rules for commercial nuclear ship installations are not yet available. Reviewing the old rules written for 3rd generation PWR technology and evaluating which parts of those will remain and which parts will be updated to cover 4th generation SMR technology will take due time to process," he said.

First on-board nuclear solutions could be pilot projects with pioneering shipowners or unique vessel types (like power plant barges). First marine-SMR adoptions could also be seen in special trades or in dedicated green corridors that are subject to bilateral agreements, Virtasalo thinks. He sums up by cautioning, "Patience will be critical. Nuclear-powered ship concept design work will involve collaboration with more stakeholders and more thorough documentation than conventional vessels and may thus take a longer time. Design schedules are also linked to SMR developers' roadmaps for developing reactors of different sizes and types." ■