SMR guide.

A simple guide to small modular reactors

Many of the benefits of SMRs are inherently linked to the nature of their design – small and modular. But can SMRs make nuclear accessible and widely adopted?

Contents

SMRs, SMRs, SMRs.

Small modular reactors (SMRs) have rapidly become a focal point in discussions about the future of clean energy. But what exactly qualifies as an SMR, and how do these systems differ from the familiar large-scale nuclear power plants?

At their core, SMRs are nuclear fission reactors with a smaller unit power output and a modular, factory fabricated design philosophy. Their reduced size enables new construction approaches, alternative deployment strategies, and a wider range of applications. However, “SMR” describes a broad family of technologies rather than a single reactor type. Today’s SMR designs differ substantially in thermal and electrical output, operating temperature, coolant and moderator materials, fuel forms, and fuel-cycle strategies.

This diversity is both a strength and a source of complexity. No single SMR design can address every decarbonization need. High-temperature reactors may be suited for industrial heat or hydrogen production; lower-temperature water-cooled reactors may excel in district heating or grid-supporting electricity generation; and some advanced concepts target remote, off-grid, or process specific applications. With over a hundred SMR designs globally at various stages of development, it is increasingly likely that future energy systems will rely on multiple complementary SMR types, each optimized for a particular role.

This guide provides a structured overview of these technologies to help clarify the evolving SMR landscape and support informed comparisons among the many designs now under development.

Introduction to nuclear energy.

The nuclear energy harnessed around the world today is primarily used to produce electricity. According to the International Atomic Energy Agency (IAEA), “nuclear energy is a form of energy released from the nucleus, the core of atoms, made up of protons and neutrons.” This energy is produced through nuclear fission.

Nuclear fission happens when the nucleus of a heavy atom, typically uranium-235 or plutonium-239, absorbs a neutron and becomes unstable. The nucleus then splits into two or more smaller nuclei, releasing the kinetic energy of the fission fragments, prompt gamma radiation, and additional neutrons. These emitted neutrons induce further fission events, enabling a sustained chain reaction.

Inside a nuclear power plant, the reactor and its associated control systems regulate this chain reaction to ensure stable and predictable operation. The kinetic energy released during fission is converted into heat within the reactor core. The heat warms up the coolant, typically water though some reactor technologies use gases, molten salts, or liquid metals. Traditionally the thermal energy would be used to produce steam to further drive the turbine and generate electricity. Regardless of the specific design, the fundamental output of fission is heat.

During the rapid expansion of nuclear power in the 1970s, reactor sizes grew larger and plant systems became increasingly complex. At the same time, safety requirements were strengthened, adding further layers of design and engineering. Over time, the pursuit of higher output and improved economic efficiency led to reactors that were highly customized for each new project. Every plant required design adjustments to meet the needs of the customer, the site, and the expectations of the local regulator. This project-by-project approach contributed to challenges such as quality control problems, schedule delays, and escalating costs.

Nuclear energy remains, however, a low-carbon energy source, playing an important role in reducing greenhouse gas emissions worldwide. And recently, SMRs have emerged as a solution capable of reversing the development trend.

While most nuclear energy is used for electricity generation, nuclear reactors have long served specialized applications where long-duration, high-energy-density power is critical. Naval propulsion is the most prominent example: submarines (e.g., U-boats), aircraft carriers, and certain icebreakers use compact nuclear reactors to provide propulsion and onboard power for extended periods without refueling. The next application for nuclear energy could be heat.

The global nuclear landscape.

An overview of how nations are utilizing nuclear energy and emerging small modular reactor (SMR) technology to meet climate and industrial goals.

Established nuclear powerhouses

United States: The world's largest nuclear fleet

Home to the largest operating nuclear fleet and leading SMR designs like NuScale and GE Hitachi's BWRX-300.

France: National energy standard

Generates approximately 70% of its electricity from a centralized nuclear fleet. Explores SMRs for industrial heat and exports. SMR designs under development (Calogena's CAL30).

South Korea: Global export leader

Renowned for highly standardized reactor designs and one of the world's most efficient construction programs.

Advanced nuclear states and emerging SMRs

UK: Net-zero strategy

An early nuclear pioneer, commissioning the world's first commercial nuclear power station at Calder Hall in 1956. Today, nuclear energy is central to its net-zero strategy, with the Rolls-Royce SMR among its leading small modular reactor designs.

Canada: Focus on off-grid applications

Leveraging a strong regulatory framework to deploy SMRs for indigenous and industrial use.

Northern Europe (Sweden & Finland)

Both Sweden and Finland are utilizing nuclear. Sweden has reversed its phase-out policy: Nuclear is returning as climate infrastructure. Interest in SMRs especially for steel, data centers, and district heating.

Finland is home to Onkalo, the world's first deep geological nuclear waste repository. Finland also has its own SMR design: Steady Energy's LDR-50 - the pilot plant is now under construction in Helsinki.

Growth and strategic expansion

China: Fastest global build program

Rapidly expanding its fleet with focus on high-temperature reactors for industrial heat. SMR design, ACP100, under construction.

Japan: Focus on off-grid applications

The country has a strong safety culture and advanced nuclear research capabilities, and is actively exploring next-generation and smaller reactor designs.

India: Growing population

An indigenous PHWR reactor program, using nuclear energy to support its large and growing population. Nuclear power forms part of its long-term development strategy, with increasing interest in smaller reactors for regional grids.

South Africa

Operates the only nuclear power plant on the African continent at Koeberg. Previously developed pebble-bed modular reactor (PBMR) technology. Renewed interest in small modular reactors as part of its future energy strategy.

What is an SMR
— And what it is not.

There is no single, universally binding definition of “small”, but most international organisations and regulators broadly agree on the same range. For example, IAEA, OECD NEA, World Nuclear Association and the European Commission typically describe SMRs as reactors with electrical output up to about 300 MWe per unit, roughly one-third of a modern gigawatt-scale reactor. The corresponding maximum thermal output translates to ca. 1000 MWth. Some documents further define very small or microreactors (vSMRs) below roughly 10–15 MWe, aimed at remote communities, mines or off-grid applications 1.

The term modular, in turn, refers to modular construction. In other words, SMR units are planned to be constructed of modules that are manufactured elsewhere, transported to the site, and installed into place. This means efficient, standardized factory-like construction with less quality issues and uncertainties.

SMRs are generally divided between “evolutionary” designs (often based on conventional light-water reactor technology, sometimes called Gen III/III+), and “advanced or next-generation” designs (so-called Gen IV) which typically employ non-water coolant, alternative moderators, or advanced fuel cycles.

Despite the new label, an SMR is still a nuclear fission reactor. The energy source and fundamental safety principles are the same as in today’s large reactors: controlled chain reaction in nuclear fuel, with multiple engineered and institutional barriers (defence-in-depth) to prevent and mitigate accidents.

Across both the public and private sectors, there is significant global

Small

- The Rolls-Royce SMR selected as the UK’s preferred design is rated at about 470 MWe, but is still widely discussed under the SMR umbrella because it uses modular construction and targets similar market segments as smaller SMRs.
- Lower end: Microreactor concepts are typically 1–10 MWe.
- Heat-only designs: Some SMRs are designed to produce heat rather than electricity. For example, the Finnish LDR-50 is a ~50 MWth, low-temperature light-water reactor intended solely for district heating and low-temperature industrial heat.

Modular

- A significant portion of the plant, including the reactor module and major systems, is fabricated in factories as standardized modules.
- Modules are transported to site and assembled, rather than building most systems from scratch on site.
- Designs often allow several reactor modules to operate on the same site, so plant output can be scaled to local demand.

Reactor

- Light-water reactors (LWRs), pressurised or boiling water, are closely related to today’s operating fleet (e.g. China’s ACP100 “Linglong One”, GE Hitachi’s BWRX-300).
- Molten salt reactors, sodium-cooled fast reactors, and high-temperature gas-cooled reactors are designed to operate at higher temperatures, use alternative fuel cycles, and in some cases improve fuel utilisation and waste outcomes.

1 World Nuclear Association

momentum to bring small modular reactor (SMR) technologies into commercial use within this decade. A few SMRs are already operating today, for example Russia's Akademik Lomonosov, the world's first floating nuclear power plant, which has supplied electricity since 2020 using two 35 MWe SMR units.

Global interest in small and medium sized modular reactors has been increasing due to their ability to meet the need for flexible power and heat generation for a wider range of users and applications and replace ageing fossil fuel fired power plants. More than 80 commercial SMR designs are currently under development worldwide. They span a broad spectrum of power outputs, technologies, and end-use applications:

- grid electricity
- district heating
- industrial steam
- hydrogen production
- hybrid energy systems
- water desalination

While SMRs typically promise lower upfront capital cost per module, enabled by factory fabrication, modularity, and shorter construction times, their overall economic competitiveness can only be confirmed once a larger number of units are built, deployed, and operated at scale.

What SMRs are not is a single uniform product or a downscaled version of today's large reactors. Instead, they represent a diverse family of advanced designs, each with its own technical approach, maturity level, and intended use case.

Market of SMRs.

As we now know, small modular reactors (SMRs) represent a broad family of nuclear technologies that serve different markets operating at different temperatures. While they share key design principles like standardized manufacturing, smaller unit size, and passive safety features, their applications differ widely. A clear market map helps distinguish these segments and shows where individual designs fit.

Electricity Focused SMRs (eSMRs)

Electricity producing SMRs are the most publicly visible category. These reactors target utilities seeking low-carbon baseload generation with reduced project risk compared to large reactors. Most eSMRs are light-water reactors (LWRs) because they build on familiar technologies and regulatory frameworks.

Typical features include:

- Outputs: 50–470 MWe
- Primary customers: utilities, energy-intensive industries, data centres
- Temperature range: 285–320°C (LWRs)
- Market advantage: decarbonizing electricity without large-plant complexity
- Examples: GEH BWRX-300, NuScale VOYGR, Rolls-Royce SMR

Some advanced eSMRs use gas, molten salt, or sodium coolants to deliver higher thermal efficiencies or support hybrid energy systems. These technologies target future multi-product energy hubs rather than single-purpose plants.

High-Temperature SMRs for Industrial Process Heat

A rapidly emerging segment focuses on high-temperature heat for industrial sectors such as steel, ammonia, hydrogen, and petrochemicals. These reactors typically operate between 500–900°C or higher, enabling steam production, thermochemical hydrogen processes, or direct industrial use.

Typical features include:

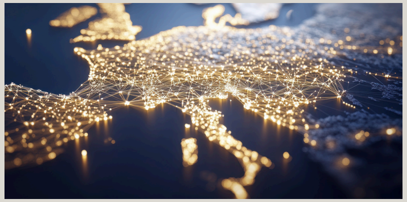
- Outputs: 50–250MWth (some with 80–200 MWe electric capability)
- Temperature range: 500–900°C (HTGRs), 565–750°C (sodium/moltens salt variants)
- Primary customers: chemical plants, steel producers, hydrogen hubs
- Market advantage: replacing fossil boilers and gas reformers
- Examples: X-energy Xe-100, HTR-PM, TerraPower Natrium, ARC-100

These designs support cogeneration, meaning one plant can simultaneously deliver electricity, process heat, and even grid services.

Heat-Only SMRs

A new and strategically important category consists of heat-only SMRs designed specifically for district heating and low-temperature industrial applications. These units do not generate electricity, eliminating the thermodynamic penalties associated with electricity production and increasing overall efficiency for thermal customers.

Regional Market Differences



Europe: Strongest demand for heat-only and DH-intergrated designs.

North America: focus on grid-scale electricity and industrial heat.

Asia: deployment of HTGRs and multi-purpose SMRs for industrial parks.

Arctic/remote markets: microreactors and mobile solutions.

They also operate at much lower temperatures, which significantly simplifies safety systems, siting requirements, and licensing demands. This segment is particularly relevant for Europe, where district heating decarbonization is a regulatory priority.

Typical features include:

- Outputs: 10–50MWth per unit
- Delivery temperature: 120–150 °C (suitable for European district heating networks)
- Primary customers: municipal district heating companies, industrial steam users, sea water desalination plants
- Market advantage: highest efficiency pathway for replacing fossil heat
- Examples: Steady Energy LDR-50, Calogena CAL-30

These systems avoid electricity conversion entirely and target markets where heat is the dominant energy demand. Their low-pressure, low-hazard characteristics represent a new licensing category emerging in multiple EU member states.

Hybrid Energy and Cogeneration SMRs

Between electricity focused and heat-only reactors is a diverse group of cogeneration SMRs designed to supply multiple outputs: electricity, district heat, process steam, and hydrogen. Their flexibility supports integrated energy systems and can stabilise grids with high renewable penetration.

Typical features include:

- Outputs: 100–300 MWth (20–200 MWe depending on configuration)
- Products: electricity + heat, or electricity + hydrogen
- Primary customers: integrated utilities, industrial clusters
- Market advantage: improved economic utilisation through multi-product output
- Examples: IMSR (molten salt), ACP100 (multi-purpose LWR), SMART (Korea)

These designs can "swing" between electricity and heat production depending on price signals or seasonal demand, which makes them attractive for markets with variable loads.

Microreactors and Remote Power Units

Microreactors occupy the lower end of the scale, typically below 10 MWth/MWe, and are intended for isolated communities, military bases, mining operations, or locations where logistics make fuel delivery expensive.

Typical features include:

- Power range: 1–10 MWe or equivalent heat output
- Primary customers: remote regions, defence, Arctic and island grids
- Market advantage: transportable, long refuelling intervals, minimal site footprint
- Examples: Westinghouse eVinci, Oklo Aurora, US DoD mobile microreactors

As Steady Energy's Senior Nuclear Safety Engineer, Antti Tarkiainen put it:"SMRs are a practical evolution of proven nuclear technology, and they are genuinely moving forward. That's very good news, because the world and our climate targets need ways to harness nuclear energy quickly, efficiently, and safely".

Read more on Antti's blog
"What Is an SMR? A Simple Guide to Small Modular Reactors"

LEU: Low-enriched uranium.

Design	Coolant / Moderator	Fuel	Electrical / Thermal Output	Typical Core / Output Conditions (Temp / Pressure)	Notes / Use Cases
BWRX-300	Light water coolant & moderator	Conventional UO_2 (LEU ≤5%)	~300 MWe	Boiling water reactor conditions; saturation temperature ~285–290 °C; pressure ~7 MPa	Grid-scale SMR for electricity generation; simplified BWR design with natural circulation and passive safety features.
NuScale VOYGR	Light water coolant & moderator (integral PWR)	Conventional UO_2 (LEU ≤5%)	~77 MWe per module (up to ~462 MWe per plant)	PWR conditions; core outlet ~300 °C; system pressure ~12–13 MPa	Modular PWR SMR with NRC-certified design; intended for flexible grid deployment and multi-module plants.
Rolls-Royce SMR	Light water coolant & moderator (PWR)	Conventional UO_2 (LEU ≤5%)	~470 MWe	PWR conditions; core outlet ~300–320 °C; system pressure ~15.5 MPa	Large-end SMR targeting fleet deployment; factory-manufactured modules with emphasis on repeatability and cost reduction.
ACP100	Light water coolant & moderator (integral PWR)	Conventional UO_2 (LEU ≤5%)	~125 MWe	PWR conditions; core outlet ~300 °C; system pressure ~15 MPa	China's first commercial SMR; designed for electricity, district heating, and cogeneration; first-of-a-kind unit under commissioning.
HTR-PM	Helium coolant, graphite moderator	TRISO fuel, LEU ~8–9% U-235	210 MWe (2 × 250 MWth modules)	Helium inlet ~250 °C, outlet ~750 °C; primary pressure ~7 MPa; secondary steam ~567 °C / ~13 MPa	High-temperature reactor for electricity and potential industrial heat, hydrogen production, or process steam.
LDR-50	Light water coolant & moderator	Conventional LEU fuel	~50 MWth (heat-only)	Low-temperature operation ~150 °C; low pressure <10 bar (~1 MPa)	Heat-only SMR optimized for district heating; low temperature and pressure simplify safety case and urban integration.

Table: Some active or emerging SMR designs.

Heat-only SMR versus eSMR.

Heat-only SMRs and electricity-producing SMRs (eSMRs) represent two diverging technological and economic strategies for deploying small nuclear reactors. Both contribute to climate and energy-efficiency objectives, but they optimize for different output profiles and market conditions.

Nuclear power provides 10 % of the world's total electricity generation, but to slow down climate change, far greater amounts of clean and reliable energy are needed. Heating and cooling, on the other hand, account for almost half of the EU's total energy demand — a sector still dominated by fossil fuels. This makes decarbonizing heat a strategic priority. Under the revised Energy Efficiency Directive (EED), EU Member States must cut their final energy consumption by at least 11.7% by 2030 relative to projected 2020 levels, pushing governments and industries to adopt cleaner, more efficient heat sources.

In this context, heat-only SMRs and electricity producing SMRs (eSMRs) offer two distinct pathways:

- Heat-only SMRs deliver thermal energy directly for district heating, industrial processes, and low-temperature applications. By avoiding electricity conversion losses, they can provide highly efficient, local, fossil-free heat.
- eSMRs are designed primarily for power generation, but their thermal output can also be used in combined heat-and-power (CHP) configurations. Their flexibility supports grid decarbonisation while enabling hybrid energy systems where heat is a secondary product.

Together, both categories expand the possible roles of SMRs in meeting Europe's energy-efficiency and climate targets, with heat-only units directly targeting the largest single segment of final energy use.

Feature	Heat-only SMRs	eSMRs
Primary Output	Thermal energy only (hot water / steam)	Electricity; heat available for CHP / industrial use
Typical Applications	District heating, low-temperature industry, desalination	Grid power generation, industrial power, hybrid energy systems
Efficiency Profile	Very high efficiency due to no power-conversion losses	Electrical efficiency depends on cycle design; total efficiency increases in CHP mode
Temperature Range	Typically low- to medium-temperature heat (e.g., 60–300°C depending on design)	Varies widely (250–750°C or higher depending on reactor type); optimised for power cycles
Plant Complexity	Simplified systems; fewer balance-of-plant components	More complex due to turbines, generators, power-conversion systems
Grid Requirements	None — suitable for off-grid or weak-grid locations	Requires grid interconnection unless operated in islanded mode
Siting Flexibility	High — can be located close to heat demand centres	Moderate — constrained by electrical infrastructure and grid stability needs
Economic Logic	Lower CAPEX relative to eSMRs; economics driven by heat demand density and baseload utilisation	Higher CAPEX; economics depend on capacity factor, power prices, and optional heat-offtake
Regulatory Considerations	Potentially simpler licensing scope (heat-only operation) but still nuclear-grade	Full nuclear power plant licensing, including electrical systems and grid safety requirements
Decarbonisation Role	Direct replacement for fossil boilers (coal, gas) in heating sector	Low-carbon electricity for grids; can provide heat as secondary product

While electricity producing SMRs are gaining momentum in the media, reactors exclusively targeted for heat production have raised renewed interest due to their safety characteristics, simplified system design, and potential for cost competitiveness. Authorities are developing frameworks specifically for low-temperature heat-only reactors and standardized multi-unit designs, enabling faster licensing.

Safety philosophy & inherent risk profile

Heat-only SMRs generally operate at lower temperatures and pressures than eSMRs, which contributes to inherently safer conditions and simpler containment structures. Their single-purpose design reduces the number of safety-critical systems (no turbine hall, no high-speed rotating machinery). For regulators, municipalities, and district heating operators, heat-only SMRs may constitute a lower perceived risk profile and potentially reduced system complexity, enabling faster licensing frameworks.

Siting, footprint, and co-location potential

Because heat cannot be transported efficiently over long distances, heat-only SMRs must be sited near heat loads. Their smaller footprint and reduced exclusion-zone requirements (a result of lower system complexity and lower stored energy) make this feasible.
eSMRs must integrate into the electrical grid, require voltage regulation and grid stability equipment, and often need more robust site infrastructure.

System Efficiency

Heat-only reactors avoid power-conversion steps, enabling direct delivery of thermal energy. Their efficiency is maximised when heat demand is strong and local.
eSMRs convert heat into electricity, which introduces conversion losses, but provide higher energy-value flexibility. Electricity can be transmitted, stored, traded, or integrated into broader power markets, offering more diverse revenue pathways.

Temperature and Performance Range

Heat-only SMRs typically operate in the low-to-medium temperature range, matching district heating requirements.
eSMRs span a wide range of operating temperatures depending on design. Higher-temperature concepts can supply electricity efficiently and can serve industrial processes that require temperatures beyond the scope of heat-only systems.

Plant Architecture and Complexity

Heat-only reactors use a simplified plant layout with fewer balance-of-plant components, such as auxiliarity or safety systems, reflecting their single-purpose design.
eSMRs incorporate turbine-generator systems and electrical infrastructure, enabling multi-output energy services. While this adds complexity, it also increases functionality and systemwide value.

Siting and Integration

Heat-only SMRs integrate most effectively when located near heat loads, fitting well with cities and industrial clusters.
eSMRs require electrical grid integration but benefit from greater siting flexibility with respect to the distance from heat loads. This allows them to serve broader regional or national energy systems.

Operational flexibility and load-following

Heat-only SMRs are typically designed to follow thermal demand profiles, which may vary seasonally and daily in district heating systems. Their integration with thermal storage can further smooth output and improve system efficiency.
eSMRs are designed to operate flexibly within electricity systems, supporting load-following, frequency control, and complementing variable renewable generation. This operational flexibility enhances their value in power systems with high shares of wind and solar.

Integration with energy storage

Heat-only SMRs pair naturally with thermal energy storage, enabling decoupling of heat production from demand and improving utilisation during low-demand periods.

eSMRs can integrate with electrical storage, hydrogen production, or synthetic fuel systems, expanding their role beyond electricity generation and enabling sector coupling.

Regulatory Considerations

Heat-only reactors may fit emerging “fit-for-purpose” licensing pathways focused on low-temperature applications, depending on jurisdiction, with the potential to shorten licensing timelines. In Finland, a heat-only reactor, LDR-50, received first preliminary regulator assessment last year.

eSMRs follow established nuclear power plant licensing frameworks, which are more mature globally. This can provide regulatory predictability, especially in countries with long experience licensing power reactors.

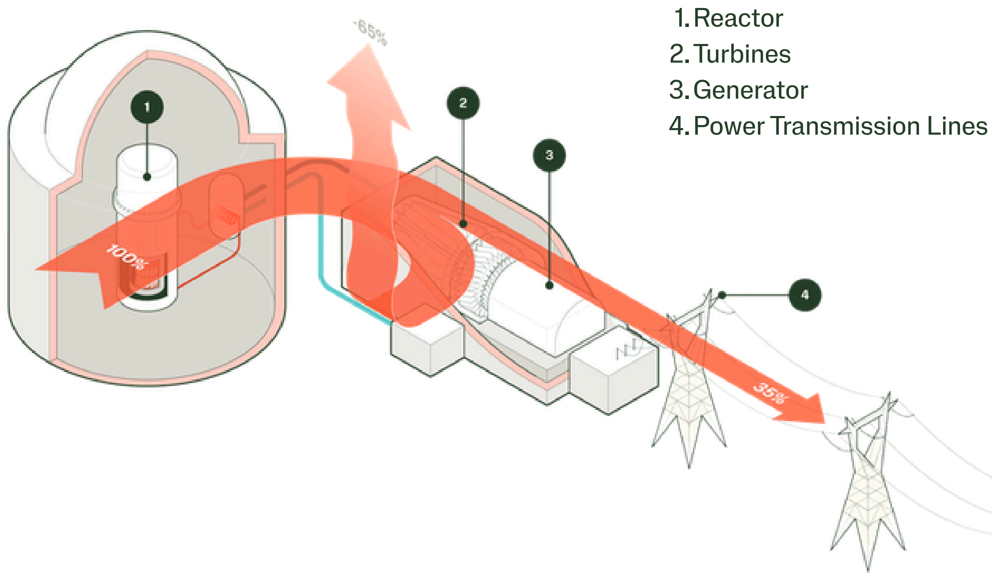
Market maturity and deployment pathways

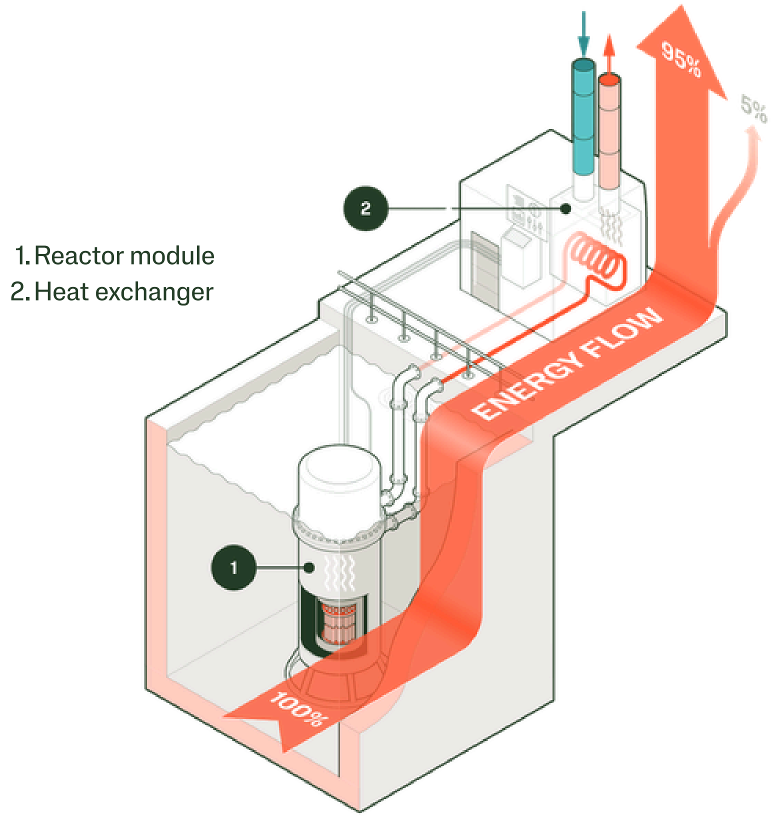
eSMRs benefit from decades of operational experience with nuclear power plants and well-established electricity market structures in many countries. This can support financing and deployment in jurisdictions with existing nuclear power frameworks.

Heat-only SMRs represent a more novel market segment, with growing interest driven by decarbonisation of heating. Their deployment pathways are emerging alongside new regulatory approaches and district heating business models.

Economic Logic

Heat-only SMRs and eSMRs follow different economic logics, reflecting the distinct markets they are designed to serve. Heat-only SMRs are economically optimised for environments with high and stable heat demand density, such as district heating networks or industrial clusters.





Their cost structure benefits from simplified plant architecture, fewer balance-of-plant components, and the absence of power conversion systems. Revenues are typically based on long-term heat supply contracts, offering predictable cash flows and high utilisation when deployed in well matched locations. Economic performance is therefore closely tied to local heat demand profiles, seasonal utilisation, and integration with existing thermal infrastructure.

eSMRs, by contrast, are capital intensive assets designed to participate in electricity markets, where revenues depend on electricity prices, capacity factors, and, in some cases, capacity or ancillary service markets. Their economic performance is influenced by grid conditions, market volatility, and policy frameworks such as power purchase agreements or capacity remuneration mechanisms. When operated in combined heat-and-power (CHP) mode, eSMRs can improve overall efficiency and diversify revenue streams, particularly where both electricity and heat demand coexist.

In practice, heat-only SMRs prioritise cost-effective decarbonisation of thermal energy, while eSMRs prioritise value maximisation across multiple energy markets. The relative attractiveness of each approach depends on local energy prices, demand structure, regulatory conditions, and long-term system planning objectives.

System study: Helsinki metropolitan area

A VTT study assessing the integration of two SMR concepts into the Helsinki district heating and cooling system found that both designs reduced CO_2 emissions. However, the heat-only LDR-50 was economically viable under local conditions, while a larger electricity-producing SMR faced challenges due to low electricity prices and demand variability. Sensitivity analyses showed that heat extraction rates, investment costs, and energy market conditions strongly influenced outcomes, underscoring that SMR viability depends on system characteristics rather than reactor type alone[1].

Choosing between heat-only SMRs and eSMRs depends primarily on:

01 Dominant energy demand (heat vs. electricity)

02 Demand density and proximity

03 Grid conditions and market design

04 Regulatory environment

05 Long-term system integration strategy

1 Nuclear Engineering and Design

Advantages of SMRs.

Many of the benefits of SMRs are inherently linked to the nature of their design – small and modular. Challenges or uncertainties have to do with assuring streamlined licensing processes, developing global supply chains and achieving transparent dialogue among regulators, suppliers, designers and clients.

01 Lower upfront capital investment

Prefabricated units of SMRs can be manufactured and then shipped and installed on site, making them more affordable to build than large power reactors. Standardization reduces customization risks, lowers construction costs, and shortens project timelines

02 Scalability

Multiple SMR modules can be added over time as demand grows, rather than requiring one large build-out all at once, reducing upfront capital requirements and aligning capacity expansion with local energy needs.

03 Flexible siting

With smaller footprint and lower power/heat output per module, SMRs can be deployed closer to demand centers, or in smaller grids, remote or industrial sites where large nuclear plants are unfeasible.

04 Technological diversity

Technological diversity enables different use cases: from conventional light-water SMRs for grid electricity and district heat, to high-temperature reactors for industrial heat or hydrogen production, to marine and remote reactors. SMRs give a broad toolbox to decarbonize not only power but heat-intensive sectors.

05 Safety through simplified design

Many SMR concepts incorporate passive safety features that rely on natural physical processes, such as gravity, convection, or natural circulation, rather than pumps, external power, or operator action. Their lower power levels and, in some designs, lower operating pressures contribute to wider safety margins and reduce the likelihood or consequences of accidents.

06 Reduced fuel use

SMRs often require less fuel overall and benefit from longer refuelling intervals. Fewer refuelling outages simplify operations and can enhance reliability, especially in remote or hard-to-access settings.

How to make the right choice.

Making the right SMR choice is a structured process:

01 **Start with the need**
Define your heat-demand profile, temperature requirement, and reliability needs.

02 **Understand your site**
Check footprint, logistics, integration points, and regulatory constraints. Only consider designs that fit your physical and permitting environment.

03 **Key considerations**
Review vendors' technology readiness, supply chain maturity, safety case completeness, contracting models, and fuel/waste strategies.

04 **Conduct a feasibility study**
Model network integration, evaluate CAPEX/OPEX, assess licensing feasibility, and create realistic site layouts. This determines technical and economic viability.

05 **Prepare for licensing and procurement**
Engage early with the regulator, align stakeholders, and begin pre-contractual work.

Key considerations for district heating operators when assessing an SMR investment.

Small modular reactors (SMRs) designed for district heating can reduce emissions, stabilize heat supply, and offer long-term price security. However, integrating a nuclear heat source into an existing municipal network requires careful assessment across technical, economic, and safety dimensions. This page outlines the essential considerations for district-heating operators evaluating SMR deployment.

Performance

□ Can the unit reliably deliver ≥120 °C?

□ Does it match my network's peak and minimum demand?

□ Does it support daily and seasonal load following?

□ Is the control strategy boron-free / low-complexity?

Economics

□ Are components commercially available?

□ What's the CAPEX/OPEX?

□ Can modules be transported by road without major logistics burdens?

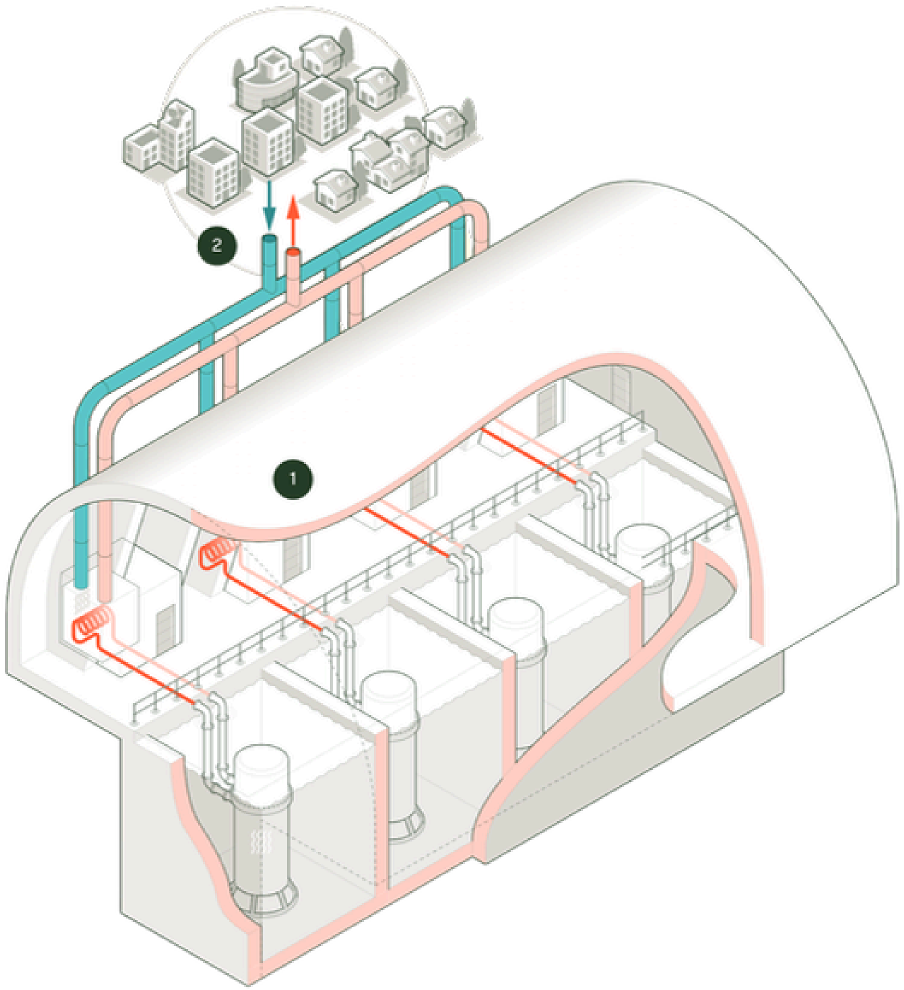
□ Is the design truly modular and repeatable?

Safety

□ Does the SMR meet IAEA SSR-2/1 Rev.1 safety functions?

□ Are shutdown, heat removal, and confinement systems diversified and independent?

□ Are siting requirements compatible with existing DH plant locations?



1. Hot water from the plant
2. Heat is distributed to the district heating network

Feasibility study helps to decide with data.

Decarbonizing heat isn't just about technology - it's about making the right choices for the right place at the right time. Every city, district, and energy system is unique, with its own network, demand patterns, and future ambitions. Feasibility study turns questions into a clear picture of what is possible.
Many reactor vendors offer paid or free feasibility studies to help with decision making. A feasibility study gives you the confidence to move forward (or not) with full visibility of the risks, opportunities, and trade-offs involved.
The feasibility study is often based on a description of the client's existing heating system, typically including historical heat consumption data, potential heat production, local heat market dynamics, and other factors relevant to simulating or modeling the operation of the LDR-50 SMR within the client's heat network.

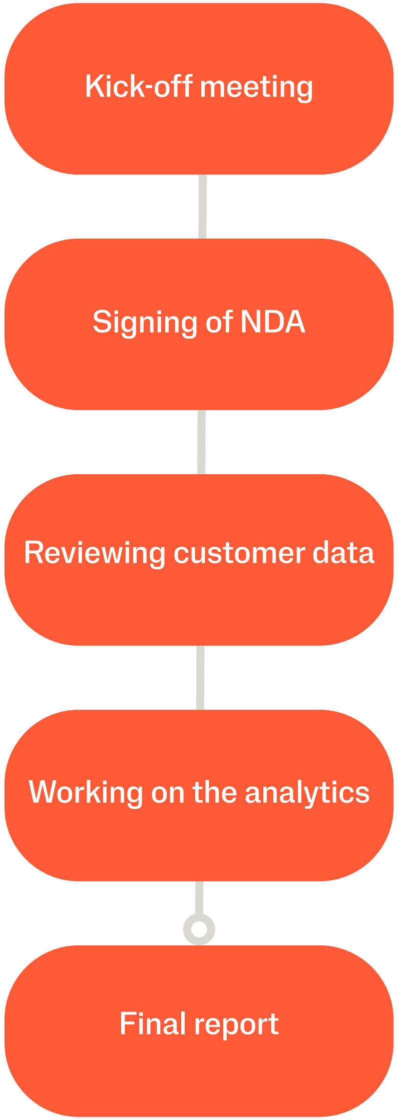
A feasibility study should give you:

Informed decision
Gain a clear, detailed report on whether the LDR-50 is the right solution for your needs, giving you the confidence to make the right energy investment.

Technical fit
Verified compatibility with your network, demand, and local conditions.

Figure out the costs
Gain a strong understanding of investments that deliver lower levelized heat costs and improved operational efficiency.

Impact potential
Discover the quantified benefits in emissions reduction, energy security, and community value.



Can nuclear be small, local, and widely adopted via SMRs?

This guide set out to answer a simple but consequential question: can small modular reactors (SMRs) move nuclear energy from a limited number of large, centralised projects to something that is repeatable, local, and widely deployable?

Across reactor designs, market maps, heat versus power comparisons and decision frameworks, one conclusion emerges: Yes. SMR designs offer scalable, flexible, and potentially widely adoptable nuclear energy. The fact that there are already SMRs in commercial operation demonstrates that SMRs are more than just theoretical concepts.

From one-off megaprojects to repeatable infrastructure

International organisations consistently frame SMRs as a response to the structural challenges of conventional nuclear projects: bespoke engineering, site-specific construction, long timelines, and escalating costs. In theory, modular construction and repeatable designs allow SMRs to behave more like infrastructure products than custom megaprojects.

What matters to decision makers is whether the technology can be licensed, manufactured and assembled through streamlined processes, and deliver improvements in cost, schedule, and risk with each subsequent unit.

1 Katsiotis

2 OECD Nuclear Energy Agency

Why heat changes the SMR equation

Heating and cooling account for roughly half of final energy demand in Europe, yet remain heavily dependent on fossil fuels. At the same time, many regions already operate district heating systems that require high-utilisation, reliable, low-carbon heat — often close to population centres.

This is where heat-only SMRs, and combined heat-and-power SMRs, fundamentally change the conversation:

- They avoid electricity conversion losses
- They align with local heat demand rather than national power markets
- They can replace fossil boilers directly, reducing emissions immediately

Where SMRs align with real local needs they offer a credible, local and complementary pathway alongside renewables.

Readiness matters more than ambition

Ambition alone does not solve the structural challenges that have constrained nuclear energy for decades: long licensing timelines, site-specific engineering, construction risk, and cost escalation. In this sense, SMRs only fulfil their promise if they behave less like one-off technology demonstrations and more like infrastructure products. With disciplined deployment strategies, realistic expectations, and a focus on repeatability rather than spectacle, they can become something arguably more valuable: a scalable, local, and dependable component of the clean energy system.

SMR market opportunity and global trends

- $300B global SMR market potential by 2040 1.
- 15 Gt CO_2 reduction potential if SMRs scale as envisioned 2.
- Over 100 design options globally

Widespread SMR deployment therefore depends less on bold promises and more on disciplined execution:

- Standard designs deployed across multiple sites
- Harmonised licensing approaches where possible
- Clear roles for utilities, municipalities, vendors, and financiers
- A focus on repeat projects, not single showcases

This does not mean innovation is trivial. It means that execution capacity might become the limiting factor. Nevertheless, SMRs are coming, are you ready?

Would you like to hear more about heat-only SMRs and LDR-50, or stay up to date with the latest news from Steady Energy?

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