

MEMORANDUM

Date: 16 October 2025

Reference: 27390/25.320897

Subject: Feasibility and added value of an SMR for the Municipality of Den Helder

Introduction

Like wind and solar energy, nuclear energy produces no CO₂ during electricity generation. It can therefore play an important role in the energy transition and in the ambition to achieve a climate-neutral energy supply by 2040. Alongside the large conventional nuclear power plants being developed by the national government, increasing attention is being paid to smaller, modular nuclear power plants (the so-called Small Modular Reactors, SMRs).

Compared with other forms of energy, nuclear energy is subject to very stringent safety requirements. Its energy density is exceptionally high, meaning that considerably less space and fewer materials are required per megawatt-hour. Nuclear power plants have an operating life of sixty to eighty years, and although the initial capital costs are high, total system costs per megawatt-hour are, in principle, favourable because of the high availability. This limits the need for additional investment in grids, storage and back-up capacity. Nuclear power generation produces radioactive waste from spent uranium fuel rods and activated infrastructure. The volume of this waste is small and it can be managed effectively. In the Netherlands, COVRA in Vlissingen is responsible for its safe removal and storage.

SMRs offer several additional advantages compared with large nuclear power plants. Their lower output and smaller footprint make them easier to integrate at a wider range of locations, such as on or near industrial estates. Centralised, standardised serial production of prefabricated components significantly shortens on-site construction time. The innovative SMR concepts of the so-called fourth generation in particular often provide inherent safety based on physical properties, reducing the need for active cooling and other safety systems. Despite their smaller scale, SMRs are expected to become cost-competitive in the future through simplified designs, modularisation of standard components, shorter construction periods and therefore lower capital costs – especially once they are produced in larger numbers.

In addition to generating electricity, an SMR can also be used for other applications. Heat generated by an SMR can be used for district heating or industrial applications. Combined heat and power is also possible. In addition, the electricity and heat can be used by an electrolysis installation to produce hydrogen, an energy carrier that may become important in various sectors in the future.

An SMR could therefore make an important contribution to realising a CO₂-free energy system. The Municipality of Den Helder has therefore asked NRG PALLAS and Tractebel to investigate the feasibility and potential added value of an SMR for the municipality. This summary memorandum presents the findings, looking at

- 1) promising SMRs for the Netherlands,
- 2) integration at the proposed site, and
- 3) energy-system integration, in other words the match with local energy demand.

1. Inventory of possible SMRs

As a first step in the study, possible SMRs for the Municipality of Den Helder that could be realised within a relatively short timeframe (2035-2040) were examined. Although approximately one hundred SMRs are under development worldwide, the number that could be commercially operational in the Netherlands in the 2035-2040 period is probably limited to a handful of SMRs based on existing technology, the so-called third generation. These SMRs are based on proven reactor technology and are at an advanced stage of development. Several reactors abroad are already being prepared or are even under construction. More advanced generation 4 SMRs are still under active development and, because they use new technologies, there is greater uncertainty regarding the period wherein these reactors will enter the Dutch market.

Inventory of promising SMRs for the Netherlands 2035-2040

Inventarisatie SMR's voor Nederland				TRACTEBEL ENGIE		NRG PALLAS Nuclear. For Life.	
Generatie 3				Generatie 4			
Grote SMR's (> 250 MWe)		Micro-SMR's (< 67 MWe)		Grote SMR's (> 250 MWe)		Middelgrote SMR's (67-250 MWe)	
							
Voorbeelden		Voorbeelden		Voorbeelden		Voorbeelden	
- Rolls-Royce – RR SMR 470 MWe - GE Hitachi – BWRX-300 300 - Westinghouse – AP300 300 - NuScale – 4NPM 4 x 77 - Holtec – SMR-300 2 x 320 - KHNP – I-SMR 4 x 170		Westinghouse - eVinci 5 MWe		- X-Energy – Xe-100 4 x 80 MWe - Newcleo – LFR-AS-200 2 x 200 - Terrestrial – IMSR400 2 x 195 - Terrapower – Natrium reactor 335		- Kairos Power – KP-FHR 2 x 75 MWe - Thorizon – Thorizon One 100 - Oklo – Aurora 75	
Toepassing		Toepassing		Toepassing		Toepassing	
- Grootschalige elektriciteit, basislast - Vaak (beperkt) regelbaar 50 -100% - Mogelijk ook voor WKK, waterstof en/of stadsverwarming		- Kleinschalige elektriciteit - Specifiek ontworpen voor afgelegen locaties of achter de meter - Tevens restwarmte voor stadsverwarming		- Flexibele regelbare elektriciteit (met warmteopslag voor batterijfunctie) - Proceswarmte op hoge temperatuur (350-600+°C) voor industrie - Mogelijk ook voor WKK, waterstof		- Flexibele regelbare elektriciteit (met warmteopslag voor batterijfunctie) - Proceswarmte op hoge temperatuur (350-600+°C) voor industrie - Mogelijk ook voor WKK, waterstof	
Wanneer beschikbaar?		Wanneer beschikbaar?		Wanneer beschikbaar?		Wanneer beschikbaar?	
- First-of-a-kinds (FOAK's) 2030 -2032 - Operationeel in NL vanaf 2035 -2037		- FOAK 2029-2031 - Operationeel in NL vanaf 2033 -2035		- FOAK's 2032-2036 - Operationeel in NL eind jaren 2030		- FOAK 2032-2036 - Operationeel in NL eind jaren 2030	
Opmerking: er zijn wereldwijd 127 verschillende SMR –concepten, waarvan 74 actief in ontwikkeling, gemonitord door de OESO. Veel zijn ons inziens de meest gevorderde en kansrijke concepten die in 2035 –2040 in Nederland commercieel beschikbaar en operationeel zouden kunnen worden; de PWR –20 van Last Energy is buiten beschouwing gelaten Bron: SMR dashboard OECD –NEA 2025, database Tractebel, publieke bronnen, teamanalyse NRG PALLAS & Tractebel							

A closer look at the generation 3 SMRs shows that they can be divided into large SMRs (more than 250 megawatts electrical output, MWe) and small reactors (less than 67 MWe). There are currently no SMRs in the medium-sized category (67 MWe to 250 MWe) under development that will become commercially available in the 2035-2040 period. There are, however, several reactor concepts, such as NuScale, for which a single unit falls within this category. For economic reasons, however, these are offered only as two or four units at a single location, meaning that in practice they still fall within the large category. The small SMRs are designed primarily to supply electricity to remote areas without a direct connection to the electricity grid, or for behind-the-meter solutions. These SMRs are relatively expensive per megawatt-hour and are therefore highly unlikely to be suitable for a location such as Den Helder.

2. Spatial integration

The Municipality of Den Helder has designated one specific location where an SMR could potentially be developed, namely Kooypunt 4. It has been indicated that this site could possibly be expanded to include the adjacent site, Kooypunt 3.

Spatial integration at the site



Gasleidingen

- Strook van 40-58 m breed
- Aan weerszijden moet nog 6+ meter extra worden vrijgehouden
- Gasleiding niet op voorhand showstopper voor de ANVS; wel extra projectrisico

Omliggende activiteiten

- Moet rekening houden met veiligheidscontouren van vergister, waterstofprojecten, luchthaven, batterijen en scheepvaart. Dit wordt niet op voorhand als rode vlaggen gezien.

Several aspects are important for integration. First, the site must be large enough to accommodate construction of an SMR. There must also be sufficient scope to dissipate the heat produced at all times, and current regulations require a connection to the electricity grid.

Space

The area required for an SMR is related to its output. Two hectares are sufficient for a micro-SMR, a medium-sized SMR requires 3-10 hectares and a large SMR requires approximately 15 hectares. An exception is Westinghouse's AP300, which requires less than 10 hectares. Temporary additional space is required during construction; in general this amounts to approximately twice as much additional space.

The available area at Kooypunt 4 is 14-15 ha, Kooypunt 3 measures 10-13 ha and the combined area is approximately 25 ha.

As shown in the table below, Kooypunt 4 is large enough for micro-SMRs and medium-sized SMRs. For large SMRs, integration becomes a challenge and further investigation is required. If combined with Kooypunt 3, all SMRs can in principle be accommodated in terms of area.

However, several gas pipelines run beneath Kooypunt and cut across the site. A reactor above gas pipelines would be unprecedented and would lead to questions and complications in the permit application. In principle, the site boundary of an SMR could run across the gas pipelines, but it would have to be demonstrated that this is acceptable from a safety perspective, possibly requiring additional measures. This also creates all kinds of additional practical challenges; for example, arrangements regarding access would have to be made with the owner of the gas pipelines. Allowance must therefore be made for a necessary division into a western and an eastern section, leaving effectively less than half of the space available.

Micro-SMRs would still fit well at Kooyunt 4 in that case. However, medium-sized and large SMRs would then generally not fit (with the exception of the Thorizon One). For these reactors it would be necessary to combine Kooyunt 3 and 4. The western section of the combination is approx. 13 ha and the eastern section approx. 10 ha. This provides sufficient space for a medium-sized SMR. Integrating a large SMR in either the western or the eastern section remains a challenge. Without further investigation, no definitive conclusion can be given on this. Possibly, a (costly) modification of the design may be required to accommodate a large SMR at Kooyunt.

Integration of SMRs at Kooyunt

		Terreingrens over gasleiding (mogelijk niet toegestaan)		Bij opdeling oost-west (meest waarschijnlijke scenario)	
		Kooyunt 4	Kooyunt 3+4	Kooyunt 4	Kooyunt 3+4
Micro-SMR	1-2 Ha	✓	✓	✓	✓
Middelgrote SMR	3-10 Ha	✓	✓	×	✓
Grote SMR	15+ Ha	(ntb)	✓	×	(ntb)

Cooling

Preliminary calculations show that cooling of SMRs is feasible for all options (large, medium-sized and micro). In most cases this would be done using cooling modules (based on evaporative cooling). Once-through cooling with flowing water from the Noord Hollands Kanaal would provide a higher efficiency, but the possibilities for this are limited. For large and medium-sized SMRs, once-through cooling is not an option. The flow rate of the Noord Hollands Kanaal is insufficient for this. Once-through cooling with water from the Noord Hollands Kanaal is possible only for micro-SMRs; however, cooling modules are generally proposed as standard for micro-SMRs.

Grid connection

An SMR will have to be connected to an electricity grid. In all cases, a connection is required to supply power to the (safety) systems of the reactor itself. This connection requires only a limited capacity.

In addition, the electricity produced will also have to be sold. For micro-SMRs, a connection to a medium-voltage grid (10, 20, 25-36 or 50 kV) is probably sufficient. Medium-sized SMRs require a connection to TenneT's 110 kV or 150 kV high-voltage grid, and larger SMRs preferably to the 380 kV high-voltage grid. At present this is not immediately possible, since the grid is currently operating at capacity. If the connection application is initiated on time, a connection to at least the medium-voltage grid could be realised from 2036 onwards.

A positive aspect is that SMRs alleviate grid congestion. Through local coupling within a low- or medium-voltage grid, less transmission takes place via the high-voltage grid. The constant, predictable or even (partly) dispatchable generation stabilises regional grids and can also help to counter peak loads from solar and wind energy. A strategically located large SMR can alleviate bottlenecks in the national grid.

For the sale of the energy, in addition to, or instead of, supplying the public electricity grid, it is also possible to set up a 'behind-the-meter' solution with a direct connection to local electricity consumers. This option presents several challenges. First, costs would still have to be incurred for the connection and a party would have to be found to construct the connection. In addition, a consumer or group of consumers would have to be found who are willing to take the risk of entering into a long-term contract with an SMR concept that has yet to be developed. Finally, additional back-up capacity would have to be found for the 5-10 per cent of the time during which an SMR is out of operation for maintenance and refuelling.

3. Energy-system integration

Ideally, an SMR should also match local energy demand. In an analysis by the municipality, three demand scenarios were defined for this purpose, as shown in the table below.

Electricity consumption and required electrical capacity in three demand scenarios

		Scenario	2020	2025	2030	2035	2040
Vraag Elektriciteit Stad Den Helder	1 Autonome groei	TWh	0,3	0,3	0,4	0,5	0,6
	2 Waterstof		0,3	0,3	0,5	0,9	1,5
	3 Waterstof en datacentra		0,3	0,3	0,7	1,6	3,8
Benodigd vermogen bij 90% loadfactor	1 Autonome groei	MWe	32	39	47	58	70
	2 Waterstof		32	39	66	113	194
	3 Waterstof en datacentra		32	39	89	206	475

Source: analysis by the Municipality of Den Helder

Future scenario 1 – Autonomous growth

Current electricity consumption in Den Helder is approximately 0.3 terawatt-hours (TWh), or approximately 300 gigawatt-hours (GWh). In an autonomous scenario, consumption will increase through natural growth. The number of residents and businesses in Den Helder will increase slightly in the coming period. In addition, average consumption will rise because of a growing number of electric cars, heat pumps and other electrification. Tenaz, the navy, TESO and the port will also require more electricity in the future for their growth ambitions. Approximately 600 GWh of electricity is expected to be consumed in 2040. This requires a capacity of 70 MWe at an availability ('load factor') of 90 per cent.

The SMRs that could be realised in the specified 2035-2040 period all have an output of 300 MWe or more and would therefore supply much more than the local electricity demand in this scenario.

Future scenario 2 – Hydrogen

In a second scenario, several hydrogen installations would be realised that will produce 15-20 kilotonnes of hydrogen per year. In that case, electricity demand in 2040 could increase to 1.5 TWh, requiring a total of almost 200 MWe of capacity.

An important consideration in this scenario is the economic business case. Producing hydrogen by means of nuclear energy is currently not profitable. At present, mainly 'grey' hydrogen is produced by means of steam methane reforming. The cost of this is less than €1 per kg of hydrogen. Green hydrogen, produced using wind or solar energy, currently costs around €7 to €8 per kg or more. Production using an SMR would cost around €3.50 according to a recent study by ULC-Energy (2024). By temporarily switching from hydrogen production to electricity generation at peak times when the electricity price is very high, this amount could be somewhat lower – but still not competitive with grey hydrogen. This situation changes once CO₂ allowances become considerably more expensive, or grey hydrogen is no longer permitted.

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Future scenario 3 – Hydrogen and data centres

In the third scenario, which also includes supplying the data centres and agricultural businesses at Agriport, electricity demand grows to 3.8 TWh, requiring 475 MWe of capacity. In this scenario, the electricity produced by an SMR could therefore be sold entirely locally. Agriport is currently (partly) supplied by a nearby wind farm. This wind farm will be due for replacement in the future, and a third data centre may also be added, creating additional demand for electricity that could be met by an SMR.

In theory, a behind-the-meter solution is possible if a 20 km electricity cable is installed from Kooypunt to Agriport, by a party such as ECW Energy, possibly underground. During the 90-95 per cent of the time that the SMR is operating, the SMR supplies the data centres. During periods of maintenance and refuelling, the data centres can use the existing grid connection. This possibility can be investigated further, both technically and economically.

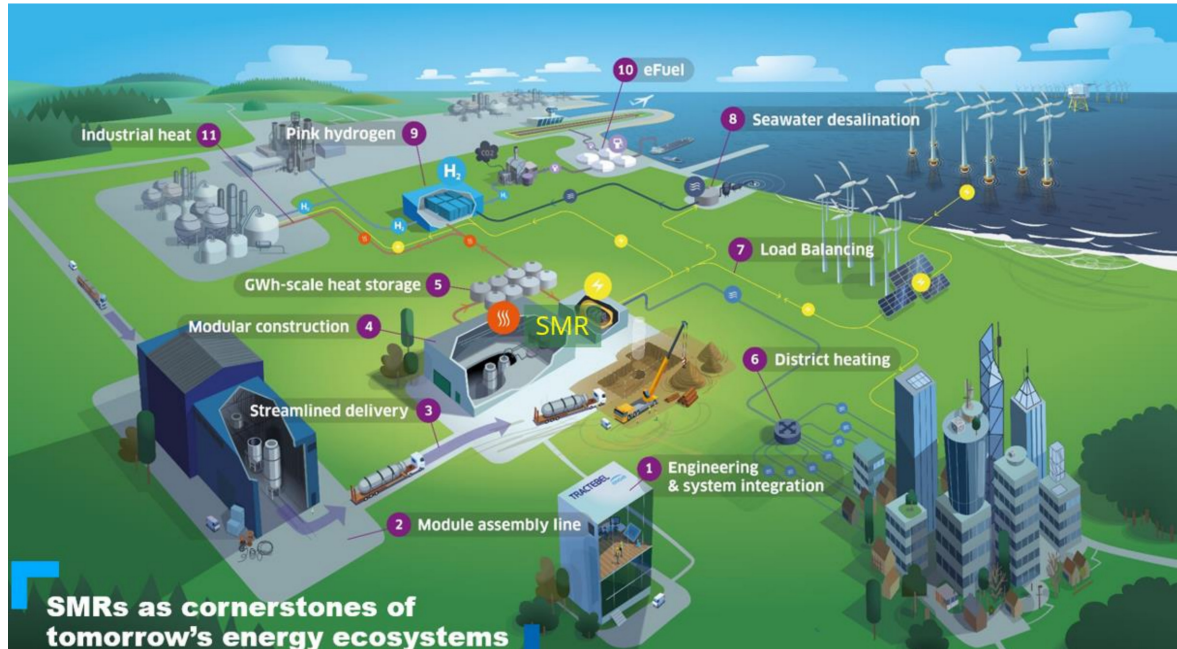
If no local demand can be mobilised, the SMR can supply the national grid, which would be arranged in consultation with Liander and TenneT.

Added value of an SMR

In its *Toekomstvisie Energie* (Energy Future Vision), the Municipality of Den Helder has formulated the ambition of being energy-neutral in 2040, using various building blocks – possibly including an SMR – to arrive at a climate-neutral energy mix. To achieve this goal, an SMR would have to be realised in the period between 2035 (the earliest possible date) and 2040. Within that timeframe, only generation 3 SMRs with a capacity of at least 300 MWe are realistic. In order to place these at Kooypunt, further investigation and possibly modifications to the site are necessary. Cooling is not a technical obstacle because all SMRs have the option of cooling modules. Local supply can only be realised through offtake contracts from Agriport, in which case a behind-the-meter connection could in theory be applied.

If an SMR is realised in Den Helder, it can provide a major boost for the city and the region. The SMR will supply the city with low-CO₂ electricity and the residual heat may be used for district heating. The SMR can also be used to supply electricity and steam to a high-temperature electrolyser with which 15-20 kilotonnes of hydrogen can be produced annually. Having a reliable and stable source of electricity and heat attracts businesses, for example businesses from the Amsterdam Metropolitan Area. In addition, a larger SMR brings with it 200 to 300 full-time jobs of structural and highly skilled employment. This number will be considerably higher during the construction phase of the reactor.

Role and added value of an SMR in a future energy system



4. Recommendations

This study has made clear that, based on the specified preconditions, namely an SMR before 2040, mainly large generation 3 SMRs are suitable. However, for this type of SMR it is not clear in advance whether the designated site at Kooypunt is suitable. More thorough research into the integration of specific SMR designs is required for this. We therefore propose that the municipality organise a market consultation in which interested SMR suppliers are asked to demonstrate, on the basis of a number of objective criteria, that their SMR can be accommodated at Kooypunt. In principle, the criteria need not exclude a generation 4 SMR.

We propose a process that could look as follows:

- Continue the consultation round with possible SMR suppliers, alongside Orange Hills / GE Hitachi also with other providers; establish clearly what is possible and what the interest from the market is.
- Carefully establish objective requirements, criteria and preconditions (with legal support from a procurement specialist). Also establish what the site boundaries are.
- If it emerges that exactly one provider meets the requirements, the municipality can publicly announce that it intends to start a further process with this provider. If no other provider objects, the process can proceed on an accelerated basis. If several providers can plausibly demonstrate that they can meet the requirements, a public procurement procedure may have to be launched.

- The municipality can conclude a letter of intent with the sole, or winning, provider, with the obligation to prepare a study and implementation plan. For its part, the municipality ensures that the land is temporarily reserved. In doing so, the responsibility is placed on the provider to demonstrate that it can integrate, cool and connect the SMR to the grid or behind the meter, and sell the output, and that the financing, organisation and partners for this can be made available.
- If that process turns out positively, the next step is an anterior agreement (*anterieure overeenkomst*).
- If that process does not turn out positively, the municipality can seek cooperation with other municipalities in the Kop van Noord-Holland, the province, the national government, Liander and TenneT, and investigate the possibility of including a regional SMR in the national grid.