# Status of Vattenfall's initiative for new nuclear

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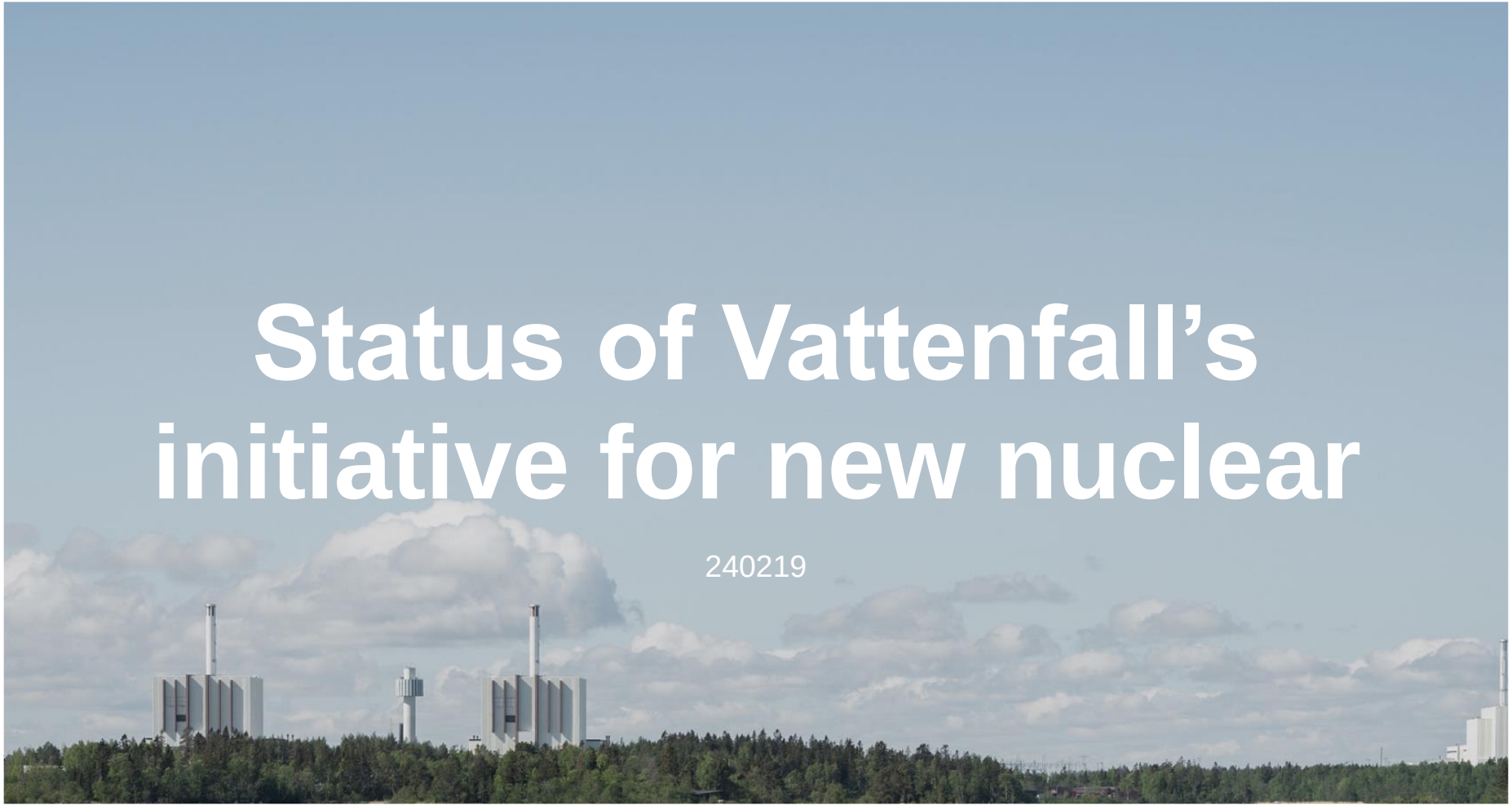
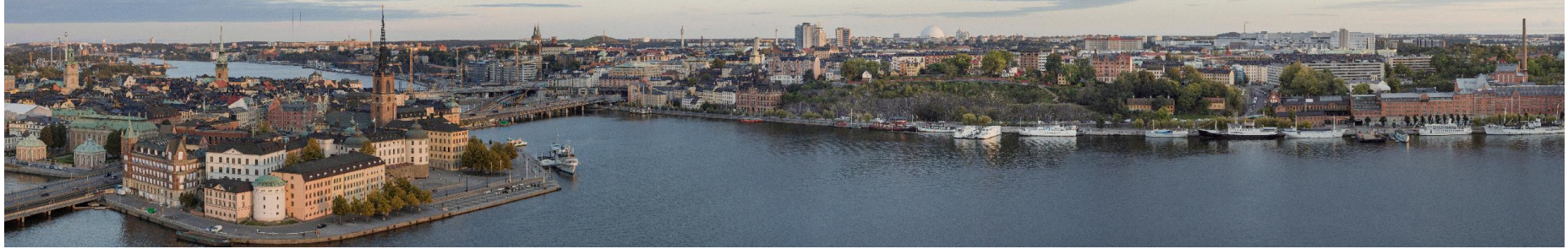


VATTENFALL

# Growing interest in new nuclear

- Increased demand
- New technical solutions
- Strong public support
- Interest from costumers
- Security of supply



Existing nuclear

# Operating time of Vattenfall's five existing reactors can be extended

**No set end date of operation**

**Operated as long as they are safe and cost-efficient**

**We investigate the possibility of operation until the 2060s**

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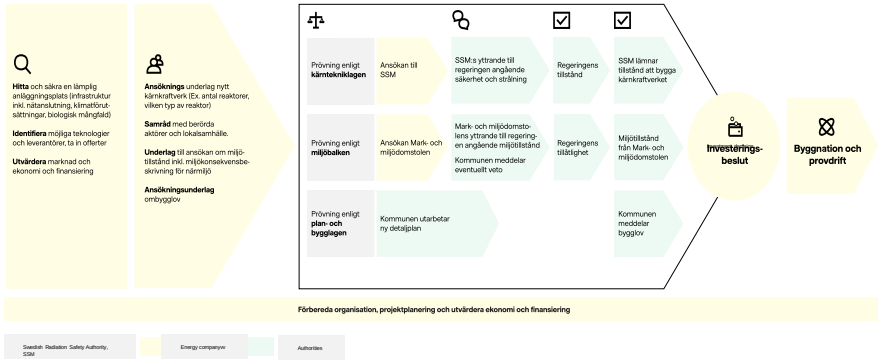
# New nuclear

# What is a feasibility study?

- A feasibility study investigates and evaluates the preconditions to carry out a specific project.
- It is an internal working material since it includes business critical and confidential information from vendor that falls under non-disclosure agreements.
- Vattenfall continuously conducts feasibility studies in all areas of our operation. In addition to the SMR study, a recent example is the feasibility study on the possibility to convert Juktan hydropower plant into a pumped storage power plant, which follows the same procedure as the SMR feasibility study.




**The purpose of the SMR feasibility study was to investigate commercial, legal and technical preconditions for Vattenfall to build at least two new SMRs adjactent to the Ringhals nuclear power plant**

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# New nuclear:
# International experiences

New nuclear: International experiences

# Experiences of completed projects

**Lessons learned from recent nuclear power projects showcase some common success factors and risk factors**

## Success factors

- Strong government involvement
- Well thought-through and focused program
- Take advantage of learning effects – Reuse same design and build several units at same site
- Experienced supply chain incl. construction contractors

## Cost drivers

- Nationally adapted reactor design
- Start of construction prior the design is licensed and/or the detailed design is completed
- Government intervention during construction
- Limited client oversight and control

Starting the construction before the detailed design is completed, and the supply chains are developed entails very high risks of cost increases and delayed projects. Projects need to be front-loaded

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# A nuclear program must include more than one reactor

**The development of a nuclear power programme can be divided into three phases**

**Construction of the first reactors**
1 -2 reactors

**Developing a viable fleet**
~3-4 GW

**Developing according to the needs of society**
> 4 GW

Phase 1 is characterized by high risks and costs – similar to other unique infrastructure projects and technology development

To benefit from the experience and development that has taken place in phase 1, several reactors need to be built in close succession so as not to lose expertise and experience

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New nuclear: International experiences

# Must include more than one reactor

## Major risk developments during a nuclear program

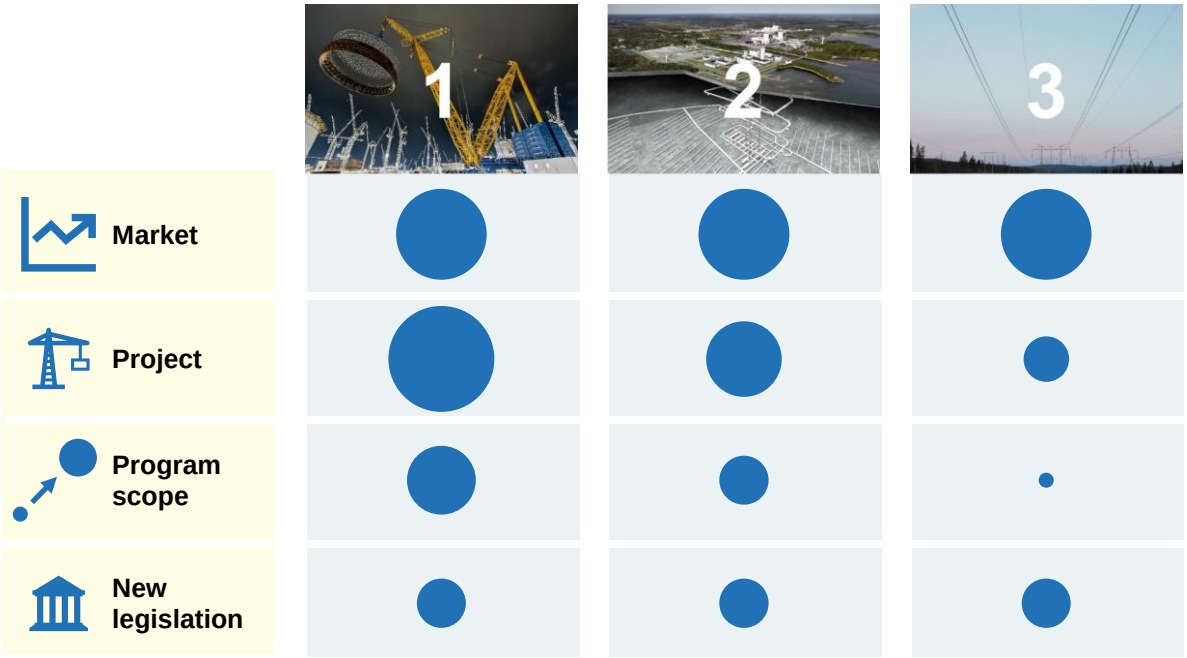


Illustration of relative risk and development over time

The risks will evolve as the program proceeds and risk sharing can be adapted accordingly

Credit guarantees will not be efficient for Vattenfall to manage these risks

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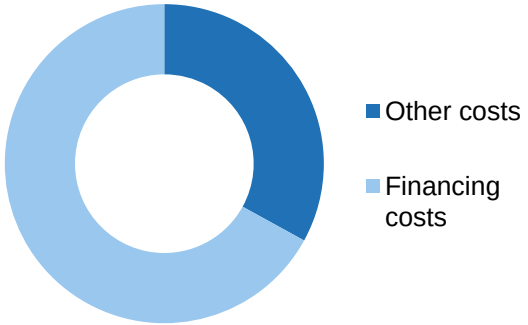
New nuclear: International experiences

# The first reactors will come with special risks – similar to other major infrastructure projects

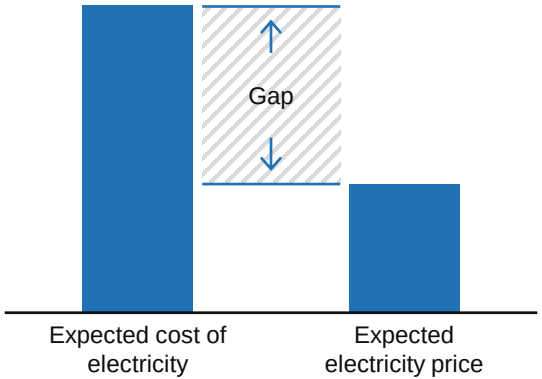
## In order for the financial costs to be manageable risks need to be shared

Order of magnitude of the components of electricity price for new nuclear




NEA: "Unlocking Reductions in the Construction Costs of Nuclear" 2020 (Real discount rate of 9%)

Higher costs and risks for the first reactors in a program create a large gap between expected revenue and cost




### International experience

Today nuclear is not built anywhere in the world on purely commercial terms (without the risk being shared with a state)

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A model for risk-sharing

# Sweden needs a risk-sharing model adapted to Swedish conditions

**UK: Hinkley Point**

Contracts for Difference (CfD)

**UK: Sizewell**

Regulated Asset Base (RAB)

**Poland**

Special purpose vehicle

**France**

State program

**Finland**

Turn key – Fixed price with state guarantees

**International examples of risk-sharing models – each one with its advantages and drawbacks**

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# New nuclear:
# Conclusions of the SMR feasibility study

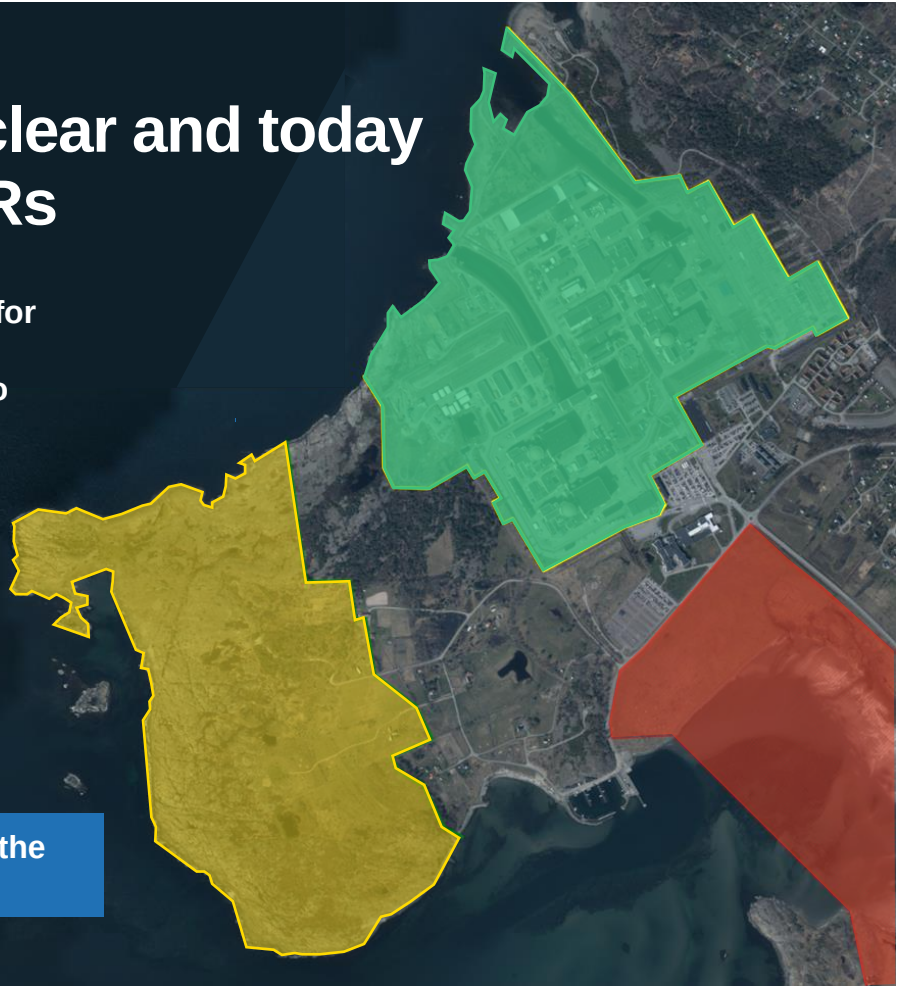
New nuclear: Conclusions of the SMR feasibility study

# The site is suitable for new nuclear and today it can accommodate 3 to 5 SMRs

The feasibility study concludes that the site is well-suited for new nuclear and may accommodate 3 to 5 SMRs, corresponding to 1 500 MW. There is good opportunities to use existing infrastructure at Ringhals, such as grid connection, cooling water tunnels and harbour facilities.

However available space on the site is limited by:

- Existing Ringhals facilities (in green)
- Biskopshagen nature preserve (in yellow)
- A Natura-2000 area (in red)



**To add additional capacity/more reactors would infringe the natural preserve which may affect schedule**

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# Existing Swedish legislation can be applied for SMR technology

Existing legislation does not prohibit SMR technology

But the permit process needs to be simplified to become more predictable and efficient

Strål säkerhets myndigheten
Swedish Radiation Safety Authority

SVENSKA KRAFTNÄT

VARBERGS KOMMUN

LÄNSSTYRELSEN
HALLANDS LÄN

VÄNERSBORGS TINGSRÄTT
SVERIGES DOMSTOLAR

**A number of authorities will be involved in our continued work**

## Nuclear Act

The permit process according to the Nuclear Act involves a stepwise approach which means that requirements on information increases as the project evolves

## Environmental Code

The environmental permit process is front-loaded and requires a lot of information at an early stage

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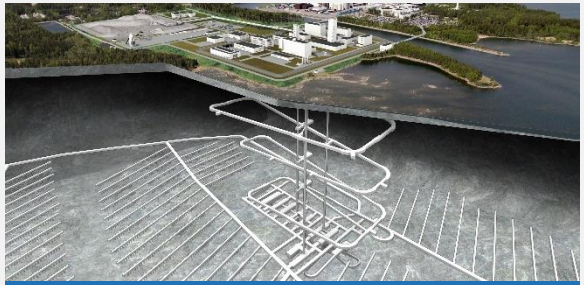
New nuclear: Conclusions of the SMR feasibility study

# Used SMR nuclear fuel can be handled with existing technology

**The conclusion is that Swedish used nuclear fuel and radioactive waste from new SMRs may be handled and stored using the same repository technology as for existing reactors**



New facilities will likely be needed due to capacity limitations and the age of existing facilities. A site needs to be investigated and new permits secured

Regarding interim storage of used nuclear fuel we recommend that a new nuclear program will use dry cask storage as this improve both safety and economy

### Size of program matters

At least 3-4 GW of new nuclear is needed for reasonable cost for new repositories

### Financing solution

The financing of a new final repository and the state's role in this need to be clarified.

### New licensing process

Regardless of new or existing facilities, a new licensing process is needed.

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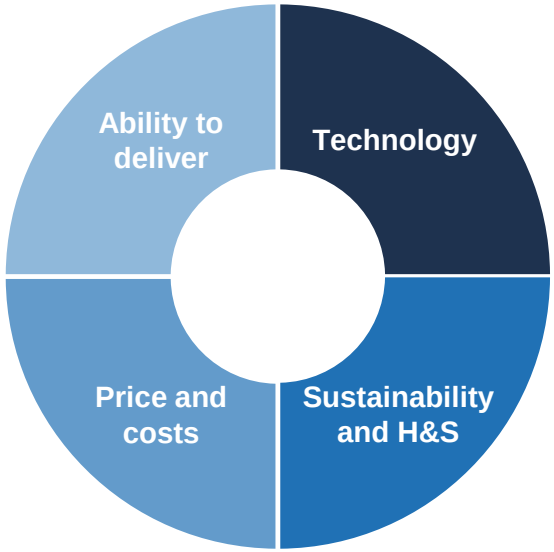
New nuclear: Conclusions of the SMR feasibility study

# Six suppliers have been evaluated according to four categories of criteria




The technology studied is mature, but more time is needed for design & modularisation

All suppliers live up to high standards of health, safety & sustainability

In all cases, close cooperation between supplier and buyer is required

Delivery models differ between suppliers

**The overall assessment is that the commercialisation of the technology will take slightly longer than previously communicated by suppliers**

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# There are good conditions for SMRs on the Värö Peninsula

**The feasibility study has given us valuable insights**

**The site is suitable, but has space limitations**

**There are good opportunities to share existing assets at the site**

**The permitting process works for SMRs but needs to become more efficient**

**Nuclear waste can be handled with existing technology, but new final repositories requires a programme**

**SMR technology remains promising**

**Risk-sharing with the state is a prerequisite for a profitable investment, also for SMRs**

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# New nuclear:
# Comparing SMRs and LSRs
## (independent of site)

# Same timeframe to for both SMRs and LSRs (large-scale reactors) to come online

## A first reactor may be expected to come online in the same timeframe – but LSRs will provide more capacity faster

**Similar timeframe for licensing can is expected** ~3 years. High uncertainty on the time required for environmental permit

**Construction work expected to start later with SMRs** due to somewhat later commercialisation

**Shorter construction time is expected with SMRs** (~4 years) compared to LSRs (6-7 years)

**It is estimated that it will require between 9-11 years from today to have the first SMR or LSR reactor go into operation**

## The technologies come with different risks – leadtime for commercialisation for SMRs but high project risk with LSRs

**Timing of commercialisation is main uncertainty with SMRs**

Modularisation and supply chain are expected to mature rapidly provided that potential clients are willing to take an active part in technology developments

**Project complexity** due to how large projects will be is the **main risk with LSRs**

**Delays and cost increases lead to considerably higher** costs in absolute terms

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# Comparing SMRs and LSRs

**Speed**

LSRs can add large capacity faster

**System resilience**

SMR reduces system impact of downtime

**Budget**

Budgets and time plans have been continuously underestimated with LSRs

**Physical footprint**

Both technologies come with limited footprint – somewhat less for LSRs

**Financing**

The fact that the price per project is lower for SMRs simplifies access to capital

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# We will continue to plan for new nuclear on the Värö peninsula

**Preparatory work for new nuclear on the Värö peninsula continue, including both LSRs and SMRs in order to create the most favorable preconditions for a successful project**

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# Next steps on the Värö peninsula

**We continue our work with the objective to have a first reactor in operation during the first half of the 2030s. We will enhance our insights with the following work streams relevant for both LSRs and SMRs**

## Delivery models

Consequences with different delivery models

## Applications

Continue to prepare applications according to both the Environmental Code and the Nuclear Act

## Ensure site availability

Complete real-estate acquisition

Advance the analysis of impact on the nature preserve

## Public consultation

Perform public consultation in the spring of 2024

New nuclear – next steps

# Proceed with LSR evaluation

**LSR evaluation involves supplier dialogue to update learnings from previous projects. Results can be expected during the spring**

## Building-phase evaluation

Analys how personnel and materials can be handled on the peninsula during construction

## Cost

Extended supplier dialogue on costs and delivery models

## Time plan

Timeplan based on recent or on-going supplier projects

## Geographical footprint

Updates based on most recent supplier project at our construction site

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# Vattenfall can make investment decision when:

**Investment is expected to be profitable**

| | |
|---|---|
| **Political support for a nuclear program** | • Broad political support for a program of at least 3-4 GW<br>• Resonable risk sharing with the state<br>• A financing modle for a new repository is finalised |
| **All permits in place** | • Swedish Radiation Safety Authority approves the construction of the reactor<br>• Conditions for construction with the Land and Environmental Court<br>• Building permit according to Planning and Building Act |
| **Reactor design and constructability complete** | • Completed detail design<br>• Robust supply chains |

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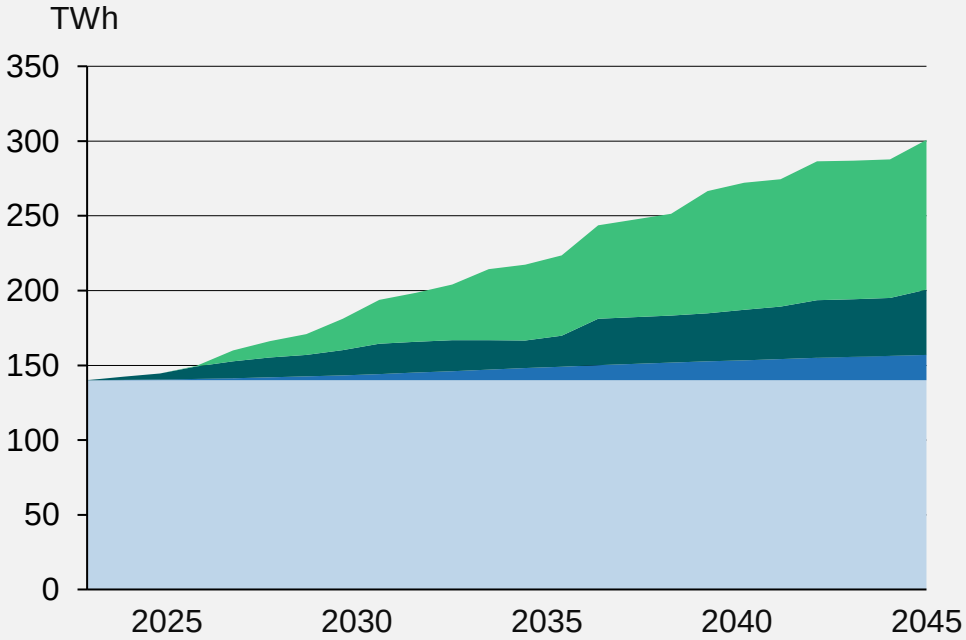
Demand growth

# Projected demand from industry and transport




Source: Vattenfall's analysis based on industry dialogue as well as "Myndighetsgemensam uppföljning av samhällets elektrifiering", December, 2022

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