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The Role of Gas and Gas Infrastructure in Swedish Decarbonisation Pathways (2020-2045)

NORDION ENERGI kraftringen Göteborg Energi ÖRESUNDS KRAFT gasnätet STOCKHOLM AB Energiforsk

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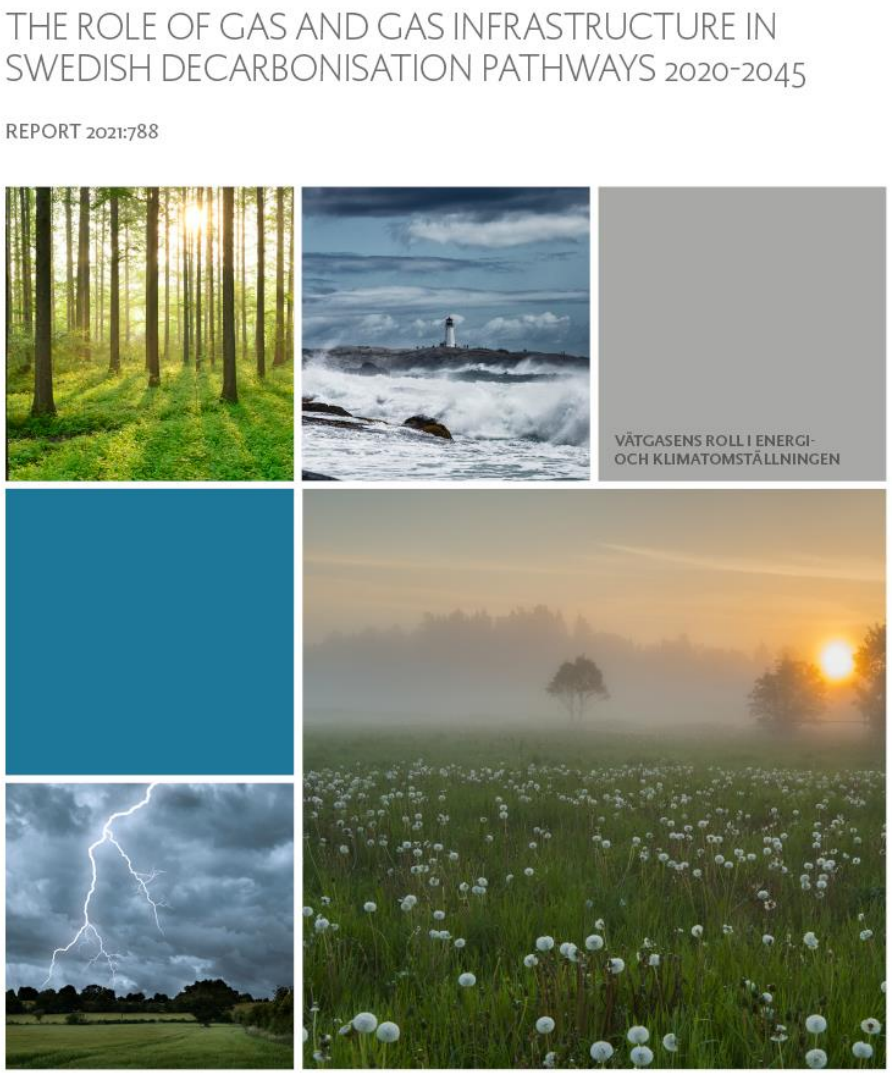


Direct Link to Report (here)

Link to introduction page (here)

Modelling Approach

This study explores the role of gas supply and gas infrastructure in achieving a net-zero Swedish energy system by 2045

- Analysis considers **4 Swedish** and **3 neighboring regions**.

Geographic Regions (x7):

Sweden & neighboring regions

Energy Carriers (x3):

- Electricity
- Hydrogen
- Methane

Seasons (x5):

- Spring
- Summer
- Fall
- Winter
- Winter Peak

Model Years (x6):

2020, 2025, 2030, 2035, 2040 and 2045

Time Granularity:

24hr profiles for each season

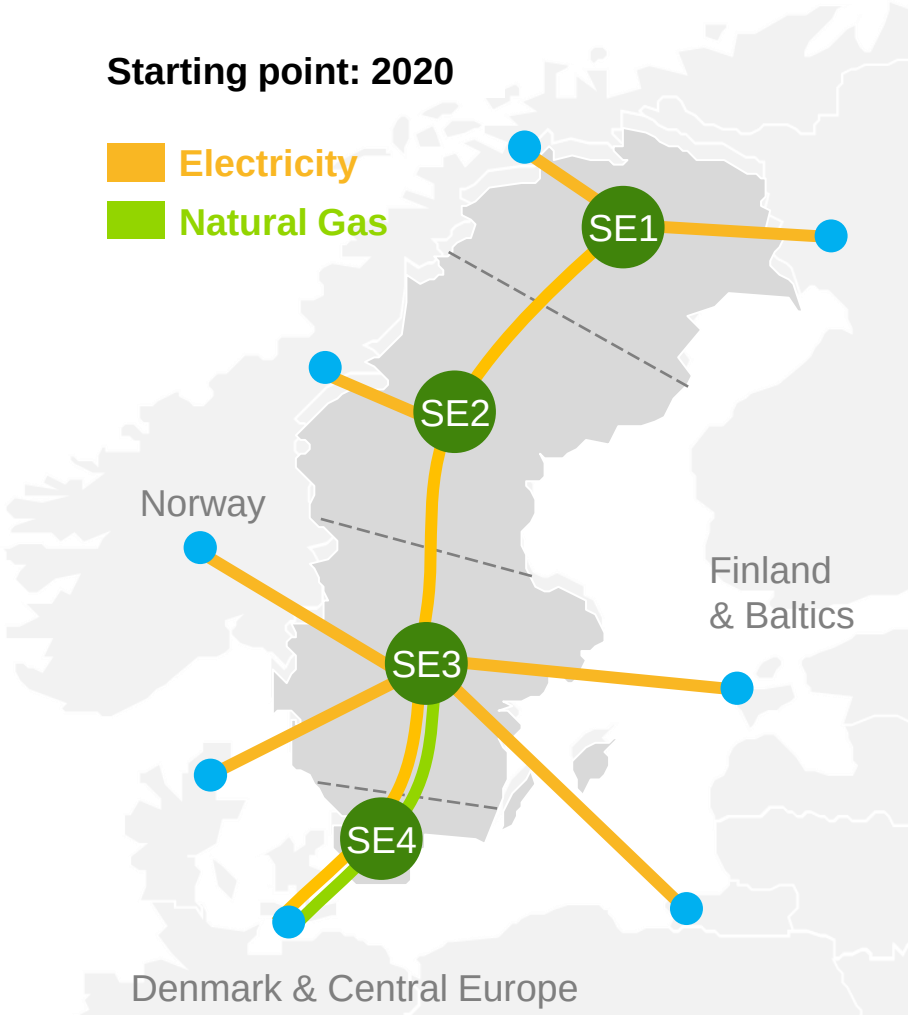
- **Two main scenarios** of 2020-2045 energy demand:

Major Role for Gas	Gas plays prominent role across industry, transport, and building heating
Limited Role for Gas	Gas plays more limited role in demand sectors

- To stress-test results, study consider **5 sensitivities**:

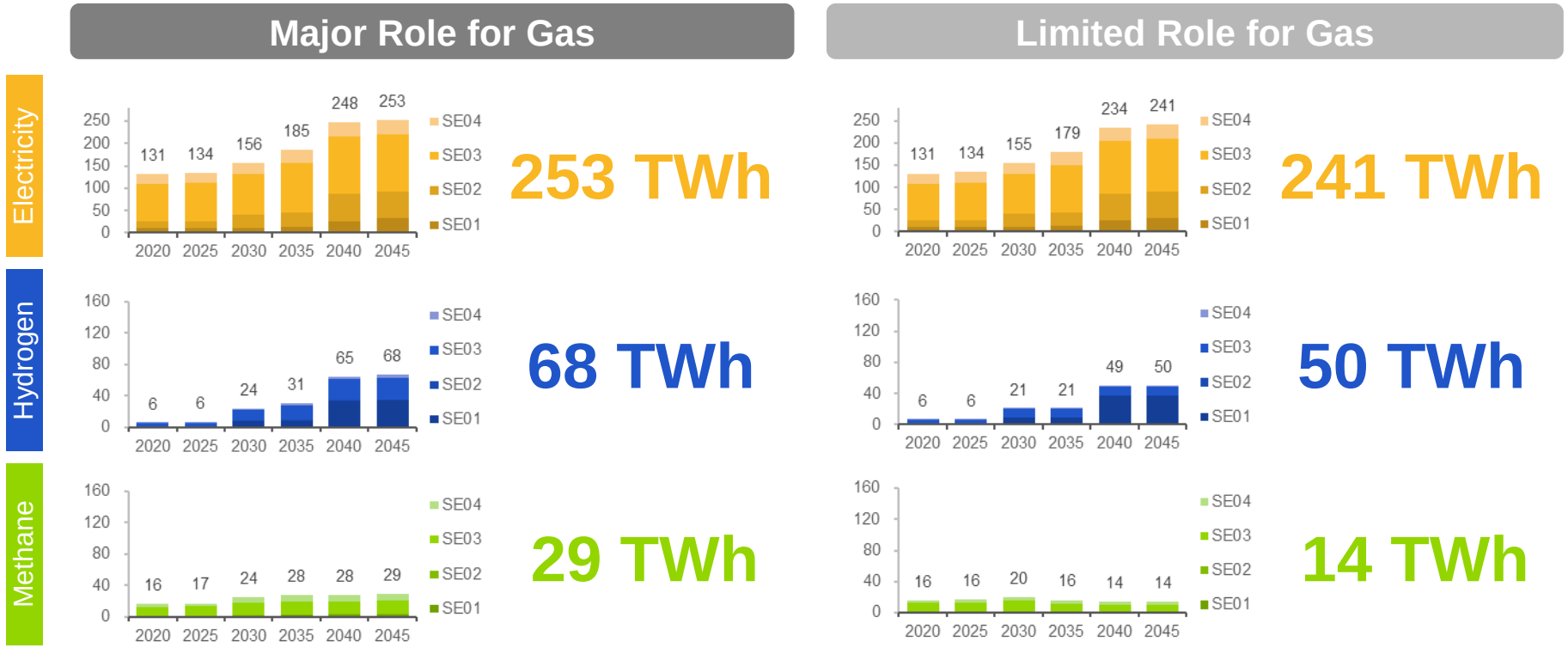
1. Low H_2 import costs	Impact of low H2 import costs
2. Low H2 Infrastructure costs	impact of low H2 infrastructure costs
3. Low Electrolyser Costs	Impact of low electrolysers costs
4. Extended Nuclear Lifetime	Impact of extending the nuclear lifetime to over 60yrs
5. High Electricity & H2 Demand	Impact of a higher electricity & hydrogen demand forecast

Starting point: 2020



Scenarios of energy demand forecast a significant increase in electricity and gas demand from today to 2045

- Electricity demand **nearly doubles** in both scenarios, largely due to hydrogen demand.
- Hydrogen demand **increases significantly** in both scenarios.
- Methane demand **increases in one** scenario but remains **consistent in the second one**.



Regional clusters of gas demand will develop and shape the development of gas infrastructure across Sweden

- **Hydrogen** demand clusters develop in **SE1 and SE3**.
- **Methane** demand growth is largely limited to **SE3 and SE4**.

Major Role for Gas

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Analysis Results: Supply Capacity Buildout

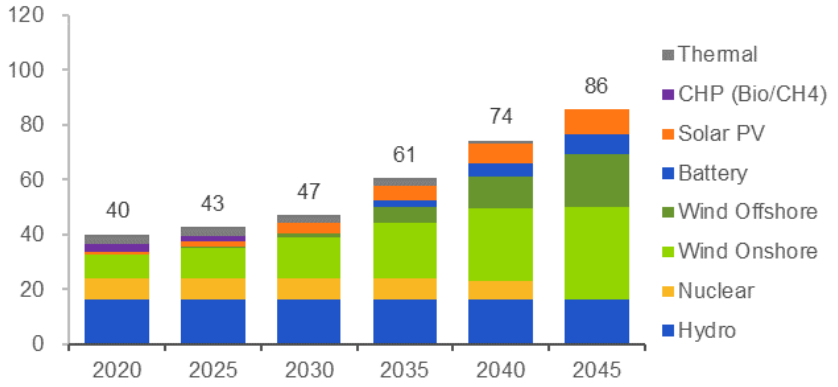
Supply capacity at the national and regional level

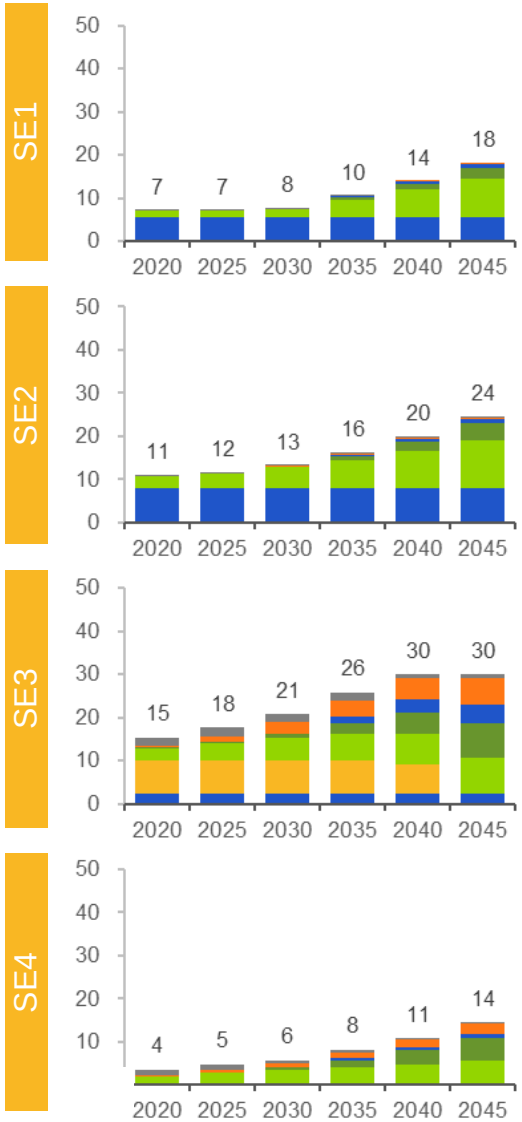
Major Role for Gas

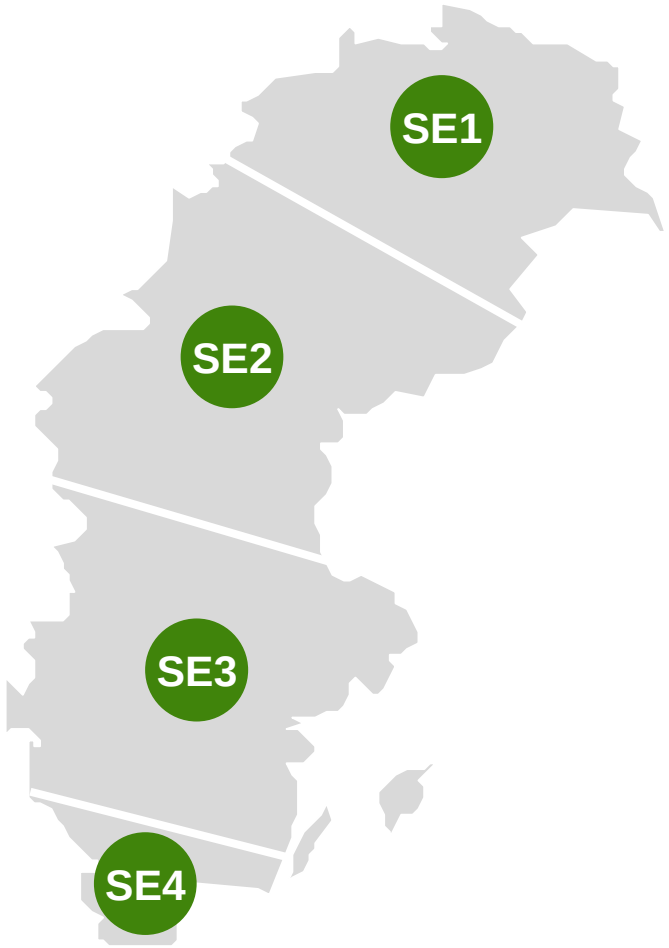
Electricity supply capacity will more than double to serve growing demand

Sweden

- **Generation capacity increase 2X** from 40 GW today to 86 GW by 2045
- Major **buildout of onshore and offshore** wind across all Swedish regions – leading to the expansion of electricity transmission interconnections
- **No major role for hydrogen** in energy supply or flexibility



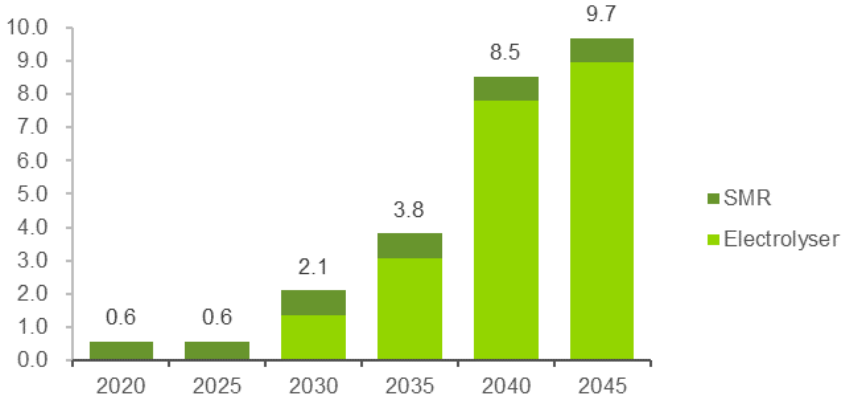


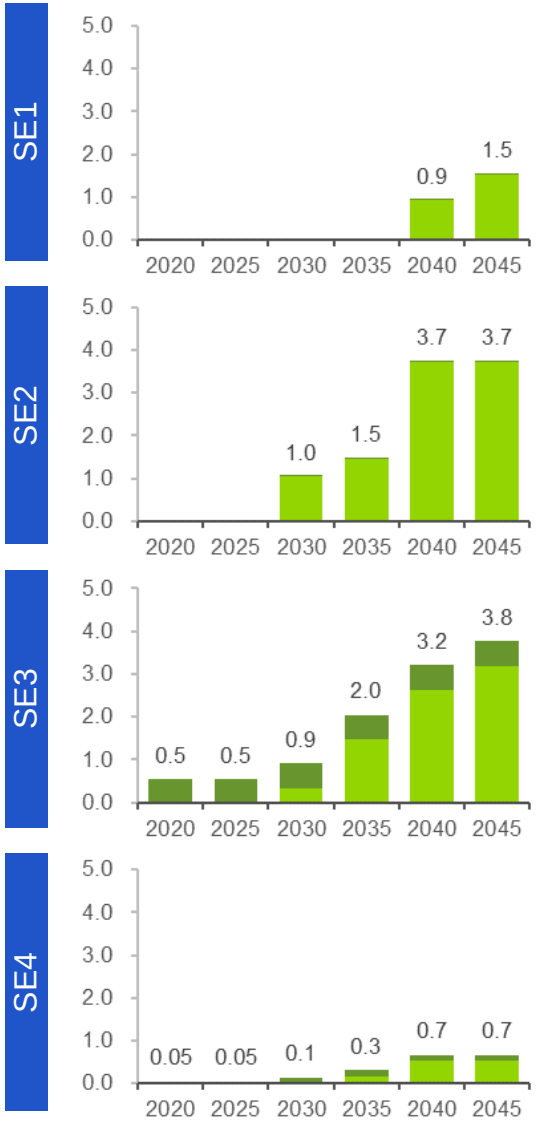


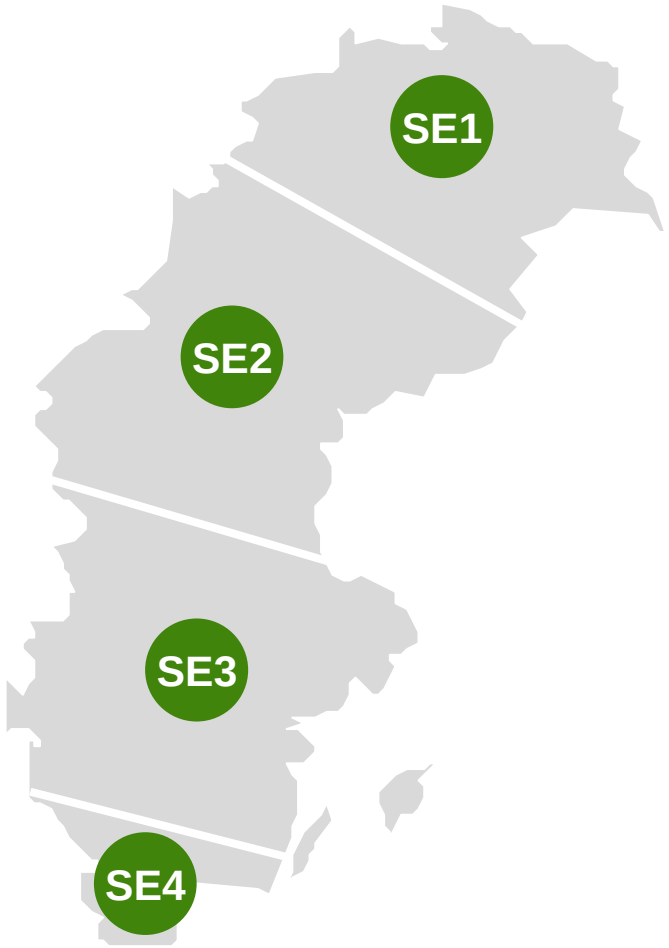
Electrolyser capacity will scale rapidly from 2030 as hydrogen demand grows

Sweden

- **Electrolyser capacity scales rapidly from 2030 to 2045** increasing to 9.0 GW_{H2} (equivalent to 12.6 GW_{Elec})
- **A significant share of electrolyser capacity is installed in SE2** to utilise an oversupply of electricity generation
- Hydrogen production via **SMR will continue to play a role**



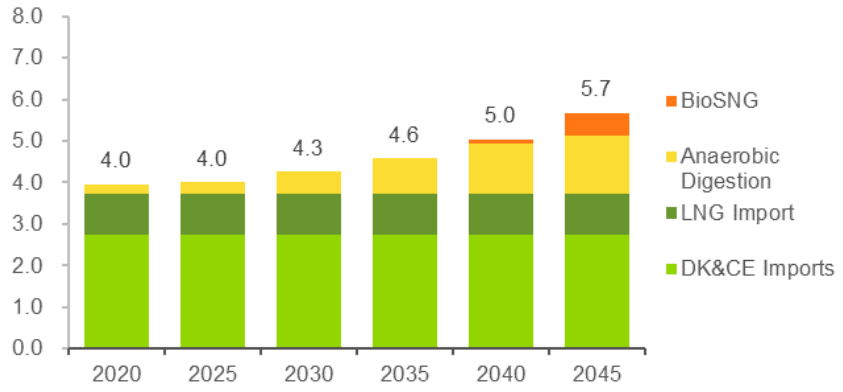


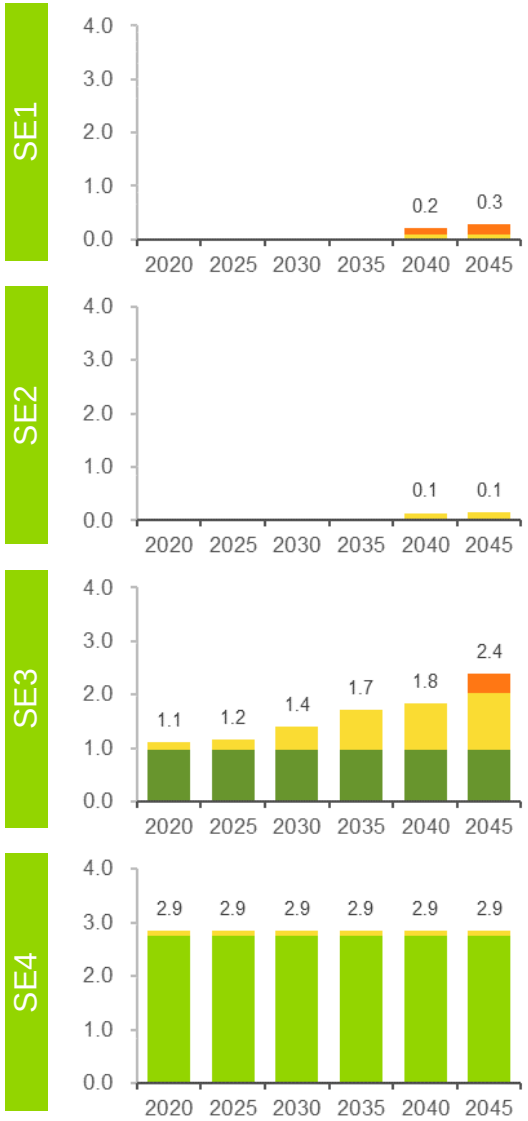


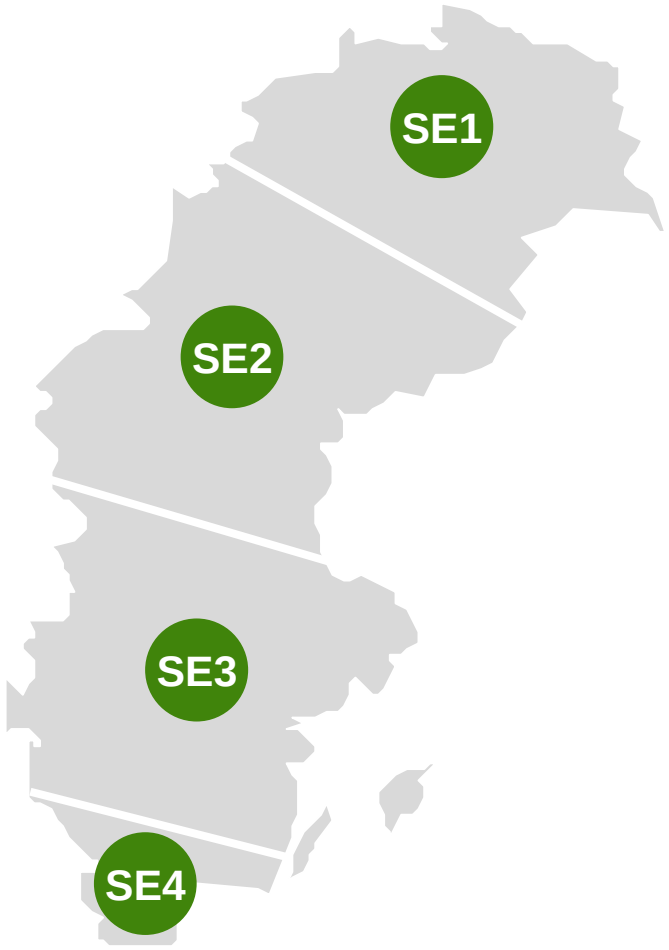
Domestic methane supply will scale steadily from 2025/2030 to 2045

Sweden

- Expansion of **existing interconnection with DK will not be needed** beyond current levels
- **Domestic methane production will scale up** displacing some share of the methane imports from DK
- **Anaerobic digestion and biomass gasification** will scale in SE3







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Analysis Results:
Infrastructure Buildout

Interconnections within Swedish regions and with neighboring regions

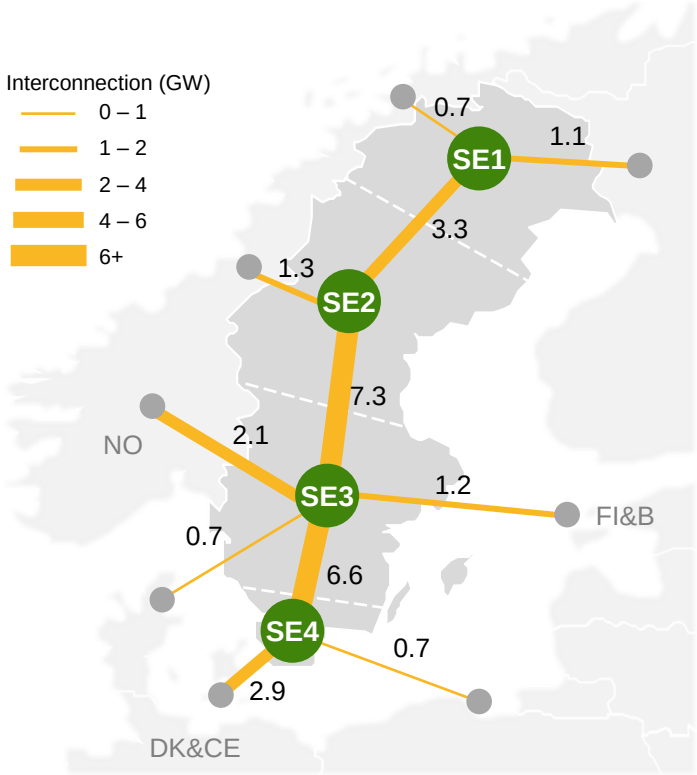
Major Role for Gas

Analysis Results

Today, gas infrastructure is limited to the south of Sweden

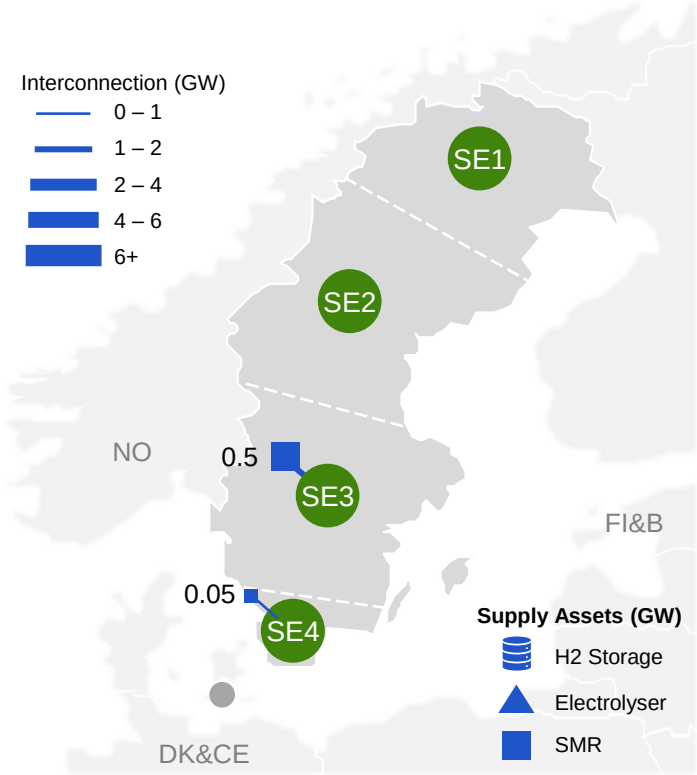
Electricity

Highly interconnected Nordic market enabled through existing transmission infrastructure.



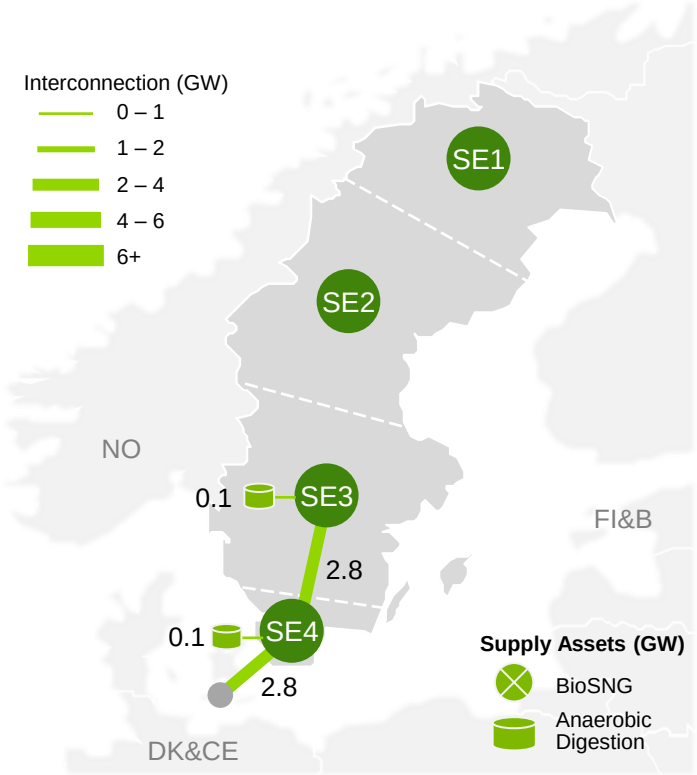
Hydrogen

No regional H_2 infrastructure exists. SMR serves existing demand in SE3/4.



Methane

Existing gas infrastructure from DK to SE3 supplies most methane demand.

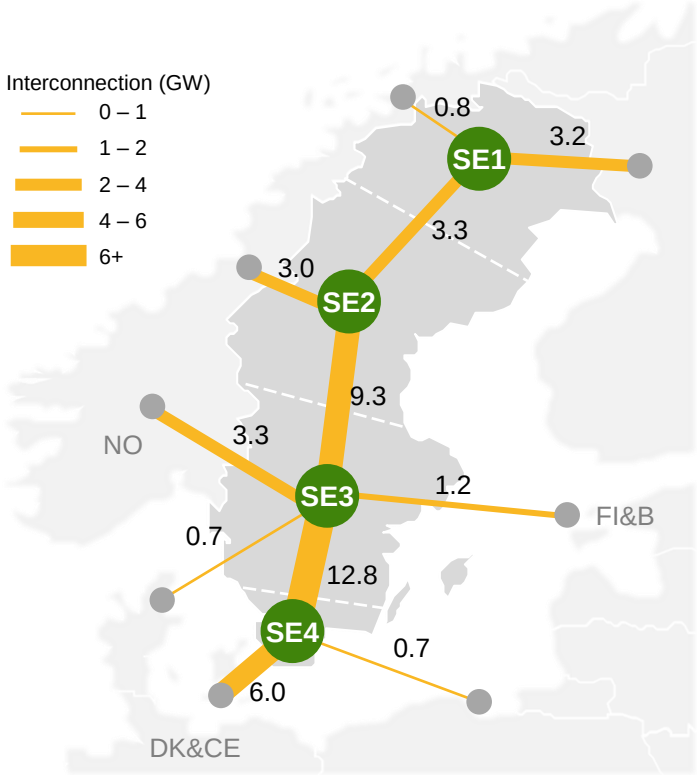


Analysis Results

By 2045, gas infrastructure will expand across most of Sweden

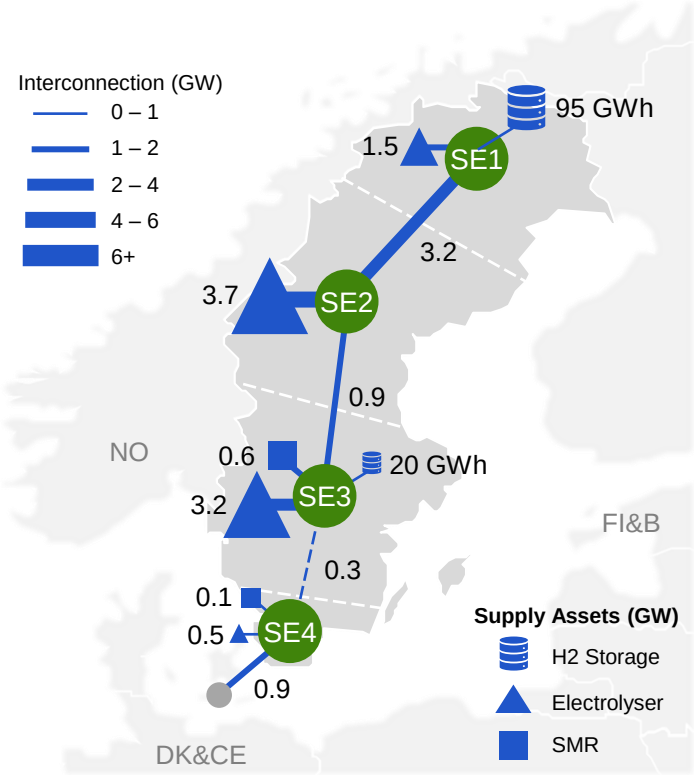
Electricity

Strong buildout of interconnection capacity to accommodate increased power flows and generation capacity



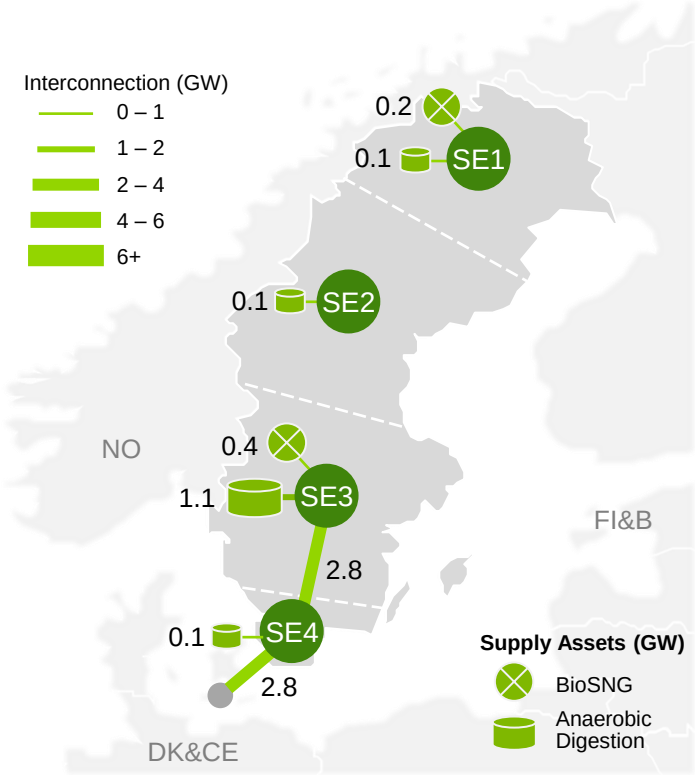
Hydrogen

A regional H_2 backbone develops between SE1 and SE3, as well as an interconnection between SE4 and DK



Methane

Domestic methane supply scales up displacing some methane imports. No expansion of methane infrastructure.



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Stress-Testing Results

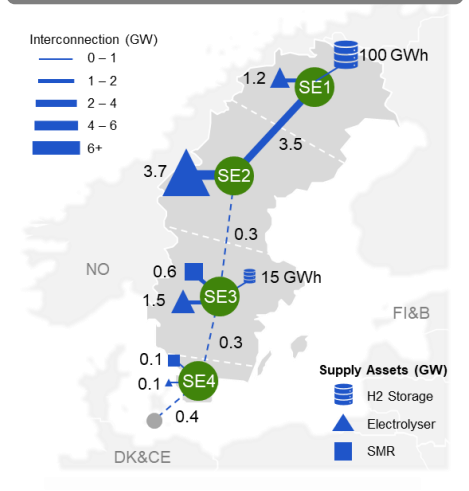
Alternative Demand Scenarios & Sensitivities

Across all scenarios and sensitivities, the development of hydrogen infrastructure remains a constant

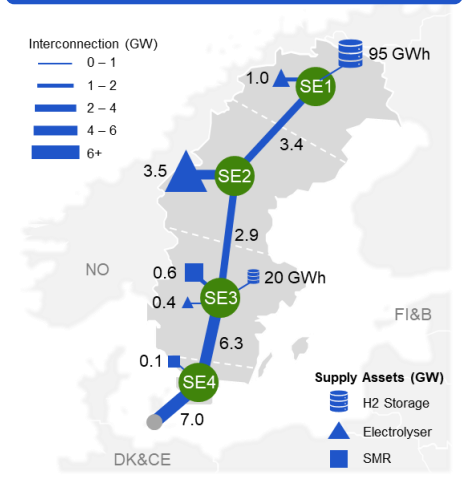
Key Messages:

1. **A regional hydrogen backbone emerges** in the north of the country
2. **Electrolyser capacity scales** rapidly from 2030 to 2045, with significant capacity installed in SE2
3. **Hydrogen production via SMR** continues to play a role in the future
4. **Hydrogen storage** is critical to optimise the balancing of hydrogen supply and demand
5. **Hydrogen infrastructure plays a complementary role** to the electricity grid

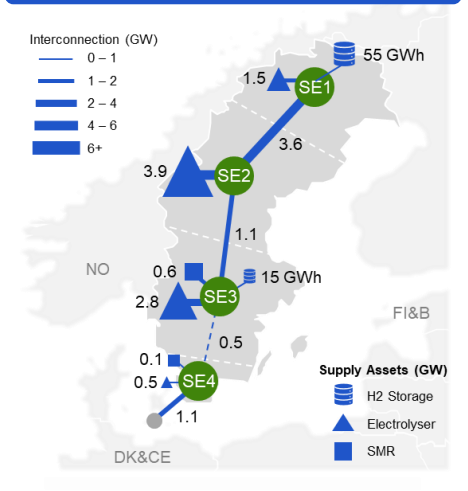
Limited Role for Gas



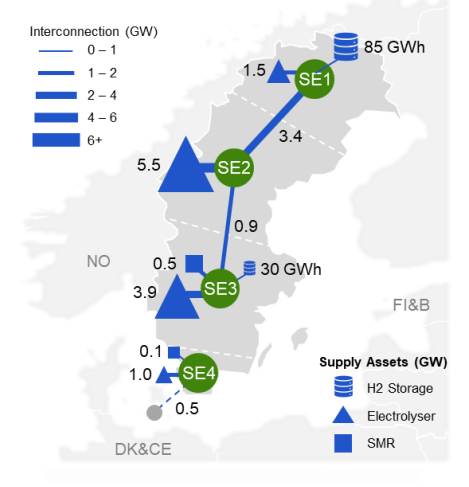
Sensitivity 1: Low H_2 Import Costs



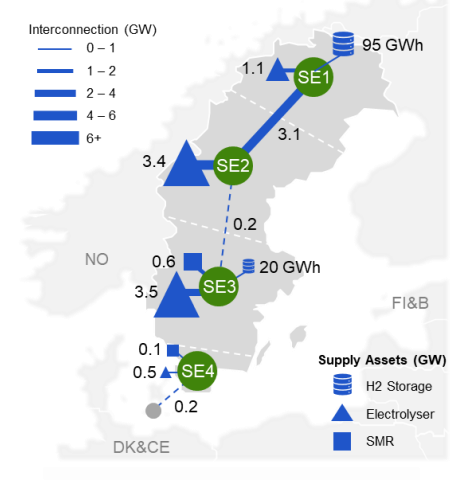
Sensitivity 2: Low H_2 Infra. Costs



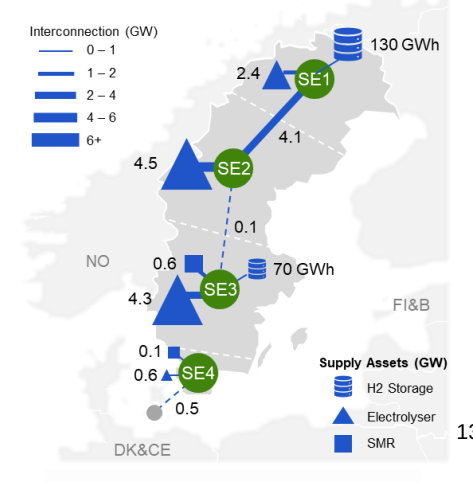
Sensitivity 3: Low Electrolyser Costs



Sensitivity 4: Extended Nuclear Life



Sensitivity 5: High Elec & H_2 Demand



Sweden has the potential to act as a hydrogen exporter to neighboring regions

Key Messages:

1. **Swedish hydrogen supply** meets nearly all hydrogen demand, with only a very small need for imports
2. **Low-cost electricity production** in northern Sweden is key in maintaining hydrogen supply cost-competitive
3. **Electrolyser capacity could scale further** in order to increase hydrogen production for exports to Denmark & Mainland Europe (via SE4) or Finland (via SE1)

Sweden as a H_2 Exporter

H_2 Interconnection with Finland

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Roadmap

To scale up gas supply and infrastructure, action is required by all Swedish energy stakeholders

2021 | 2022 | 2023 | 2024 | 2025

1. Supporting the Strengthening of the Electricity System

Several key actions are required by the TSO and other major stakeholders: identifying priority electricity transmission lines and future electricity supply capacity, engaging in proactive grid investment, developing an electricity-and-gas integrated "whole of system" planning approach, among others.

2. Setting a Clear and Decisive Decarbonisation Direction

Several key actions are required by the Government: a Swedish view on future EU hydrogen regulations, an offshore wind strategy, and guidance to Sweden's major energy stakeholders with regards to long-term planning of low-carbon and renewable gas supply.

3. Supporting the Transition of End-Users to Fossil-Free Energy

Several key actions are required by several major stakeholders: clear guidance on the application of certain market rules to the consumption of biomethane and hydrogen, a Swedish view on a potential carbon border adjustment mechanism (CBAM) and cross-industry collaboration on low carbon and renewable gas projects.

4. Developing Market Conditions for H_2 and BioCH4 Investments

Several key actions are required by public agencies: the implementation of proposals from the Biogas Market Inquiry to support the scale up of biomethane, identifying market measures to boost hydrogen demand and supply, and investigating hydrogen contracts-for-differences.

5. Preparing for a Future Hydrogen System

Several key actions are required by Nordion Energi, the Gas DSOs, and other major stakeholders: assessing future networks needs to meet hydrogen and biomethane demand, investigating the role of blue hydrogen and the need for hydrogen storage in Sweden, and analysing the potential of gas-to-power technologies in the Swedish electricity system.

6. Creating an Enabling Regulatory Environment

Several key actions are required by the Energy Markets Inspectorate: establishing electricity and hydrogen regulatory sandboxes to evaluate new, large-scale infrastructure projects, assessing its readiness to manage a large pipeline of future hydrogen and electricity projects, and conducting a consultation on hydrogen regulation and financing measures.

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