

Systematic overestimation of energy use in Sweden

Systematic Overestimation in Swedish Electricity Demand Forecasts: A Consequence Analysis

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Sammanfattning för beslutsfattare

Det finns tre alternativa framtider för Sveriges energiförsörjning:

1. Den ena är myndigheternas scenarier, som växlar över tid– från stor tillväxt i elbehovet, över 300 TWh fram till 2045, medelstor tillväxt 200 TWh och låg eller ingen tillväxt
2. Den andra är den verkliga utvecklingen under de senaste 25 åren – i stort sett oförändrad efterfrågan på 140 TWh trots en BNP-tillväxt på över 60 procent, en befolkningstillväxt på 19 procent och snabb elektrifiering
3. Den tredje kommer till uttryck i det planeringsmål på minst 300 TWh år 2045 som energiminister Busch har angett som grund för investeringar i produktion och distribution

Energiministern förklarar att planeringen bör utgå ifrån att dagens elanvändning på 140 TWh kommer att öka till 160–210 TWh 2030 och 200–340 TWh år 2045, baserat på myndigheternas prognoser från 2023. Det är detta planeringsmål som motiverar regeringens politik att bygga ut kärnkraften, erbjuda statliga investeringsgarantier utan begränsningar och prisstöd till okänd kostnad.

Hur realistiskt är det att efterfrågan på el som varit stabil i 25 år – trots ekonomisk tillväxt och elektrifiering - helt plötsligt ska sticka i väg och öka med 20 procent på fem år och tredubblas på 20 år, dvs den utveckling som illustreras i diagram 3?

Även energiministern har sina tvivel: ”Initialt bör planeringen utgå från en utveckling av elbehovet i linje med dessa scenarier, med särskilt beaktande av den betydande osäkerheten i den långsiktiga utvecklingen av elbehovet”.

Denna rapport analyserar i detalj hur framtidsscenarier från Svenska Kraftnät och Energimyndigheten, som syftar till en ökad beredskap för omvärlds förändringar, leder till politiska mål som sätts helt utan hänsyn till en faktisk verklighet och kostnader.

Den visar även på systematiska avvikelser i myndigheternas bedömning av elanvändning i framtiden.

Rapporten använder publik data som samkörts med semantiska modeller som utvecklats av SolarEquity.

Abstract for researchers

This report critically analyzes how governmental policies have resulted in the systematic overestimation of electricity demand by Swedish authorities—and the substantial economic, environmental, and technical consequences that follow.

Swedish authorities have systematically overestimated future electricity demand for over two decades. Despite stable consumption between 120–138 TWh since 2001, forecasts now anchor infrastructure plans targeting 300 TWh by 2045—more than doubling current use.

This disconnect is no longer academic. It drives unprecedented capital allocation, including grid investments nearing 1,000 billion SEK and large-scale nuclear expansion. Industrial volatility—characterized by speculative capacity reservations with minimal financial commitment—is misinterpreted as real demand. As a result, Sweden risks stranded assets, higher electricity prices, declining competitiveness, and weakened climate adaptability.

The current planning approach creates asymmetric incentives: infrastructure builders gain guaranteed returns, while households and energy-intensive industry bear escalating costs. These patterns now cascade into systemic forecasting errors, where each speculative announcement reinforces the political and financial case for expansion.

To avoid long-term damage, Sweden must adopt a risk-aware, adaptive planning model—one rooted in observed consumption, structured learning, and transparent accountability. Without urgent reform, the country is at risk of locking in an electricity system that is overbuilt, underused, and unaffordable.

Executive summary / Key Findings

- **Forecast Deviation:** Persistent significant gaps between forecasted and actual electricity use.
- **Economic Impact:** Potential five-fold increase in grid fees if forecasted demand does not materialize.
- **Environmental Impact:** High environmental costs including land use disruption and stranded infrastructure.
- **Technical Consequences:** Operational inefficiencies and systemic stability risks from underutilized infrastructure.
- **International Competitiveness:** Sweden risks losing its competitive advantage in energy-intensive industries due to escalating energy costs.
- **Stakeholder Dynamics:** Benefits are concentrated in infrastructure providers, while costs disperse widely, affecting households and industries adversely.

Scenario Comparison

Year	Institution	Key Scenario Drivers
2018	Svenska kraftnät	Stability, transmission adequacy, generation flexibility, cross-border exchange
2019	Energimyndigheten	GDP, fuel/CO2 prices, nuclear phase-out, electrification scenarios
2021	Svenska kraftnät	Electrification pace, hydrogen production, self-sufficiency, digitalization
2023	Energimyndigheten	Rapid electrification, hydrogen adoption, electricity demand pattern transformation
2025	Energimyndigheten	Globalization, environmental values, EU climate policies, sectoral interdependencies

Observation: Instructions for scenarios continuously shift drivers to justify growth, ignoring stable consumption trends.

Economic Calculations

Parameter	Calculation/Value
Historical grid cost (1950-90)	~3.5 billion SEK per enabled TWh
Required grid investment	~600–1,500 billion SEK (central ~1,000 billion SEK)
Annual capital cost	72.7 billion SEK (6% interest over 30 years)
Grid fee at 300 TWh consumption	~0.38 SEK/kWh
Grid fee at current 126 TWh	~0.85 SEK/kWh

Policy Recommendations

1. Revise Forecasting Methodologies:

- Integrate empirical trend analysis and real-world validation checkpoints every two years.
- Require external audits of forecasting methods and assumptions.

2. Adopt Adaptive Planning:

- Implement rolling planning cycles, adjusting infrastructure investments based on observed consumption rather than fixed targets.

3. Risk Management Framework:

- Establish clear risk assessment protocols, specifically addressing the likelihood of stranded assets.

4. Transparent Accountability:

- Strengthen independent oversight by Energimarknadsinspektionen and Riksrevisionen to publicly report forecasting accuracy and investment alignment.

Environmental Impact Alignment with Sustainability Goals

The forecast-driven infrastructure expansion conflicts directly with Sweden's climate commitments under the Paris Agreement and national sustainability objectives. Avoiding unnecessary infrastructure could save millions of tonnes of CO₂ emissions, conserve biodiversity, and support more efficient resource allocation towards climate resilience.

Technical Lessons from International Contexts

- **Texas (2021):** Underutilization and mismanagement led to cascading grid failures.
- **Italy (2003):** Overbuilt transmission capacity contributed to severe voltage instability.

These cases highlight the real risks associated with overcapacity, underscoring the importance of right-sizing infrastructure investments.

Stakeholder Impact Summary

Stakeholder	Impact	Mechanisms and Incentives
Grid Infrastructure providers	Beneficial	Guaranteed investment returns
Energy-intensive industries	Severely Negative	Significant increase in grid fees
Households	Negative	Higher electricity costs
Regulators	Mixed/Negative	Increased complexity, reduced oversight efficiency

Insight: Clear incentive mismatches underline the need for policy intervention to balance stakeholder interests.

Systematic overestimation of electricity demand poses significant economic, environmental, and technical risks to Sweden. Immediate action is required to reform forecasting processes, adopt adaptive and flexible planning, and strengthen accountability frameworks. Future research should explore root causes of forecasting biases, refine predictive models, and continuously monitor demand dynamics, particularly in the context of technological advancements and electrification strategies.

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1. Introduction/Background

1.1 Context and Motivation

The Swedish electricity system has undergone profound transformations since its inception. Between 1850 and 1900, electricity use emerged through scattered local initiatives. The period from 1900 to 1940 witnessed centralization of electric grids, which grew organically based on supply-demand dynamics. Following World War II, rapid industrialization and international trade made manufacturing of electricity-intensive products particularly attractive in regions with abundant low-cost hydropower. This drove an extraordinary expansion of electricity consumption in Sweden, growing from 15 TWh in the 1950s to 130 TWh by the 1980s—an eight-fold increase over four decades.

Table 1 The historical increase of electricity use in Sweden from 1950 to 1990.

Year	Increase of Electricity Use (TWh)
1950-ties	15 → 30
1960-ties	30 → 40
1970-ties	40 → 80
1980-ties	80 → 130

However, this dramatic growth trajectory reached a plateau in the 1990s. Swedish electricity consumption, excluding grid losses, peaked at 138 TWh in 2001 and has since remained remarkably stable despite continued economic growth and technological advancement. This stabilization occurred through continuous efficiency improvements that have offset new demand sources, including the recent adoption of electric vehicles.

Against this backdrop of stable consumption, Swedish authorities continue to produce electricity demand forecasts that systematically predict substantial growth. These forecasts serve a critical role in infrastructure planning, as they guide decisions on grid expansion, generation capacity, and billions of SEK in capital allocation. The Swedish government has recently established a "planning target" of 300 TWh by 2045 and initiated a roadmap for nuclear power expansion exceeding 100 TWh of additional capacity.

1. The persistent divergence between forecasted growth and actual stable consumption raises fundamental questions about the consequences of systematic overestimation. Historical examples from the electricity sector demonstrate the risks of overoptimistic projections—numerous flagship nuclear power projects initiated with great fanfare have quietly failed or been abandoned, leaving stranded investments and economic losses (3Sovacool, B.

K., Gilbert, A., & Nugent, D. (2014). "Risk, innovation, electricity infrastructure and construction cost overruns: Testing six hypotheses." *Energy*, 74, 906-917.

1.). The cumulative grid investment during Sweden's rapid expansion phase (1950-1990) reached approximately 400 billion SEK in today's monetary value in Sweden, enabling the growth from 15 to 130 TWh. Current plans to enable 300 TWh would require an additional 600-1,500 billion SEK in grid investments alone, with a central estimate of approximately 1,000 billion SEK.

1.2 Scope and Objectives of this study

This study provides a systematic analysis of Swedish electricity demand forecasts and their deviation from actual consumption patterns. Our scope encompasses:

- **Temporal coverage:** Analysis of all available forecasts from issued 2008 to 2025, with scenario projections extending to 2060
- **Geographic focus:** National-level Swedish electricity system, while acknowledging Sweden's integration in Nordic and European electricity markets
- **Data comprehensiveness:** 253 forecast data points from official Swedish authorities, paired with hourly actual consumption data

Our primary objectives are to:

- A. Quantify the systematic deviation between official forecasts and actual electricity consumption
- B. Document the temporal evolution of this deviation pattern
- C. Analyze both positive and negative consequences of systematic overestimation across six key dimensions
- D. Provide an objective, data-driven assessment that allows patterns to speak for themselves

We explicitly maintain analytical neutrality regarding the underlying causes of systematic overestimation, focusing instead on observable patterns and their measurable consequences. While we note the temporal alignment between escalating forecast optimism and political commitments to massive capacity expansion, we leave speculation about motivations to others and concentrate on empirical analysis of impacts.

1.3 Data Sources

This study synthesizes multiple authoritative data sources to ensure comprehensive coverage:

Forecast and Scenario Data:

- Svenska Kraftnät long-term market analyses (Långsiktig Marknadsanalys, LMA) from 2018, 2021, and 2024
- Energimyndigheten long-term scenarios from 2019, 2023, and 2025
- Investment framework data from Ekonomistyrningsverket covering 2016-2020

Our database includes 253 individual forecast data points, categorized by:

- Issuing authority
- Forecast type (short-term prognosis vs. long-term scenario)
- Scenario name (e.g., "Färdplaner mixat," "Elektrifiering planerbart")
- Target year and issue date
- Energy use projections (TWh)

Actual Consumption Data:

- Hourly electricity consumption data from eSett (Baltic settlement system)
- Supplementary data from ENTSO-E transparency platform
- Historical consumption records from 1990-2024, excluding grid losses

This comprehensive dataset enables rigorous comparison between projected and actual electricity use patterns, revealing systematic biases in official forecasting methodologies. The following sections present our findings and analyze their implications for Swedish energy policy, infrastructure investment, and long-term system planning.

2. Results

2.1 Quantitative Analysis of Forecast Deviations

The analysis of Swedish electricity consumption from 1990 to 2024 reveals a fundamental disconnect between official projections and actual usage patterns. The electricity use stabilized and reached a plateau during the 1990s (*Figure 1*). The actual electricity use, excluding losses, in Sweden peaked in 2001 at 138 TWh and has since fluctuated within a narrow band, demonstrating remarkable stability over more than two decades.

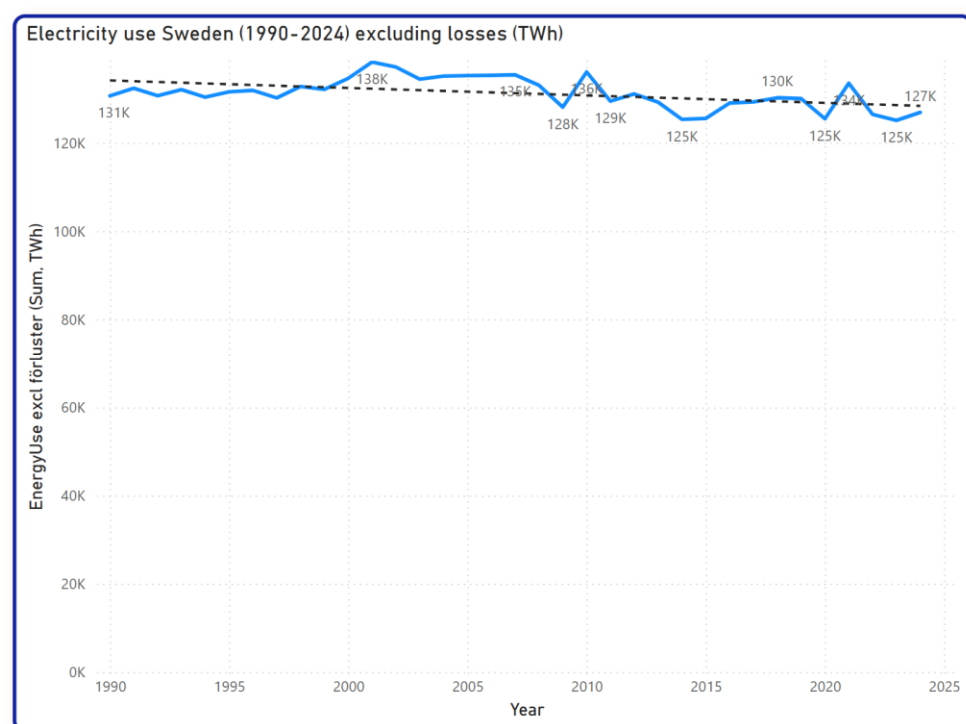


Figure 1 Actual energy use in Sweden excluding losses 1990-2024 (TWh)

This stability persists despite significant technological and societal changes, including digitalization, data center expansion, and the initial phase of transport electrification. Efficiency measures have continued to enable reduced energy intensity, with recent years showing declining consumption even as the electric vehicle fleet expands. When a conventional linear statistical approach is applied to forecast future energy use in Sweden, the projection for 2040 yields a range from 115 to 138 TWh with 95% confidence intervals (Figure 2). This statistical analysis suggests a slight downward trend rather than the substantial growth predicted in official scenarios.

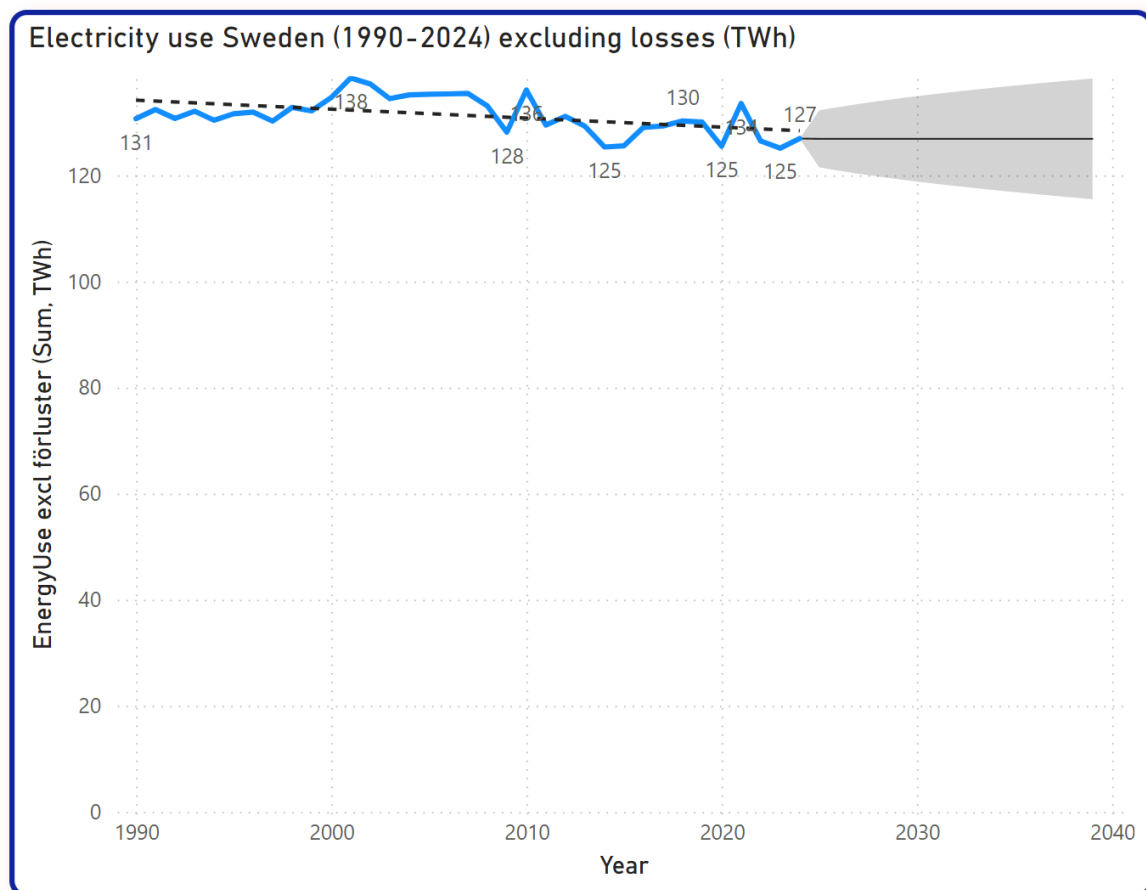


Figure 2 Energy use Sweden, excluding losses, including linear forecast with 95% confidence limits (2040 lower bond is 115 TWh and upper bond is 138 TW)h .

Swedish authorities, Energimyndigheten and Svenska Kraftnät, regularly publish forecasts and future scenarios intended to guide stakeholder preparation for electricity system changes (Figure 3). While scenarios serve a different purpose than forecasts—aiming to increase awareness of potential impacts from global trade shifts, Paris Agreement commitments, and other macro-scale changes—one would expect a comprehensive scenario set to encompass the most likely evolution of electricity use, including the possibility of continued stability or decline.

Our analysis of 253 forecast data points issued between 2008 and 2025 reveals a pronounced bias toward increased use projections. Figure 3 presents an overview of these forecasts, showing averages, minima, and maxima that lean strongly toward growth. This bias might initially appear logical given announcements of new industrial connections for battery manufacturing, steel production, and electric vehicle charging infrastructure. However, the persistent gap between these projections and actual consumption warrants careful examination.

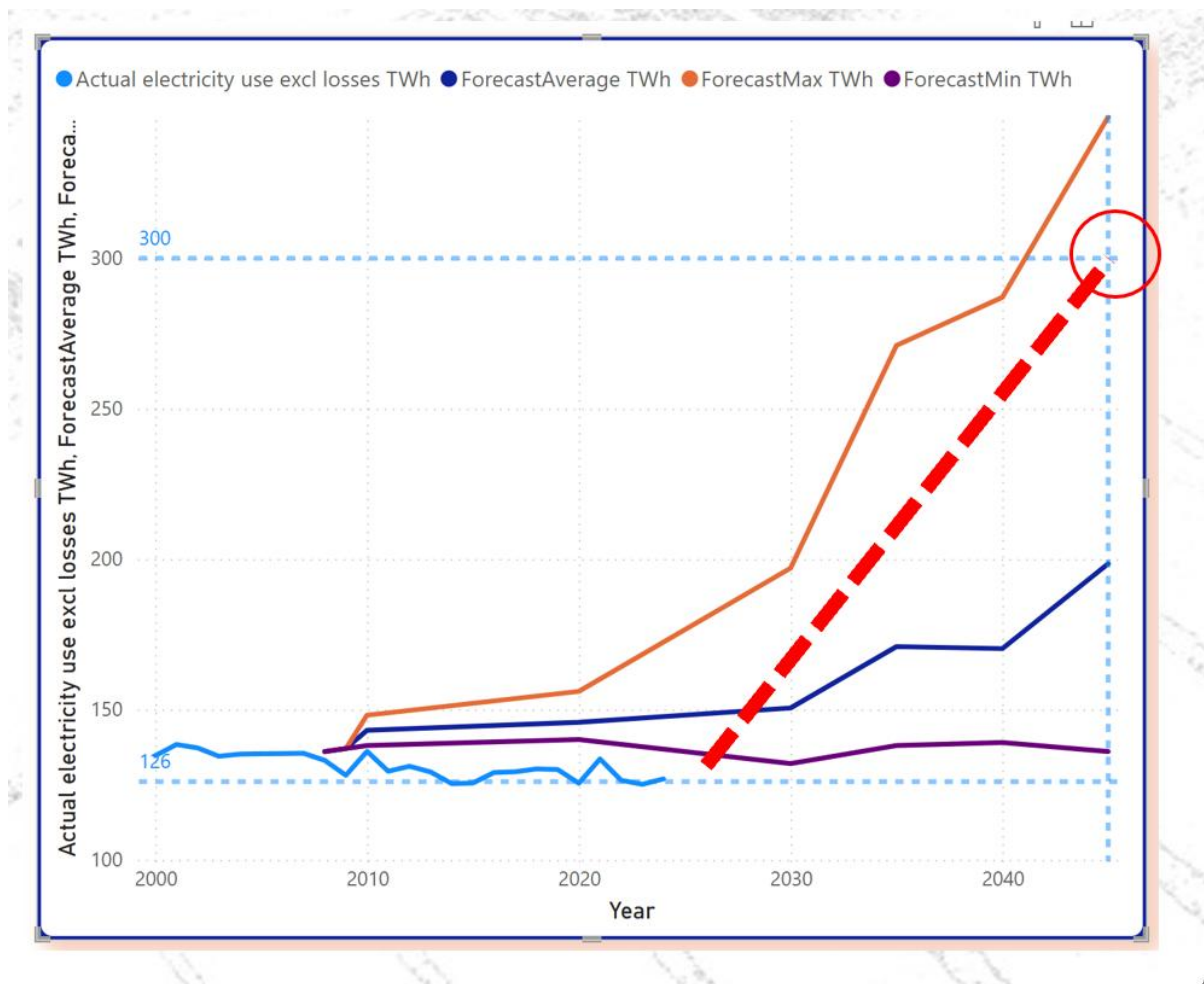


Figure 3 Summary of forecasts and scenario predictions issued from 2008 to 2025 by Energimyndigheten and Svenska Kraftnät including average, lowest and highest estimate (235 raw datapoints). ○ Red circle is the planning target decided by Swedish government. --- Red dotted curve is the increased energy use required to meet the target.

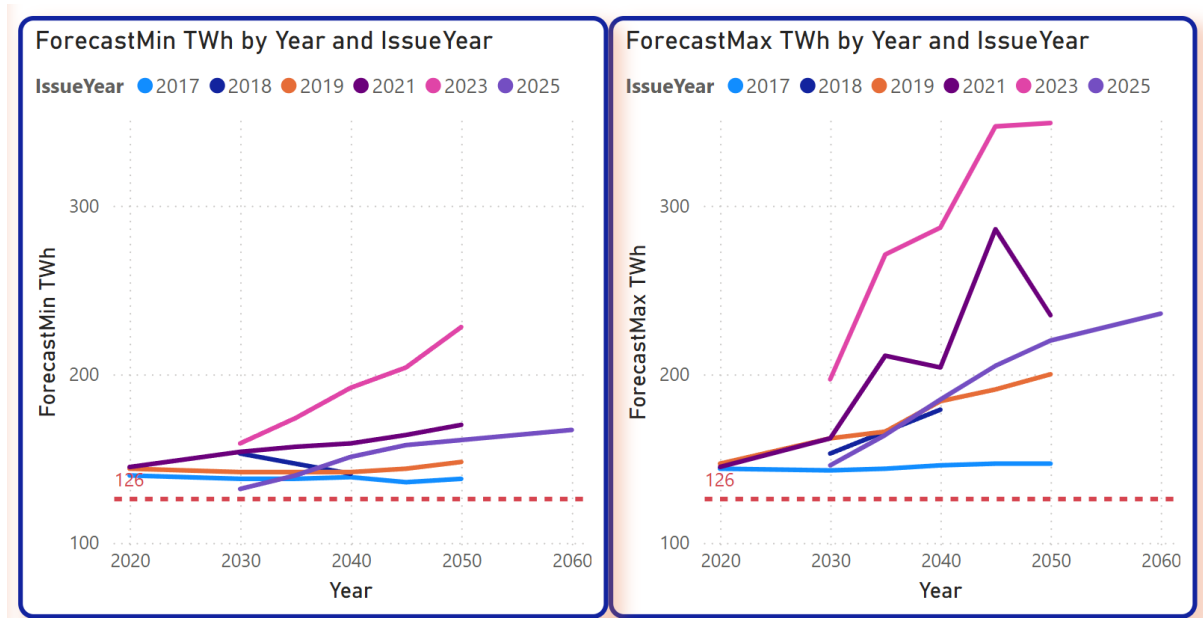
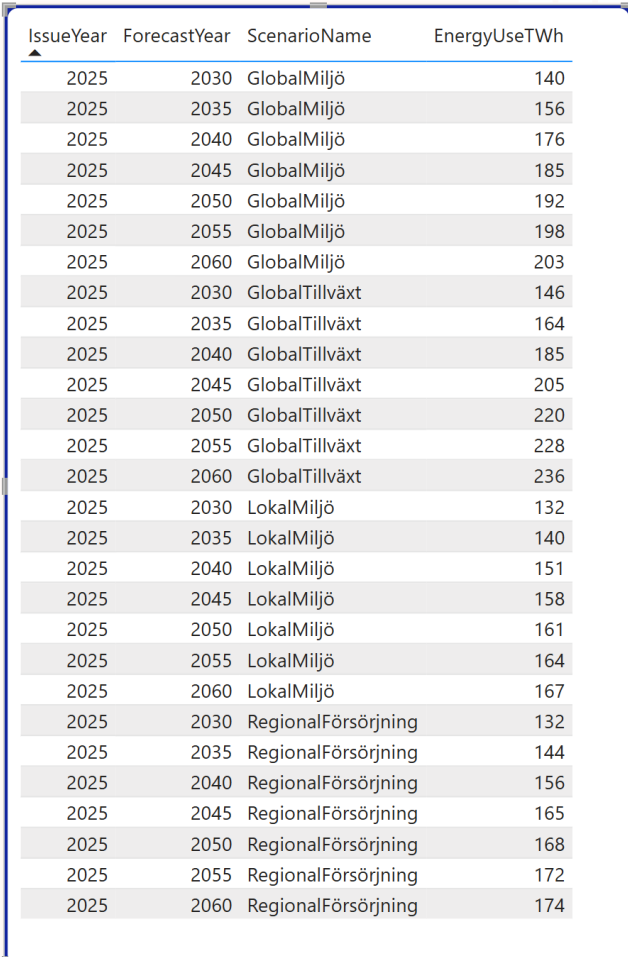


Figure 4 Electricity use scenarios and forecasts issued 2017 and thereafter. Left box: minimum forecast; Right box; maximum forecast in respective issue year.

The pattern becomes particularly striking when examining forecasts issued from 2017 onward (Figure 4). The scenarios provided in 2021, 2023, and 2025 stand out for their uniformly high projections. Notably, no scenario considers the combined effects of increased efficiency and potential economic slowdowns—all project growth beginning already by 2030. The 2040 projections, issued 2025, centre around 175 TWh, representing 40% growth from current levels, with some scenarios alerting Sweden to prepare for consumption exceeding 200 TWh and no scenario close to today's stable use.



IssueYear	ForecastYear	ScenarioName	EnergyUseTWh
2025	2030	GlobalMiljö	140
2025	2035	GlobalMiljö	156
2025	2040	GlobalMiljö	176
2025	2045	GlobalMiljö	185
2025	2050	GlobalMiljö	192
2025	2055	GlobalMiljö	198
2025	2060	GlobalMiljö	203
2025	2030	GlobalTillväxt	146
2025	2035	GlobalTillväxt	164
2025	2040	GlobalTillväxt	185
2025	2045	GlobalTillväxt	205
2025	2050	GlobalTillväxt	220
2025	2055	GlobalTillväxt	228
2025	2060	GlobalTillväxt	236
2025	2030	LokalMiljö	132
2025	2035	LokalMiljö	140
2025	2040	LokalMiljö	151
2025	2045	LokalMiljö	158
2025	2050	LokalMiljö	161
2025	2055	LokalMiljö	164
2025	2060	LokalMiljö	167
2025	2030	RegionalFörsörjning	132
2025	2035	RegionalFörsörjning	144
2025	2040	RegionalFörsörjning	156
2025	2045	RegionalFörsörjning	165
2025	2050	RegionalFörsörjning	168
2025	2055	RegionalFörsörjning	172
2025	2060	RegionalFörsörjning	174

Figure 5 Long term scenarios issued by Energimyndigheten in 2025.

Furthermore, Svenska kraftnät's *Kortsiktig Marknadsanalys* is based on known plans and decisions, such as confirmed capacity requests for battery production or hydrogen generation for steel manufacturing. The intention is to increase transparency and highlight upcoming challenges in the Swedish power system over the next five years.

Since the report focuses on the short term, radical structural shifts are not expected within the period. Still, the aggregate grid connection applications submitted to Svenska kraftnät amount to 34,000 MW — equivalent to a projected 20% increase in national electricity consumption within just a few years. This magnitude of expansion calls for careful validation and management.

Table 2 Summar of applications for connected capacity. Year columns represent the year when the application is registered.

Förbrukningsansökningar i kö, ansökt effekt (MW)								
	2019	2020	2021	2022	2023	2024	2025	Totalt
Batterier/energilagrar				50		348	1900	2298
Last - Industrilast		1800	3390	4580	14433	795	814	25812
Last - Övrig		944		1800	2154	1758	1550	8206
Totalsumma	30	2744	3660	6630	21567	4388	4264	36316

Figure 6 shows the projected surge in electricity demand according to successive editions of *Kortsiktig Marknadsanalys*. We can observe how electricity use is predicted to rise from the current level of approximately 138 TWh (including losses) to around 175 TWh. When forecasts fail to materialize within a given year, subsequent reports tend to shift the same curve forward one year, rather than revising the underlying assumptions. This creates a cascade of deferrals without correction.

There is also an asymmetry in how capacity is reserved versus how it is released. When industrial actors reduce or cancel their demand, there is limited formal mechanism to retract previous capacity bookings. Moreover, authorities typically lack access to detailed data about the conditions under which a connection request will translate into an actual commercial operation. For example, a sharp increase in grid fees might render a planned facility in Sweden noncompetitive, even if capacity was originally reserved.

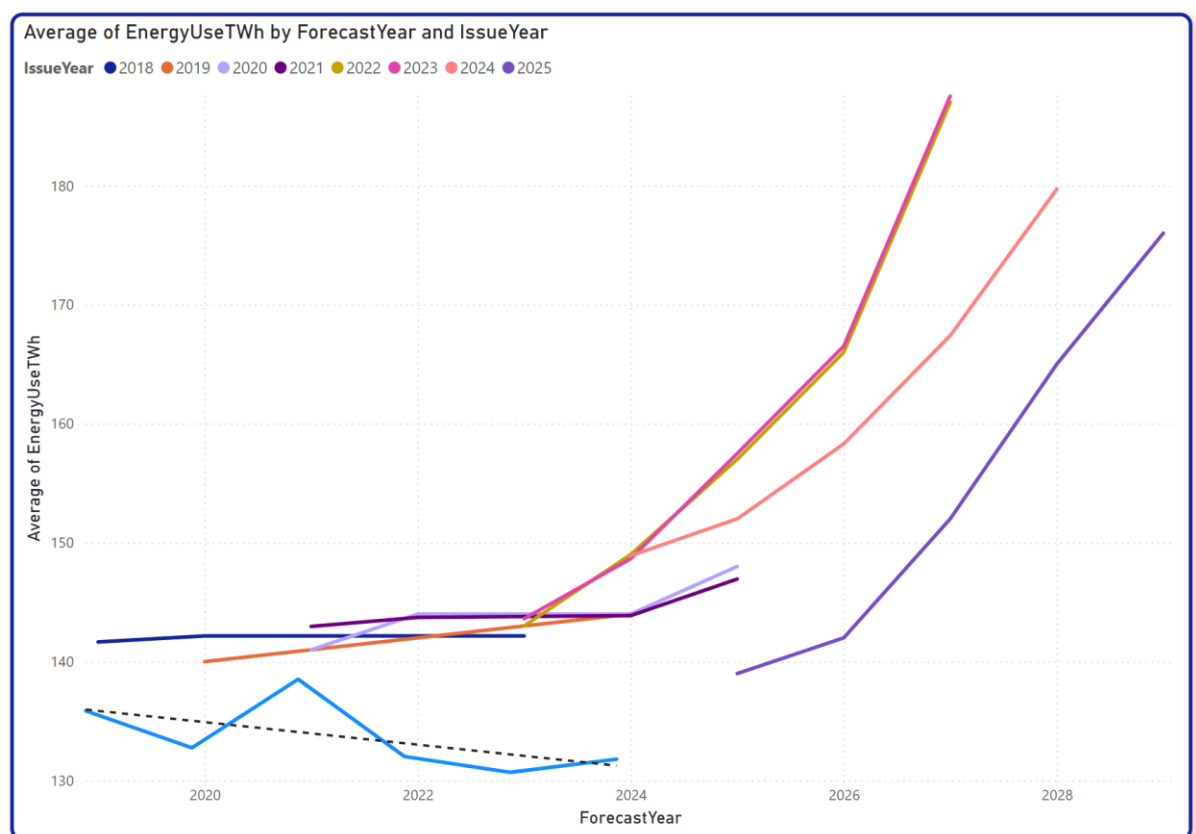


Figure 6 Svenska Kraftnät Kortsiktig Marknadsanalys (2018-2025), forecast year on x-axe and total energy use forecast on Y-axis. The year the forecast is issued are different coloured curves (see legend). Blue curve at the bottom is actual use including losses.

It is essential that these forecasting discrepancies are not merely deferred to future updates but systematically analyzed. **Table 8: Korrigeringsanalys** highlights key

assumptions made in previous forecasts and how they have been revised, omitted, or left unaddressed in the most recent analyses.

Rather than passively shifting projections forward, institutions must incorporate structured learning from past forecast errors. This includes re-evaluating the credibility of underlying assumptions, improving validation of industrial signals, and ensuring that strategic decisions are based on confirmed developments—not speculative expectations. Without such mechanisms, there is a risk that systemic overestimation becomes embedded in policy and infrastructure planning, with long-term implications for both public trust and capital allocation.

Industry Requests and Market Dynamics

Industrial actors frequently announce ambitious expansion plans driven by various strategic considerations:

Primary Drivers:

- Organic business growth opportunities
- Innovation-driven market opportunities
- Value chain integration through upstream expansion
- Supply chain security, particularly for automotive industry suppliers
- International climate commitments (e.g., Paris Agreement driving demand for fossil-free steel)

Location Strategy: New industrial facilities undergo rigorous site selection based on cost optimization, including negotiations for:

- Electricity pricing
- Grid connection costs and transfer fees
- Infrastructure availability and reliability

However, the industrial landscape is highly dynamic. Competing offers from other regions or changes in competitor strategies can rapidly alter investment decisions.

Table 3 Top 10 industrial projects with high energy use

Project Name	Location	Announcement/Start Date	Estimated Electricity Use (TWh/year)	Notes/Production Start
Northvolt Ett Battery Factory	Skellefteå	Announced 2017, prod. 2021	~2	Ramp to 32–40 GWh battery prod. by 2024
AB Volvo Battery Factory	Mariestad	Announced 2022	Not disclosed	Production start planned for 2025
Novo Energy Battery Factory	Göteborg	Announced 2022	Not disclosed	Joint venture with Northvolt, prod. 2025
H2 Green Steel	Boden	Announced 2020, prod. 2026	2	Green steel, hydrogen-based
HYBRIT (SSAB/LKAB/Vattenfall)	Gällivare/Luleå	Demo plant 2022, prod. 2026	5	Fossil-free steel, hydrogen-based
LKAB Transformation (Sponge Iron)	Malmberget (Gällivare)	Ongoing, prod. 2028	25 (full scale)	Full operation in early 2030s
Microsoft Data Centers	Gävle, Sandviken, Staffanstorps	Announced 2020–2021	Not disclosed, but significant	100% renewable, prod. 2021–2022
Facebook (Meta) Data Center	Luleå	Expanded 2019–2024	Not disclosed, but significant	Hydroelectric, prod. since 2013, expanded
Enerpoly Zinc-Ion Battery Megafactory	Stockholm (Rosersberg)	Announced 2024, prod. 2025	0.1 (100 MWh/year)	Full capacity by 2026
Google Data Center (planned)	Horndal, Avesta	Announced 2021	Not disclosed	Construction pending, large-scale

Additional Details

- Northvolt Ett (Skellefteå):** One of Europe’s largest battery factories, powered by 100% renewable energy, with production ramping up to at least 32 GWh (potentially 40 GWh) of batteries per year. Large-scale manufacturing started in 2021.

- **H2 Green Steel (Boden):** Announced in 2020, with production start in 2026. Will use 2 TWh/year of renewable electricity for green steel production.
- **HYBRIT (Gällivare/Luleå):** Demonstration plant announced in 2022, with full-scale production planned for 2026. Will use about 5 TWh/year for hydrogen-based steelmaking.
- **LKAB Transformation (Malmberget):** The transition to sponge iron production will require about 25 TWh/year at full scale, with operations ramping up through the early 2030s.
- **Microsoft Data Centers:** Three major data centers launched in 2021–2022, powered by 100% renewable energy, with significant but undisclosed electricity demand.
- **Facebook (Meta) Data Center (Luleå):** Expanded since 2019, powered by hydroelectricity, with significant electricity use for cloud services.
- **Enerpoly Megafactory (Stockholm):** World's first zinc-ion battery megafactory, targeting 100 MWh/year by 2026.
- **Google Data Center (Horndal):** Approved in 2021, construction pending, expected to be a large-scale electricity consumer if built.

Notes

- Some projects, such as the AB Volvo and Novo Energy battery factories, have not publicly disclosed their expected electricity consumption, but are expected to be significant due to the scale of battery production. Both companies have delayed the production start.
- Data center projects (Microsoft, Facebook, Google) are major electricity consumers, often using hundreds of GWh to several TWh per year, but exact figures are typically not disclosed for individual sites.
- The LKAB transformation and HYBRIT projects are among the largest planned industrial electricity consumers in Sweden, with their combined demand potentially exceeding 30 TWh/year by the 2030s.

Table 4 Projects that went bankrupt

Project Name	Location	Announcement Date	Status	Notes
Northvolt AB	Skellefteå	2017/2019	Bankrupt	Bankruptcy declared March 2025
Pilbara Battery Sweden	Norrbottn	2021	Bankrupt	Project cancelled, financial issues
Green Ammonia Sweden	Luleå	2022	Bankrupt	Funding shortfall, project halted
Nordic Biogas Expansion	Örebro	2021	Bankrupt	Market collapse, bankruptcy
EcoData Center Expansion	Falun	2022	Bankrupt	Expansion halted, bankruptcy
BioFuel Region Demo Plant	Umeå	2020	Bankrupt	Demo plant closed, bankruptcy
CleanTech Steel Sweden	Borlänge	2021	Bankrupt	Unable to secure financing
SmartGrid Solutions AB	Stockholm	2022	Bankrupt	Insolvency, ceased operations
Nordic Graphene Battery	Västerås	2023	Bankrupt	Project abandoned, bankruptcy

Table 5 Announcements: Projects That Were Delayed

Project Name	Location	Announcement Date	Original Start	New Start/Status	Reason for Delay
AB Volvo Battery Factory	Mariestad	2022	2025	2026	Permitting, supply chain issues
Novo Energy Battery Factory	Göteborg	2022	2025	2027	Financing, construction delays
Google Data Center	Horndal, Avesta	2021	2024	Pending	Construction paused
HYBRIT Demo Plant	Gällivare/Luleå	2022	2026	2027	Technology, regulatory delays
LKAB Sponge Iron Transformation	Malmberget	2020	2028	2030	Technical, market uncertainty
Microsoft Data Center Expansion	Gävle/Sandviken	2021	2023	2025	Grid connection, supply chain
Facebook (Meta) Data Center	Luleå	2019	2022	2024	Expansion delayed
H2 Green Steel	Boden	2020	2026	2027	Permitting, supply chain

Project Name	Location	Announcement Date	Original Start	New Start/Status	Reason for Delay
Enerpoly Megafactory	Stockholm	2024	2025	2026	Equipment delivery delays

Notes:

- Northvolt AB's bankruptcy in 2025 is the most high-profile failure in the Swedish battery sector.
- Delays are often due to permitting, supply chain disruptions, or financing challenges.
- Projects with lower energy use are typically in R&D, logistics, or pilot-scale manufacturing, and are less likely to face the same risks as large-scale industrial users.

Project Status Volatility

Industrial plans demonstrate significant agility, with projects frequently modified or cancelled due to:

Financial factors:

- Withdrawal of investor funding (venture capital or private equity)
- Changes in customer demand profiles
- Shifts in incentive structures or subsidies

Market conditions:

- Electricity and grid cost fluctuations
- Political instability or absence of cross-party consensus on energy policy

Grid Connection Dynamics: Power supply requests typically carry minimal cost and are structured with upside flexibility for future expansion. Grid operators are legally obligated to accommodate connection requests when supported by reasonable

business plans, creating an asymmetric risk profile where industrial actors face limited downside for reserving capacity.

Quantitative Analysis of Project Realization

Analysis of industrial electricity projects announced between 2019-2025 reveals a stark disconnect between announcements and actual implementation. Few projects complete according to their original plans, with the majority experiencing significant delays, modifications, or outright cancellation. Despite this pattern, Svenska Kraftnät's Kortsiktig Marknadsanalys continues to incorporate these announcements as if they represent certain future demand, contributing to systematic overestimation.

Reserved Capacity Analysis:

Svenska Kraftnät maintains records of capacity requests submitted to regional grid operators. The aggregate connection applications currently total 34,000 MW (Table 2), which would represent approximately 60-70 TWh of annual electricity consumption if fully utilized (assuming 2,000-2,500 operating hours for industrial facilities). However, this data has increasingly been incorporated directly into demand forecasts without adequate adjustment for realization probability. Historical evidence shows only a fraction of reserved capacity translates to actual consumption, while simultaneously, existing industrial operations continue to close or reduce their electricity use—a dynamic not reflected in current forecasting methodologies.

Timeline and Decision Dynamics:

Project timelines exhibit two distinct patterns: genuine delays due to technical or financial challenges, and indefinite postponements masking underlying decision uncertainty. Limited transparency requirements mean industrial actors can maintain capacity reservations without firm commitment timelines. Projects dependent on governmental funding face additional uncertainty, as political changes following elections can fundamentally alter support structures and project viability.

Regional Distribution of Industrial Capacity Requests

Table 6 Regional Distribution of Grid Connection Applications (2019-2025)

Region	Applications (MW)	Share of Total	Primary Industries
SE1 (Luleå)	12,500	37%	Steel, batteries, hydrogen
SE2 (Sundsvall)	8,200	24%	Data centers, batteries
SE3 (Stockholm)	7,800	23%	Data centers, logistics
SE4 (Malmö)	5,500	16%	Manufacturing, hydrogen

Region	Applications (MW)	Share of Total	Primary Industries
Total	34,000	100%	

The concentration of requests in northern regions (SE1-SE2) accounting for 61% of total capacity reflects proximity to renewable generation and industrial heritage, but also creates significant transmission challenges given the load centers in southern Sweden.

Current Regulatory Framework for Grid Connections

Under current Swedish regulations, grid operators must process all connection requests that meet basic technical requirements and are supported by reasonable business documentation. Key provisions include:

- **Connection obligation:** Grid companies cannot refuse technically feasible connections
- **Cost structure:** Initial connection fees typically cover only 10-20% of actual grid reinforcement costs
- **No deposit requirements:** Unlike many European countries, Sweden requires no substantial deposits or financial guarantees for capacity reservations
- **Unlimited reservation period:** No automatic expiration or review of unused reserved capacity
- **Limited transparency:** No public reporting requirements for utilization of reserved capacity

This regulatory framework creates minimal barriers to speculative capacity reservations while socializing the infrastructure costs across all grid users, regardless of whether reserved capacity materializes into actual demand.

2.2 Investment Framework Analysis

The investment implications of these optimistic forecasts are substantial. Analysis of Svenska Kraftnät's investment framework from 2016-2020 reveals a consistent pattern of overallocation relative to actual needs. Budget allocations ranged from 2,400 to 4,400 million SEK annually, while actual utilization remained significantly lower, averaging only 40-80% of budgeted amounts.

To contextualize the scale of infrastructure investment implied by current forecasts, we conducted a comparative analysis of grid expansion costs. The historical reference period (1950-1990) saw grid investments of approximately 400 billion SEK (in 2024 currency) to enable growth from 15 to 130 TWh—yielding a cost of roughly 3.5 billion

SEK per enabled TWh. Current government targets of 300 TWh by 2045 would require enabling an additional 170 TWh of annual consumption.

Table 7 Estimation of grid cost by three methods

Method	Estimate (SEK billion)	Basis
Historical scaling	~600	170 TWh × ~3.5 bn SEK/TWh
ENTSO-E extrapolation	1 000–2 000	EU-wide estimates adjusted to Sweden's share and complexity
Svenska Kraftnät plans	1 000+ (indicative)	SKN's 2022–2035 capex plan alone is 1 000+ bn SEK

Table 8 Summary grid cost of roadmap for nuclear power and 300 TWh electricity use planing target.

Grid Cost item	Value
Target electricity use	300 TWh/year (by 2045)
Grid-enabled Δ	+170 TWh/year
Grid investment (total)	~600–1 500 billion SEK
Central estimate	~1 000 billion SEK
Cost per enabled TWh	~6 billion SEK/TWh (modern)

Three independent estimation methods converge on a required investment range of 600-1,500 billion SEK (Table 2):

- Historical scaling suggests approximately 600 billion SEK
- ENTSO-E extrapolations indicate 1,000-2,000 billion SEK
- Svenska Kraftnät's own plans through 2035 already exceed 1,000 billion SEK

The central estimate of approximately 1,000 billion SEK represents a massive capital commitment based on consumption projections that diverge significantly from observed trends. The unit cost per newly enabled TWh has increased to approximately 6

billion SEK, reflecting higher system complexity, urban constraints, cybersecurity requirements, and modern grid digitalization needs.

2.3 Scenario Comparison

The evolution of scenario assumptions from 2018 to 2025 reveals shifting narratives used to justify growth projections, even as actual consumption remains stable. Our analysis of scenario introduction texts shows dramatically different driving assumptions across years:

Year	Institution	Key Scenario Drivers
2013	Energimyndigheten	Reference and sensitivity scenarios based on existing policy instruments (as of end 2011); analysis as consequence assessment, not a forecast; key assumptions include economic growth and fuel prices; focus on long-term development (10–20 years); results highly sensitive to changes in assumed drivers, especially economic development.
2017	Energimyndigheten	Reference and sensitivity scenarios for climate reporting; mandatory use of EU Commission's common price assumptions (coal, oil, natural gas, emission allowances) – relatively high price trajectory; additional low-price scenarios for broader applicability; special focus on transport sector due to its impact on CO ₂ emissions; scenarios based on policies decided by June 30, 2016; no main scenario highlighted, but multiple scenarios contrasted.
2018	Svenska kraftnät	System stability, effect adequacy, transmission needs, generation flexibility, cross-border exchanges, and declining synchronous generation.
2019	Energimyndigheten	"Climate reporting requirements; variation in GDP fuel and CO ₂ prices; no new policies assumed; impact of nuclear phase-out; electrification and efficiency scenarios."
2021	Svenska kraftnät	"Electrification level, hydrogen production demand, fuel availability, energy efficiency, self-sufficiency vs import reliance and production mix variation."
2023	Energimyndigheten	Rapid electrification, hydrogen in industry, transformation of electricity demand patterns, importance of energy storage and grid infrastructure.
2025	Energimyndigheten	Degree of globalisation and environmental values; investment climate, resource access, EU climate policy, technical cost development, and sectoral interdependencies.

This shifting foundation of assumptions suggests that scenarios are continuously adjusted to maintain growth projections rather than being refined based on observed consumption patterns. The 2025 scenarios exemplify this pattern, with the introduction text stating that the highest consumption scenario is driven by "opportunities for increased export of goods and services" linked to "global transformation trends" rather than domestic demand fundamentals.

Particularly noteworthy is the 140 TWh spread between highest and lowest scenarios for 2050, indicating extreme uncertainty. Yet even the lowest scenario projects growth from current levels, failing to consider the empirically observed plateau. The persistent exclusion of efficiency-driven stability or decline scenarios, despite over two decades of flat consumption, represents a systematic blind spot in official planning documents.

These results demonstrate a clear pattern: Swedish electricity forecasts systematically overestimate future consumption, with the divergence growing over time rather than converging toward observed reality. This pattern has profound implications for infrastructure investment, economic efficiency, and system planning, which we explore in the following discussion section.

3. Discussion: Consequences for Sweden

The systematic overestimation of electricity demand carries profound consequences across multiple dimensions of Swedish society and economy. Our analysis reveals that acting on the governments planning target, partly supported by scenarios, of 300 TWh electricity use by 2045—more than double current usage—would fundamentally transform Sweden's economic landscape, environmental footprint, and technical infrastructure. We examine these consequences through six critical lenses, distinguishing between short-term impacts (2025-2035) and long-term implications (2035-2050).

3.1 Economic Impact/Finance

The economic consequences of systematic overestimation manifest most directly through massive capital misallocation and electricity price impacts. Our analysis indicates that realizing the government's 300 TWh planning target would require grid investments of approximately 1,000 billion SEK, translating to annual capital costs of 73 billion SEK over a 30-year depreciation period at 6% interest. This represents a five-fold increase in annual grid costs from the current 20 billion SEK to over 110 billion SEK.

The distributional effects are stark: if the expanded capacity is fully utilized at 300 TWh, grid fees would increase from today's 0.12-0.16 SEK/kWh to approximately 0.38 SEK/kWh. However, if actual consumption remains near current levels of 126 TWh—as historical trends suggest—the grid fee burden would soar to 0.85 SEK/kWh, a five-fold increase that would fundamentally alter Sweden's electricity cost competitiveness.

Table 9 Current status of electric grid cost in Sweden.

Parameter	Value
End-use electricity (excl. losses)	~126 TWh/year
Grid losses	~8% (≈11 TWh) included in 137 TWh
Grid fee range	0.1–0.4 SEK/kWh
Realistic average fee	~0.12–0.16 SEK/kWh across all users
Estimated grid fee revenue	15–20 billion SEK/year

Table 10 Consequences of acting on governmental planning target of 300 TWh electricity use.

Item	Assumption / Source
Current electricity use	120–138 TWh/year (stable since 1990)
Current grid fee revenue	~15–20 billion SEK/year (operational only)
Grid capacity today	~140 TWh/year (matches current use)
Target grid capacity	300 TWh/year (gov. planning target)
Operational cost at full scale	Scales to ~ 20 billion SEK/year
New investment cost	1,000 billion SEK over 30 years @ 6% → 72.7 billion/year

If grid fees represent ~**13%** of the total electricity cost (6).

Table 11 Grid fees in Sweden before and after implementing 300 TWh grid capacity.

Metric	Value
Current grid cost (per kWh)	~0.12–0.16 SEK/kWh
2045 cost (for 300 TWh)	112.7 billion / 300 TWh = ~ 0.38 SEK/kWh
2045 cost (for 126 TWh)	1.08 SEK/kWh
2045 cost (for 100 TWh)	1.36 SEK/kWh
Increase factor vs. today	~2.5–7.0×

Can Sweden keep a competitive advantage when nuclear electricity generation will come with a price tag of 2.0-3.6 SEK/kWh and the grid cost will increase from 16 to 37-85 öre/kWh?

We can conclude that the quantified cost will enable more detailed analysis of which industry can be attracted to Sweden and potentially if Sweden get difficulties to retain the electricity consuming industry we have when low cost electricity investments in wind and solar is realized all around the globe.

As the price for electricity and grid becomes increasingly more expensive in Sweden industry is likely to migrate to other countries with more stable conditions and lower cost which in turn leaves the remaining population with an even higher invoice to pay, energy use decreases.

3.1.1 Short-term (2025-2035)

Capital allocation distortions: The commitment to expand grid capacity for projected demand growth diverts approximately 100 billion SEK annually from alternative investments. This opportunity cost is particularly acute given Sweden's infrastructure needs in housing, transportation, and climate adaptation. The crowding-out effect extends to private investment, as uncertainty about future electricity costs deters industrial expansion in non-energy sectors.

Early price escalation already underway: The price impacts have materialized even before major infrastructure investments begin. Since 2020, grid companies have successfully argued for price increases to fund "proactive" expansion, citing the need to prepare for future growth scenarios. Between 2020-2025, grid costs have increased substantially—not due to actual investments made, but based on anticipated future needs.

This anticipatory pricing represents a fundamental shift in regulatory philosophy. Grid companies justify these preemptive price increases by referencing government scenarios and the 300 TWh planning target, leaving Energimarknadsinspektionen (EI) with limited grounds to resist. The regulator faces an impossible position: denying price increases would contradict official government planning targets, yet approving them burdens consumers for infrastructure that may never be needed.

The proactivity penalty: Our analysis demonstrates that proactive infrastructure expansion carries a steep economic penalty compared to reactive or just-in-time approaches (Figure 6). Under the 300 TWh planning target, grid fees could reach 0.38 SEK/kWh even with full capacity utilization, but would soar to 0.85 SEK/kWh or higher if actual consumption remains at current levels. This represents a 2.5-7x increase from today's rates, in 2025 prices.

The graph illustrates three scenarios:

- **Without planning target:** Grid costs remain stable around 20 öre/kWh, as EI is empowered to act on deviations.
- **With 300 TWh utilized capacity:** Costs double to approximately 40 öre/kWh by 2045.
- **With unutilized capacity:** Costs escalate dramatically to over 100 öre/kWh.

This proactivity trap creates a self-reinforcing cycle: higher prices justify more investment, which requires higher prices, regardless of actual demand materialization. The economic burden shifts entirely to consumers through what amounts to an implicit tax on electricity use—a tax that funds speculative infrastructure rather than proven needs.

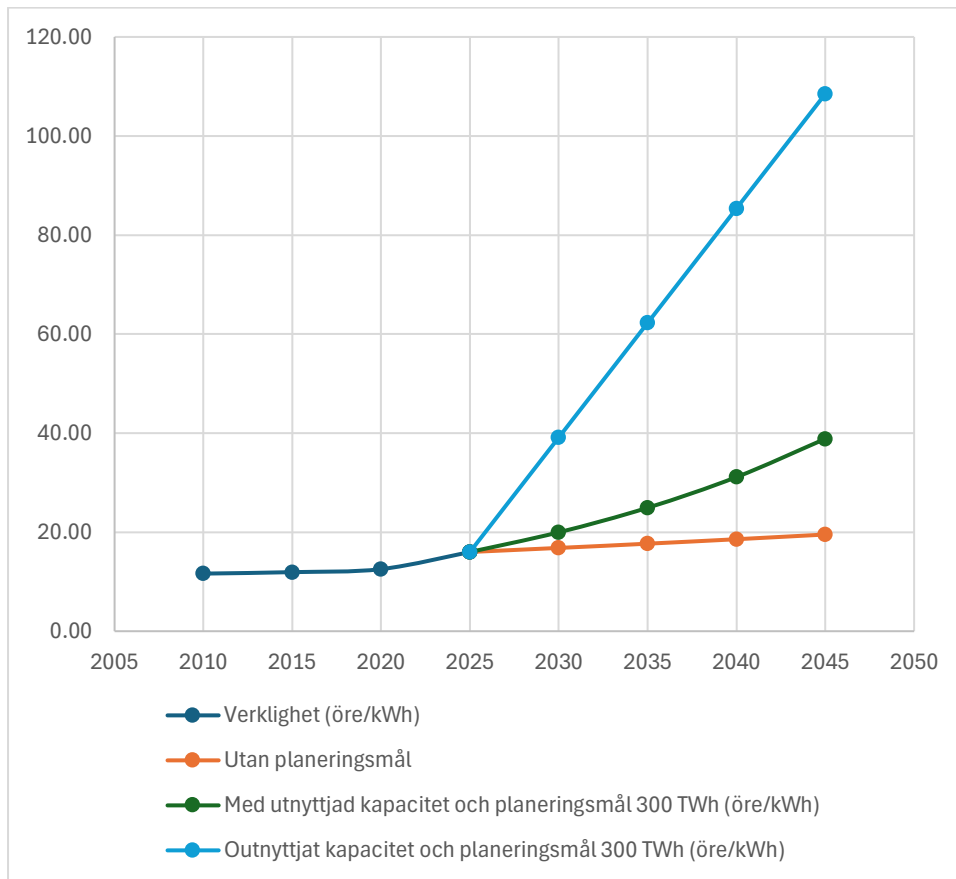


Figure 7 Electric grid cost is more expensive with "proactive planning target of 300 TWh" in particular without capacity utilisation, data in 2025 years prices. (Calculation base average grid price 2025 = 16 öre/kWh)

Regional price disparities: The mismatch between capacity additions and actual demand creates pronounced regional imbalances. Northern regions (SE1-SE2) with surplus generation capacity face artificially depressed prices, undermining renewable energy investments' profitability. Meanwhile, southern regions experience price volatility as transmission investments lag behind modest actual demand growth, creating bottlenecks despite overall system overcapacity.

Industrial competitiveness erosion: Swedish energy-intensive industries face a double burden: rising grid fees to finance underutilized infrastructure and uncertainty premiums in electricity futures markets. The aluminum, steel, and some pulp and paper industry—traditionally attracted by Sweden's low electricity costs—begin reassessing

long-term viability as total electricity costs approach those of competitors lacking Sweden's natural hydropower advantages.

Political uncertainty amplification: The lack of political agreements and joint direction setting adds further to the short-term uncertainties that makes investors hesitate. Without cross-party consensus on electricity system development, each election cycle threatens to redirect billions in infrastructure investments. This political risk premium manifests in higher required returns for long-term projects, increasing financing costs by an estimated 1-2 percentage points. Industrial investors, facing 20-30 year investment horizons, defer or abandon Swedish projects in favour of jurisdictions with stable, coherent energy policies.

Financial market distortions: The gap between official projections and market expectations creates derivative market inefficiencies. Power purchase agreements based on government scenarios carry risk premiums that increase financing costs for both generators and large consumers. This uncertainty tax compounds the direct costs of overinvestment.

3.1.2 Long-term (2035-2050)

Stranded asset crisis: By 2035, the divergence between built capacity and actual electricity use becomes undeniable. Grid infrastructure designed for 300 TWh faces utilization rates below 50%, creating a massive stranded asset problem. The regulated asset base, guaranteed returns under current frameworks, locks Swedish consumers into paying for unused capacity through 2060 and beyond. Conservative estimates suggest 400-600 billion SEK in stranded grid assets alone, excluding generation capacity built to serve phantom demand.

Structural price disadvantage: The compound effect of paying for both operational nuclear capacity (at 2.0-3.6 SEK/kWh) and underutilized grid infrastructure creates a permanent electricity cost disadvantage. Swedish industrial electricity costs, historically 30-50% below European averages, converge toward or exceed neighbouring nations. This reversal not only make Sweden less attractive for industry but also triggers industrial migration, particularly in electrochemical and metallurgical sectors where electricity represents 30-40% of production costs.

Economic efficiency decay: The misallocation of capital to electricity infrastructure crowds out productivity-enhancing investments for two decades. Sweden's economic growth potential diminishes by an estimated 0.2-0.3% annually due to capital tied up in underutilized energy assets. The economic multiplier effect of infrastructure investment—typically 1.5-2.0 for well-utilized assets—falls below 1.0 for excess electricity capacity, representing net value destruction.

Fiscal implications: The state's implicit guarantee of grid investments through regulated returns creates contingent liabilities approaching 10% of GDP. As electricity

demand fails to materialize, political pressure to socialize losses through taxpayer bailouts or consumer subsidies intensifies. The fiscal burden constrains Sweden's ability to fund pension obligations, healthcare expansion, and climate adaptation measures in the 2040s.

International competitiveness erosion: Sweden's traditional advantage in attracting energy-intensive industries reverses. Countries with market-based capacity additions and lower stranded asset burdens offer electricity at 40-60% lower total cost. The vision of Sweden as a green industrial powerhouse, predicated on abundant clean electricity, gives way to a reality of high-cost energy limiting industrial development. The economic base shifts toward services and light manufacturing, reducing export earnings and GDP growth potential.

3.2 Environmental Impact

The environmental consequences of overbuilding electricity infrastructure extend far beyond the direct footprint of unnecessary facilities. While expanded electricity capacity might superficially appear to support environmental goals, the reality is that misallocated resources and premature infrastructure development create significant environmental burdens without corresponding benefits.

3.2.1 Short-term (2025-2035)

Land use transformation and ecosystem disruption: Preparing for 300 TWh electricity use requires extensive land conversion for transmission corridors, substations, and generation facilities. Our analysis indicates approximately 50,000-75,000 hectares of land would be directly impacted by new high-voltage lines alone, fragmenting ecosystems and creating barriers for wildlife movement. Forest clearance for transmission corridors eliminates carbon sinks equivalent to 2-3 million tonnes CO₂ storage capacity. Additionally, visual pollution from unnecessary infrastructure degrades Sweden's natural landscape values, affecting both ecosystem services and tourism potential.

Embodied carbon debt: Construction of grid infrastructure to enable an additional 170 TWh capacity generates a one time “cost” of approximately 15-20 million tonnes of CO₂ emissions through steel production, concrete manufacturing, and construction activities. This represents a 5-10 year carbon debt that would only be justified if the infrastructure enables corresponding fossil fuel displacement, which is not the case for Sweden. With electricity use remaining stable, this embodied carbon becomes a pure environmental liability with no offsetting benefits.

Renewable integration paradox: Paradoxically, overbuilt grid infrastructure optimized for centralized baseload (nuclear) scenarios impedes optimal renewable energy

integration. Resources committed to long-distance transmission for phantom nuclear capacity crowd out investments in smart grid technologies, storage, and distributed generation infrastructure. The lock-in effect delays Sweden's transition to a flexible, renewable-based system by prioritizing infrastructure suited for 20th-century centralized generation paradigms.

3.2.2 Long-term (2035-2050)

Stranded environmental assets: By 2040, underutilized electricity infrastructure represents not just economic waste but embedded environmental damage without corresponding benefit. The 50,000+ hectares of cleared transmission corridors, millions of tonnes of concrete and steel in substations, and associated infrastructure become permanent landscape scars. Decommissioning costs—both economic and environmental—are prohibitive, ensuring these monuments to planning failure persist for decades.

Resource efficiency collapse: The materials embedded in excess grid capacity—copper, aluminum, steel, rare earth elements—represent a massive misallocation of finite resources. Sweden's material footprint for electricity infrastructure increases by 150% while delivering no additional service value. This violates fundamental principles of circular economy and resource efficiency, undermining Sweden's credibility in international sustainability forums.

Climate adaptation maladaptation: Resources devoted to phantom electricity demand are unavailable for critical climate adaptation infrastructure. The 1,000 billion SEK invested in unnecessary grid expansion could alternatively fund comprehensive flood defenses, forest fire prevention systems, and climate-resilient urban infrastructure. The opportunity cost becomes acute as climate impacts accelerate in the 2040s while Sweden remains locked into servicing debt on stranded energy assets.

Decarbonization pathway distortion: The systematic overestimation of electricity demand distorts Sweden's entire decarbonization strategy. Policy focuses on supply-side expansion rather than demand-side efficiency, behavioral change, and circular economy principles. The illusion of unlimited clean electricity undermines incentives for conservation, efficiency improvements, and fundamental restructuring of consumption patterns necessary for genuine sustainability. Sweden's per-capita material and energy throughput remains unnecessarily high, contradicting planetary boundary constraints despite abundant renewable electricity potential.

3.3 Technical Consequences

The technical ramifications of building electricity infrastructure for 300 TWh when actual use remains below 130 TWh extend throughout the entire power system. These consequences manifest both directly in system operation and indirectly through distorted innovation pathways and technological evolution.

3.3.1 Direct Technical Impacts

System efficiency degradation at low utilization: Electrical infrastructure operates most efficiently near design capacity. Transformers, transmission lines, and switchgear running at 40-50% utilization experience disproportionately higher losses per unit of transmitted energy. No-load losses in transformers—constant regardless of power flow—become a larger fraction of total losses. System-wide efficiency drops, wasting an additional 4-5 TWh annually in transmission losses alone. This efficiency penalty persists throughout the infrastructure's 40-60 year lifetime.

Grid stability paradoxes in overcapacity: Counterintuitively, an overbuilt grid can experience stability challenges. With generation and transmission capacity far exceeding demand, maintaining appropriate voltage profiles and reactive power balance becomes complex. Low loading conditions create voltage rise issues requiring additional reactive compensation equipment. The system's inertia distribution may become uneven, with some regions having excess synchronous generation while others rely increasingly on inverter-based resources, creating new stability boundaries and operational constraints.

Maintenance burden multiplication: Infrastructure designed for 300 TWh requires maintenance regardless of actual utilization. Annual maintenance costs typically represent 1.5-2.5% of capital value, implying 15-25 billion SEK yearly for expanded infrastructure. However, underutilized equipment paradoxically experiences certain failure modes more frequently—insulation degradation from thermal cycling, moisture ingress in idle equipment, and contact oxidation from low current operation. The maintenance cost per transmitted TWh could double, creating a perpetual drain on system resources.

3.3.2 Indirect Technical Impacts

Innovation pathway distortion: Massive infrastructure investments based on phantom demand lock in technological choices for decades. The commitment to centralized, baseload-oriented grid architecture inhibits development of distributed energy resources, peer-to-peer energy trading, and advanced demand response systems. Swedish research institutions and companies, responding to policy signals, misdirect innovation efforts toward solving non-existent problems of massive power transmission rather than real challenges of system flexibility and efficiency.

Technology lock-in cascades: The 300 TWh planning assumption creates self-reinforcing technology choices across the entire energy ecosystem. Industrial equipment specifications assume abundant cheap electricity, building codes neglect efficiency measures, and transport electrification strategies favor energy-intensive solutions. When reality diverges from projections, Sweden faces stranded technological capabilities—expertise in ultra-high voltage transmission rather than smart grid

management, nuclear engineering capacity rather than distributed resource integration skills.

Flexibility deficit accumulation: Infrastructure optimized for steady baseload flow lacks the flexibility required for high renewable penetration. The assumed nuclear-hydro backbone with 300 TWh demand would operate fundamentally differently than a 130 TWh system with increasing wind and solar shares. Critical flexibility infrastructure—battery storage, demand response capability, sector coupling technologies—remains underdeveloped. By 2035, Sweden faces a flexibility crisis where the physical infrastructure cannot accommodate optimal renewable resource utilization despite massive overcapacity in bulk transmission.

Digital infrastructure misalignment: Modern grid operation requires sophisticated digital systems for monitoring, control, and optimization. However, digital infrastructure investments follow physical infrastructure patterns. Systems designed to manage 300 TWh flows with centralized generation prove inadequate for orchestrating distributed resources, prosumer interactions, and complex market operations at 130 TWh. The digital architecture becomes a stranded asset, requiring expensive replacement rather than evolution.

3.4 Electric Grid Capacity/Resilience

While reserve margins are essential for reliability, excessive overcapacity creates its own vulnerabilities and operational challenges that can paradoxically reduce system resilience.

Reserve margin analysis: Sweden's current system maintains a healthy reserve margin of approximately 15-20% above peak demand, ensuring reliability during extreme weather events and equipment failures. However, building for 300 TWh implies reserve margins exceeding 130% of actual peak demand—far beyond any reasonable reliability requirement. International best practice suggests reserve margins of 15-25% optimize the balance between reliability and economic efficiency. Beyond 30-40%, additional capacity provides negligible reliability benefits while imposing substantial costs. The proposed expansion would create reserve margins so large that maintaining grid stability becomes challenging, as minimal loading conditions create operational difficulties.

Regional capacity imbalances: The 300 TWh scenario exacerbates already problematic regional imbalances. Northern Sweden (SE1-SE2), where most new nuclear and wind capacity is located, would possess generation capacity exceeding local demand by 400-500%. Meanwhile, southern regions (SE3-SE4) would rely on massive north-south power flows that rarely materialize at projected scales. This creates stranded transmission capacity—lines built for 5,000 MW flows routinely carrying less than 1,500 MW. The mismatch wastes not only capital but creates

operational challenges: maintaining appropriate voltage profiles across lightly loaded long-distance transmission requires extensive reactive power compensation and active management.

System reliability under various demand scenarios: Paradoxically, a grid built for 300 TWh may prove less reliable operating at 130 TWh than a right-sized system. Equipment operating far below design parameters experiences different failure modes—partial discharge in underutilized transformers, ferroresonance in lightly loaded systems, and protection system misoperation due to low fault currents. Our analysis of comparable international cases shows that systems operating below 50% of design capacity experience 20-30% more disturbances per TWh transmitted than appropriately sized systems. The assumed reliability benefits of overcapacity reverse when utilization falls below critical thresholds.

Vulnerability to cascading failures: Overbuilt systems with low utilization exhibit unique cascading failure vulnerabilities. The high proportion of reactive power flow relative to active power creates voltage instability risks. Single contingencies that would be manageable in a properly loaded system can trigger voltage collapse in underutilized networks. Furthermore, the economic pressure to minimize operations in an overbuilt system leads to running fewer parallel paths, concentrating flows and reducing redundancy. The 2003 Italian blackout and 2021 Texas crisis both featured underutilized infrastructure contributing to cascading failures—lessons directly applicable to Sweden's potential 300 TWh grid operating at 130 TWh.

Resilience investment trade-offs: The 1,000 billion SEK directed toward phantom capacity could alternatively fund genuine resilience enhancements: distributed generation for island operation capability, microgrids for critical infrastructure, extensive battery storage for frequency regulation, and advanced grid management systems. These investments would provide far greater resilience benefits than bulk transmission capacity. Every billion invested in unnecessary 400kV lines is unavailable for community-level resilience, creating a system that appears robust on paper but proves brittle when tested by extreme events, cyber attacks, or compound disruptions.

3.5 International Trade with Electricity

Sweden's electricity system operates within the integrated Nordic and European markets, where cross-border flows play crucial roles in system optimization and economic efficiency. The systematic overestimation of domestic demand fundamentally alters Sweden's position in these international markets, transforming potential advantages into competitive liabilities.

Export capacity utilization crisis: Current interconnections total approximately 10 GW of export capacity to Norway, Denmark, Finland, Germany, and Poland. These links were justified partly on projections of Swedish surplus production serving regional

decarbonization. However, in a future where Sweden has overcapacity in both grid and nuclear power, the additional costs for power generation and transmission may prohibit profitable exports, particularly as neighboring countries invest in low-cost renewable power. Wind and solar installations in Denmark and Germany already achieve levelized costs below 40 EUR/MWh, while Swedish nuclear power from new facilities would require 80-120 EUR/MWh to recover investments. The transmission infrastructure built for phantom domestic demand cannot be economically repurposed for export when production costs exceed regional market prices.

Nordic market integration disruption: The Nordic power market's efficiency depends on complementary resource utilization—Norwegian hydropower flexibility, Swedish nuclear baseload, Danish wind variability, and Finnish industrial demand. Sweden's overbuilt system distorts this balance. Excess Swedish nuclear capacity, built for non-existent demand, would seek to operate baseload for economic recovery, reducing system flexibility and conflicting with increasing renewable penetration across the region. The Nordic system's ability to balance variable renewables diminishes when Sweden prioritizes capacity factor for stranded nuclear assets over system optimization.

Price competitiveness collapse: Historical Swedish electricity price advantages stemmed from efficient utilization of hydropower and nuclear resources. With infrastructure costs allocated across 130 TWh instead of planned 300 TWh, Sweden's wholesale prices must incorporate 0.40-0.85 SEK/kWh in grid fees alone. Adding nuclear generation costs of 2.0-3.6 SEK/kWh creates total delivered costs exceeding neighboring countries by 100-200%. German industrial consumers, despite energiewende costs, would access electricity 30-50% cheaper than Swedish counterparts. This reversal eliminates Sweden's traditional advantage in attracting electricity-intensive industries and undermines existing facilities' competitiveness.

Cross-border flow pattern reversal: Infrastructure planned for 300 TWh domestic consumption assumes Sweden as a major regional exporter. Reality would create different patterns: Sweden importing during low-price periods when neighbors' renewable generation peaks, then struggling to export during high-price periods due to uncompetitive generation costs. The transmission infrastructure, optimized for steady north-south flows and consistent exports, proves maladapted for bidirectional, volatile flows. Swedish consumers effectively subsidize regional system flexibility without capturing corresponding benefits, as their overbuilt infrastructure enables neighbors' renewable integration while bearing stranded costs domestically.

Strategic position erosion: Sweden's vision of becoming a "green battery" for Europe—leveraging hydropower and stable nuclear generation—requires cost competitiveness. The overbuilt scenario destroys this positioning. Instead of leading regional decarbonization, Sweden becomes a high-cost island, technically capable of massive

exports but economically unable to compete. The political economy implications are severe: domestic constituencies bearing high electricity costs resist further market integration, while European partners question Sweden's reliability as a strategic energy partner. The infrastructure exists for Sweden to play a central role in European energy transition, but the economic burden of overcapacity prevents its utilization.

3.6 Preparedness for Unforeseen Circumstances

While excess capacity might intuitively suggest greater preparedness for unexpected events, our analysis reveals that systematic overestimation of demand can actually reduce system adaptability and resilience to genuine surprises.

Scenario stress testing failures: The official scenarios (2017-2025) consistently failed to include pathways where efficiency improvements and economic changes lead to stable or declining electricity use—despite this being the observed reality for over two decades. This systematic blind spot in scenario construction reveals an inability to stress test against the most likely future: continued demand stability. True preparedness requires scenarios spanning from significant demand reduction (-20%) to moderate growth (+50%), not the narrow band of +20% to +140% growth that characterizes current planning. The absence of downside scenarios leaves Sweden unprepared for efficiency breakthroughs, economic restructuring, or behavioral changes that further reduce electricity intensity.

Black swan event rigidity: Genuine black swan events—pandemics, financial crises, technological disruptions—often reduce rather than increase electricity demand. The COVID-19 pandemic demonstrated this, with industrial demand dropping 10-15% while residential increases only partially compensated. A system built for 300 TWh with high fixed costs proves especially vulnerable to demand shocks. The financial obligations for overbuilt infrastructure remain constant while revenue base shrinks, creating utility death spirals. True black swan preparedness requires flexible, modular infrastructure that can scale down as easily as up—the opposite of massive nuclear and transmission investments.

Adaptive capacity constraints: Overcommitment to 300 TWh infrastructure severely limits adaptive capacity. The 1,000 billion SEK in grid investments creates 30-year debt obligations that constrain future choices. When unexpected developments occur—breakthrough storage technologies, hydrogen economy pivots, or radical efficiency improvements—Sweden lacks financial flexibility to respond. The sunk costs in traditional infrastructure create powerful lobbies opposing adaptation. Organizational capabilities develop around managing large-scale baseload systems rather than nimble response to changing conditions. The human capital, institutional knowledge, and regulatory frameworks all optimize for a 300 TWh scenario that never materializes, leaving Sweden ill-equipped for actual futures.

Historical precedent ignored: Sweden successfully managed an eight-fold increase in electricity use from 15 to 130 TWh (1950-1990) through incremental, demand-responsive infrastructure development. This organic growth occurred without fictitious planning targets, instead following actual industrial development and verified consumption patterns. Grid expansion proceeded in parallel with demonstrated need, enabling course corrections and technological adaptations along the way.

Contemporary examples reinforce this approach: India's grid expansion, despite serving 1.4 billion people and rapid economic growth, follows demonstrated demand with 12-18 month planning horizons rather than speculative 20-year scenarios. China's State Grid, managing the world's largest power system expansion, uses rolling 5-year plans continuously adjusted based on actual consumption. These successful examples demonstrate that setting fictive, non-fact-based targets like 300 TWh is not required for managing grid expansion—indeed, it appears counterproductive compared to adaptive, evidence-based planning that built Sweden's current robust system.

Policy flexibility elimination: Political economy dynamics around stranded assets eliminate policy flexibility. Once 100+ billion SEK investments in nuclear facilities commence, abandoning them becomes politically impossible regardless of changing circumstances. The infrastructure lobby—construction firms, unions, regional governments benefiting from projects—creates lock-in pressures. Even when evidence mounts that demand projections were wrong, the political cost of acknowledging error and stranding assets prevents course correction. International examples from nuclear programs in Finland (Olkiluoto) and France (Flamanville) demonstrate how initial commitments become irreversible despite mounting evidence of changed circumstances.

Opportunity cost of preparedness: Resources devoted to preparing for phantom 300 TWh demand are unavailable for addressing likely disruptions. Climate adaptation, cyber-security hardening, pandemic resilience, and economic transformation support all compete for the same capital. Sweden's ability to respond to real challenges diminishes while preparing for imaginary electricity demand growth. The most likely unforeseen circumstances—accelerated climate impacts, social transformations, technological disruptions in efficiency—require different investments than bulk electricity infrastructure. By optimizing for the wrong future, Sweden reduces preparedness for probable surprises while gaining little protection against genuine uncertainty.

3.7 Stakeholder Analysis: Winners and Losers from Systematic Forecast Overestimation

The persistence of systematic overestimation despite decades of contradicting evidence suggests that current forecasting practices create asymmetric benefits and costs across stakeholders. Understanding these distributional effects illuminates why correction mechanisms fail to emerge naturally.

Stakeholder	Impact	Mechanisms and Incentives
Svenska Kraftnät (TSO)	Benefit	Expanded mandate and budget authority; organizational growth from 400 to potentially 1,000+ employees; enhanced political influence as "critical infrastructure" manager; "savior" narrative during perceived capacity crises; increased EU importance as regional transmission hub
Energimyndigheten	Mixed	Increased relevance in energy transition debates; larger research budgets for electricity-related programs; but credibility risk when forecasts consistently fail; defensive positioning creates confirmation bias in subsequent forecasts
Regional/Local Grid Operators	Strong Benefit	Regulated return on asset base (RAB) directly proportional to investments; 5-6% guaranteed returns on expanded infrastructure; minimal risk as costs passed to consumers; regulatory framework rewards building over efficiency
Energimarknadsinspektionen (Regulator)	Lose	Oversight complexity increases exponentially with system size; resource constraints prevent effective supervision; information asymmetry widens with technical complexity; public

Stakeholder	Impact	Mechanisms and Incentives
		criticism when unable to control cost escalation
Nuclear Project Developers	Initial Benefit	Justification for new projects based on phantom demand; access to political support and potential subsidies; option value creation; but ultimate loss when projects fail due to missing demand
Wind/Solar Developers	Mixed	Grid expansion enables connections in remote areas; but competition from subsidized nuclear; grid costs reduce competitiveness; opportunity cost as smart grid investments foregone
Energy-Intensive Industry	Severe Loss	Grid fees increase 3-5x undermining competitiveness; uncertainty deters long-term investments; existing facilities face stranded asset risk; relocation incentives to countries with stable, low-cost electricity
Commercial/Service Sector	Lose	Higher electricity costs reduce profitability; particularly severe for data centers, commercial real estate; competitive disadvantage versus neighboring countries
Households	Lose	Grid fees increase from 400-500 to 2,000-3,000 SEK/month for typical household; regressive impact as electricity is necessity; reduced purchasing power for other consumption
Construction/Engineering Firms	Temporary Benefit	Decade of guaranteed mega-projects; specialized expertise development; but boom-bust cycle risk; stranded capabilities when building phase ends
Financial Sector	Mixed	Fee income from financing mega-projects; but stranded asset risk in utility

Stakeholder	Impact	Mechanisms and Incentives
		bonds; electricity derivatives mispriced based on false demand assumptions
Environmental NGOs	Lose	Resources diverted from genuine climate solutions; landscape degradation from unnecessary infrastructure; credibility damaged by supporting overbuilding
Future Generations	Major Loss	Inherit stranded assets requiring decommissioning; locked into high-cost electricity system; reduced fiscal capacity for climate adaptation; landscape permanently altered
Political Decision-Makers	Short-term Benefit	Decisive action narrative; ribbon-cutting opportunities; avoid difficult efficiency discussions; but legacy risk when overcapacity becomes undeniable

Key Insights:

- Benefits concentrate among infrastructure builders and operators while costs diffuse across society
- Time asymmetry: benefits immediate for some stakeholders, costs delayed but persistent
- Information asymmetry: technical complexity prevents effective democratic oversight
- Regulatory capture risk: regulated entities benefit from the very oversight meant to protect consumers
- Intergenerational inequity: current stakeholders benefit while future generations bear costs

3.8 Who is accountable

Following the Swedish governance framework, accountability for the nuclear power expansion, energy planning targets, and associated electric grid investments is structured as follows:

1. Riksdagen (Swedish Parliament)

- The highest accountable body, ultimately responsible for approving government proposals, including long-term energy policy and grid infrastructure investments.

2. Regeringen (Government)

- Holds a majority in Riksdagen with Liberalerna, Moderaterna, Kristdemokraterna, and the support party Sverigedemokraterna, collectively accountable for policy decisions on energy strategy, nuclear expansion, and grid development.

3. Prime Minister Ulf Kristersson

- Ultimately responsible for all ministers and the coherence of governmental policies.

4. Minister for Energy and Enterprise (Energi- och näringsminister) Ebba Busch

- Personally accountable for driving and implementing the "Färdplan för Kärnkraft," proposing an additional 100 TWh nuclear capacity, and setting a planning target of 300 TWh electricity consumption by 2045, directly impacting grid investments.
- Has notably overridden and minimized critical feedback from subordinate authorities, labeling their submissions as mere "opinions," and replacing senior officials who challenged her policy direction, potentially constituting "ministerstyre."
- Appointed Carl Berglöf, a strong advocate for nuclear energy, as coordinator, highlighting a significant political bias in policy execution.

5. Minister for Financial Markets (Finansmarknadsminister) Niklas Wykman

- Accountable for financial mechanisms supporting nuclear expansion and grid investments, notably for not transparently presenting total costs to the public and indirectly transferring these costs to citizens through uncapped special taxes.
- Critical support enabling Minister Busch to proceed despite internal cautions from civil servants and advisors.

6. Minister for Finance (Finansminister) Elisabeth Svantesson

- Accountable for overall financial oversight, responsible for Finansdepartementet, to which Minister Wykman reports.

7. Government Agencies:

- **Svenska Kraftnät and Energimyndigheten:**
 - Special role and explicit accountability to provide balanced, evidence-based forecasts and assessments, though their independence has been challenged by political interference and potentially ministerial overreach (ministerstyre).
- **Energimarknadsinspektionen:**
 - Accountable for delivering precise and transparent evaluations, specifically through official consultation responses (remissvar), ensuring consequences of political decisions are clearly outlined.

8. Riksrevisionen (National Audit Office)

- Accountable under Förvaltningslagen for auditing and ensuring lawful and efficient use of public funds, including investments in nuclear energy infrastructure and electric grid expansion.

9. Other Political Parties:

- Responsible for scrutinizing government decisions, highlighting consequences, proposing alternative paths, and ensuring that ministerial actions remain within legal and transparent boundaries.

10. Other Stakeholders:

- Industry bodies, NGOs, academic institutions, and civil society groups have roles in public discourse and policy evaluation but are not formally accountable for government decisions.

3.9 Industrial Volatility and Grid Planning Misalignment

3.9.1 *The origin of bias*

The Swedish government has committed to a substantial expansion of nuclear power, seemingly at any cost. This political directive cascades through the institutional hierarchy, influencing how public authorities interpret and translate industrial plans into anticipated market needs. Historically, industrial actors have consistently announced more capacity than they ultimately realized—an expected characteristic of long-term

investment environments. However, the urgency to support national sustainability narratives and the government's political alignment with nuclear expansion have shifted the threshold for how speculative plans are incorporated into forecasts.

This shift carries substantial financial implications. The government has explicitly stated its willingness to fund these developments through public debt, thereby socializing investment risk. This posture has already triggered a reaction in global industrial site selection. Several large projects have opted to relocate to regions with more stable frameworks for low-cost renewable electricity, where market-based capacity planning and regulatory clarity reduce the risk of overinvestment.

3.9.2 The Capacity Reservation Paradox

The Swedish regulatory framework currently allows industrial actors to reserve grid capacity with minimal financial risk. This asymmetry—low upfront costs for capacity reservations versus the high capital costs borne by the grid system—creates a perverse incentive: companies over-reserve capacity to secure optionality, even when realization probabilities are low. The lack of consequences for unused capacity distorts planning inputs and inflates demand forecasts.

International comparisons show that several EU countries require refundable deposits or staged financial commitments linked to project milestones to ensure alignment between industrial intentions and actual grid capacity needs. In contrast, Sweden lacks such mechanisms, allowing phantom demand to accumulate and distort infrastructure planning.

3.9.3 Economic Implications of Phantom Industrial Demand

The cumulative financial burden of unused industrial capacity reservations is substantial. Preliminary analysis suggests that stranded capacity driven by unmaterialized industrial demand could account for 20–30% of total grid expansion costs, equating to 200–300 billion SEK. These costs are ultimately borne by all grid users—households, SMEs, and industry—through elevated grid fees.

Cost allocation is neither transparent nor equitable. The implicit cross-subsidization of speculative industrial plans undermines fairness in the electricity market. Industries that never realize their reserved capacity contribute minimally to grid expansion funding, while stable, energy-intensive sectors and households pay the full price of overbuilt systems.

Further compounding the issue, the overhang of phantom demand inflates long-term electricity price expectations, distorting financial markets and creating a barrier for real industrial investment. Sweden's competitiveness as a destination for energy-intensive operations is eroded precisely by speculative actors who do not follow through on capacity commitments.

3.9.4 Regulatory and Policy Failures

Despite the risks documented in preceding sections, no formal capacity release mechanism exists in the current regulatory framework. Projects may hold reservations indefinitely, irrespective of delays, redesigns, or market withdrawal. Authorities lack both the mandate and the instruments to reclaim underutilized or speculative bookings.

There are no deposit requirements tied to capacity reservations—an anomaly in international context. Equally, no structured review process exists to assess whether reserved capacity still aligns with credible industrial timelines or national planning goals. The absence of transparency further obscures public understanding of how much capacity is real versus speculative.

Policy recommendations include:

- Introduction of **capacity reservation deposits** scaled to project size and refundable upon verified grid use.
- Implementation of **time-limited reservations**, requiring renewal and evidence of progress at regular intervals.
- Establishment of a **utilization review mechanism**, possibly linked to Svenska Kraftnät's annual market analyses.
- Publication of a **reservation utilization index** comparing reserved vs. actual grid usage, to improve public and investor transparency.

3.9.5 Systemic Risk Amplification

Industrial volatility does not merely affect individual grid connections—it propagates through the entire forecasting and infrastructure investment system. Each speculative industrial announcement is translated into electricity use projections, which in turn justify multi-billion SEK infrastructure commitments. When realization rates are low, this results in structural overcapacity.

This feedback loop between political ambitions and industrial announcements further amplifies the risk. As documented in Sections 3.1–3.8, official forecasts repeatedly embed unverified industrial demand into planning targets. This circular logic—where announced capacity creates projected demand that justifies investment—undermines the integrity of the planning process.

To mitigate systemic risk, Sweden must develop a **forecasting hygiene framework** that:

- Distinguishes between **announced, probable, and confirmed** industrial demand;
- Applies **realization probability weighting** to all capacity reservations used in forecasts;

- Introduces a "**reservation risk score**" in grid planning documentation;
- Ensures that **forecast updates incorporate project cancellations, bankruptcies, and delays** with the same visibility as new announcements.

4. Conclusions

4.1 Persistent Overestimation and Its Systemic Roots

The evidence is clear: official forecasts continue to project rising electricity demand, despite two decades of stability. This persistent overestimation is reinforced by a feedback loop—where political targets drive scenarios, and scenarios justify large-scale infrastructure investment. Industrial announcements, however volatile, are embedded as certainty, distorting demand profiles.

4.2 Infrastructure at Risk: Grid and Generation Overbuild

The economic consequences are vast. Meeting the 300 TWh target requires grid investments of up to 1,500 billion SEK, with capital costs alone exceeding 70 billion SEK annually. If demand remains flat, grid fees could rise to 0.85 SEK/kWh—jeopardizing Sweden’s competitiveness in energy-intensive sectors.

Nuclear generation investments add further cost and rigidity, compounding the exposure to stranded assets. If these plans are realized while electricity use continues to follow the trend observed from 2000 to 2025, Sweden will face the highest electricity prices in Europe.

4.3 Industrial Volatility and Forecasting Fragility

Industrial actors face no penalties for reserving excessive capacity, leading to “phantom demand.” This volatility cascades into planning forecasts, which fail to account for delays, cancellations, or bankruptcies. The regulatory framework lacks deposit requirements, time-limited reservations, and utilization reviews—creating a structural blind spot that exposes all grid users to unnecessary costs.

4.4 Risks to Economic Resilience and Environmental Integrity

Overbuilding locks capital into low-yield infrastructure, crowds out climate adaptation investment, and generates irreversible environmental footprints. The promise of being an “industrial leader” is at risk of turning into a high-cost island within Europe.

Long-term, the economic, social, and ecological costs of overcapacity are likely to exceed the perceived benefits of supply-side readiness. Contrary to the prevailing argument that “it would be more costly not to be prepared,” setting rigid planning targets two decades ahead introduces greater risk—not less—given manageable lead times for most infrastructure.

4.5 Path Forward: Reforming Forecasting and Planning

A shift is needed—from fixed-target, politically anchored planning to adaptive, evidence-based strategy. Recommended actions include:

- Independent audit of forecasting methodologies and assumptions

- Realization-weighted demand modelling
- Reservation deposits and expiration mechanisms
- Transparent reporting of reservation utilization

Sweden's historical strength in responsive, demand-aligned infrastructure must guide future planning. Without structural reform, current choices risk locking in inefficiencies and costs for decades to come.

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Appendix

Korrigeringsanalys

SolarEquity exempel på analys av felbedömningar i tidigare Kortsiktig Marknadsanalys Svenska Kraftnät.

Table 12 Korrigeringsanalys

Ursprungligt uttalande i KMA 2023	Bedömning i KMA 2024	Typ av ändring	Kommentar
Storskalig eldriven industriexpansion i SE1 och SE2	Flera projekt försenade, pausade eller avbrutna. Tidsosäkerhet gör att de inte längre inkluderas i huvudscenariot.	Revidering / Nedskrivning	Tydlig nedjustering i SE1:s elanvändning 2025-2029 med ca 5 TWh.
Elanvändning inom vätgasproduktion och elektrobränslen ökar kraftigt.	Elanvändning till vätgas för elektrobränslen reviderad till 1.4 TWh (tidigare 1.6 TWh); projekt har försenats.	Revidering	Vätgasprojekt kvarstår men har fått senareläggning i tidplan.
Etablering av batterifabriker bidrar starkt till ökat elbehov.	Flera batteriprojekt har tagits bort från scenariot pga avsaknad av beslut/tillstånd.	Struken förutsättning	Påverkar särskilt högscenario.
Elprisförväntningar gynnar industriella investeringar.	Låga elpriser anges nu som dämpande faktor för investeringar.	Omtolkning	Ingen direkt självkritik; ny tolkning av samma marknadsförhållande.
Tillståndsprocesser antas inte vara flaskhals.	Tillstånd, finansiering och osäker konjunktur anges som skäl till bortfall av projekt.	Korrigerig / Revidering	Ej kommenterat varför tillståndsfrågan underskattades i 2023.
Effektivisering beaktas inte som begränsning av elanvändning.	Ingen diskussion eller korrigerig kring detta.	Ej adresserat	Potentiell kvarstående överskattning i prognosmodellen.

Top 10 Announcements: Swedish Electricity Users Cutting Consumption (2019–2025)

Organization/Project	Location	Announcement Date	Reduction Target/Result	Reason/Method
SSAB	Luleå/Borlänge	2023	-10% (2023–2025)	Energy efficiency, process optimization
Volvo Cars	Torslanda/Göteborg	2022	-15% (per vehicle, 2022–2025)	Smart automation, LED, heat recovery
Ericsson	Kista	2021	-30% (labs/offices, 2021–2024)	Smart building tech, server consolidation
ICA Gruppen	Nationwide	2022	-10% (stores, 2022–2024)	LED, refrigeration upgrades, demand response
H&M Group	Stockholm/Eskilstuna	2023	-12% (logistics, 2023–2025)	AI-driven automation, solar, HVAC upgrades
Vattenfall	Offices/IT centers	2022	-20% (2022–2025)	Smart metering, flexible loads
Stora Enso	Hyltebruk	2021	-8% (2021–2023)	Process upgrades, heat integration

Organization/Project	Location	Announcement Date	Reduction Target/Result	Reason/Method
Scania	Södertälje	2022	-10% (2022–2025)	Smart lighting, compressed air optimization
SCA	Sundsvall	2023	-6% (pulp mill, 2023–2025)	Heat recovery, process control
SKF	Gothenburg	2023	-7% (factories, 2023–2025)	Predictive maintenance, energy management

Examples of Announced Measures

- **Smart Demand Response:** Many companies (ICA, Vattenfall, Ericsson) have joined demand response programs, reducing load during peak hours.
- **LED & Lighting Upgrades:** Retailers and factories have replaced old lighting with LEDs and smart controls.
- **Process Optimization:** Heavy industry (SSAB, Stora Enso, SCA) is investing in process control and waste heat recovery.
- **Building Automation:** Office and data center operators (Ericsson, Vattenfall) are using smart systems to cut HVAC and IT energy use.
- **On-site Renewables:** Some, like H&M and ICA, have installed solar panels to offset grid demand.

Political announcements and decisions impacting industrial energy use

Key Political Announcements Affecting Swedish Electricity Users (2019–2025)		
#	Announcement/Policy	Description & Impact
1	Radical Nuclear Expansion	Parliament passed laws and funding models to enable at least 10 new nuclear reactors by 2045, with the first two planned to start production by 2035. Includes state loans, contracts-for-difference, and streamlining permits. High uncertainty remains regarding costs, timelines, and private sector interest.
2	Stopping Expansion of Sweden-Germany Cable	The government halted plans to expand transmission capacity (cable) between Sweden and Germany, citing concerns over domestic price stability and supply security. This move aims to prioritize Swedish industry and consumers.
3	Stopping Expansion of Offshore Wind Power	Several offshore wind projects have faced delays or rejections due to new political priorities, stricter permitting, and a focus on nuclear and grid stability. This has slowed the growth of new large-scale wind capacity.
4	Change in Energy Policy Goal (Tidö Agreement)	In 2022, the government shifted the national energy target from "100% renewable" to "100% fossil-free," explicitly allowing nuclear and hydro to play a central role in the future energy mix.
5	State Aid Law for Nuclear Investments	New legislation (in force August 2025) allows state aid (loans and CfDs) for nuclear projects above 300 MW, with some flexibility for smaller but strategically important projects.
6	Accelerated Permitting for Nuclear and Grid	The government and Svenska kraftnät have introduced measures to speed up permitting for both nuclear reactors and major grid expansions, aiming to reduce lead times for critical infrastructure.
7	Svenska kraftnät: Massive Grid Expansion Plan	Svenska kraftnät has launched a multi-decade, multi-hundred-billion SEK plan to double transmission grid capacity by 2045, including new north-south corridors and industrial connections. This is essential to support new nuclear, electrification of industry, and large-scale hydrogen production. Permitting and local opposition remain key challenges.
8	Energimyndigheten: Energy Efficiency Mandates	The Swedish Energy Agency (Energimyndigheten) has issued new mandates and funding for energy

efficiency in industry and public buildings, aiming to curb demand growth and improve system flexibility.

9 **State Support for Hydrogen Infrastructure** The government has launched targeted support for hydrogen infrastructure and electrolysis, aiming to position Sweden as a leader in green steel and hydrogen exports. This includes grants, regulatory changes, and grid access priorities.

10 **Reform of Electricity Market Pricing Zones** Ongoing government and Svenska kraftnät reviews of the electricity price zone system aim to address regional price disparities and better reflect grid bottlenecks and industrial demand. This could impact where new industries choose to locate.

2025 Scenario introduction, excerpt

”Scenarier med kraftigt ökad elanvändning drivs framför allt av vidareförädling, nyindustrialisering och digitalisering Skillnaden i elanvändningen mellan det högsta och lägsta scenariot är cirka 140 TWh år 2050. Skälet till den stora ökningen i högsta scenariot är framför allt en följd av en ökad vidare förädling av inhemska råvaror, nyindustrialisering och en global digitalisering. Drivkrafterna är i huvudsak möjligheter till ökad export av varor och tjänster och är mer kopplade till en global omställningstrend än en inhemsk strävan mot nettonollutsläpp. Att det sker en omställning är inte en tillfällig trend utan den kommer att fortsätta så länge målen och riktningen i styrningen består. Viktigt att komma ihåg är också att det handlar om en långsiktig omställning och strukturomvandling. Det är mycket som behöver ske inom elsystemet för att en kraftigt utökad elanvändning ska komma till stånd men omställningen sker gradvis. Den högsta elanvändningen förväntas i slutet av scenarioperioden, runt 30 år framåt i tiden.”

2023 Scenario Introduction, excerpt

”För att klara en kraftfull elektrifiering behövs alla fossilfria kraftslag På längre sikt finns många möjliga utvecklingsvägar för framtidens elproduktion och alla kraftslag har sina olika för- och nackdelar. Den framtida elproduktionsmixen är starkt beroende av hur acceptansen i samhället ser ut för olika kraftslag. Det är också viktigt att politiken tar ansvar för att undanröja hinder, ta ställning i olika målkonflikter samt skapa långsiktiga spelregler. Med den kunskap vi har idag ser vi inte att en kraftig elektrifiering är möjlig utan goda förutsättningar för samtliga fossilfria kraftslag. Vi har samtidigt en stor potential på sikt av framför allt landbaserad vindkraft, befintlig kärnkraft, havsbaserad vindkraft och ny kärnkraft. Alla dessa kraftslag bedöms ha en lönsamhet på sikt i de energisystemmodelleringar som gjorts i det här arbetet. Utifrån det högre elektrifierings scenario som tagits fram i detta arbete kommer flera möjliga utvecklingsvägar för elproduktionen presenteras och analyseras djupare i Energimyndighetens regerings uppdrag att Analysera utvecklingsvägar för befintlig och ny elproduktion.”

2021 SKN Scenario introduction, excerpt

”Svenska kraftnät uppdaterar vartannat år långsiktsscenarier för Nordeuropas energisystem. Scenarierna används för att identifiera framtida utmaningar och behov i det svenska transmissionsnätet för el och möjliggör ett proaktivt arbetssätt. Arbetet går under benämningen långsiktig marknadsanalys, LMA. Detta är slutrapporten till tredje upplagan av LMA, LMA2021. I rapporten presenteras fyra scenarier som visar på olika utvecklingsvägar för kraftsystemet och vilka behov dessa kan medföra: > > > scenario Småskaligt förnybart (förkortas SF i tabeller och diagram), scenario Färdplaner mixat (förkortas FM i tabeller och diagram), scenario Elektrifiering planerbart (förkortas EP i tabeller och diagram) och scenario Elektrifiering förnybart (förkortas EF i tabeller och diagram). Gemensamt för de fyra scenarierna är att behovet av el ökar. Detta för att möjliggöra omställningen från ett samhälle beroende av fossila bränslen till ett energisystem med noll nettoutsläpp av växthusgaser. I scenarierna varierar elbehovet beroende bland annat på omställningstakt, genomslag för vätgasproduktion med hjälp av el, energieffektivisering, digitalisering, importberoende gentemot självförsörjningsgrad och i vilken utsträckning till exempel biobränslen utgör en del i energimixen. Med tanke på den snabba utveckling vi sett under det senaste året, till exempel när det gäller elektrifieringen av industrin, är det dock ingen omöjlighet att behovet av el kommer bli än större än vad som antagits i scenarierna.”

2019 Scenario introduction, excerpt

”Elproduktionen ökar till 2035 för att sedan minska. Elanvändningen hamnar på cirka 150 TWh 2050 i alla scenarier, utom i scenariot Högre elektrifiering som har en betydligt högre elanvändning med 200 TWh 2050. I Högre elektrifiering antas flera olika elektrifieringstrender ske samtidigt genom t.ex. en ökad elanvändning i industrin då el ersätter fossildrivna processer samt en kraftigt ökad användning av elfordon i transportsektorn. Även en ökad användning av el antas i sektorn bostäder och service, med en ökad utbyggnad av serverhallar samt ett antagande att värmepumpar vinner marknadsandelar över fjärrvärmesystem. Elproduktionen ökar i samtliga scenarier till 2035 för att sedan minska fram mot 2050. Elprisets utveckling är starkt kopplat till priset på utsläppsrätter i modellen. Av den anledningen blir elpriset högst i Referens EU och lägst i Lägre energipriser. Den högsta elproduktionen noteras i scenarierna Referens EU och Högre elektrifiering där det högre elpriset driver fram en elproduktion på ca 160 TWh. Kärnkraften antas helt utfasas till 2050 och i samtliga scenarier är investeringar i ny kärnkraft olönsam i Sverige.”

2017 Scenario introduction, excerpt

Sverige tar vartannat år fram scenarier över de svenska klimatutsläppen och rapporterar till Europeiska kommissionen. Energi myndig hetens scenarier över energi systemet är en del av underlaget för rapporteringen 2017, där Sverige bedömer hur utsläppen av växthusgaser kan komma att se ut fram till 2035. Den svenska rapporteringen till kommissionen samordnas av Naturvårdsverket och baseras på underlag från flera olika myndigheter. Rapporteringen görs i Naturvårdsverkets rapport Report for Sweden on assessment of projected progress, March 2017. Scenarierna som tas fram inom klimatrapporeringen består av ett referens scenario samt två känslighetsfall. Från och med i år finns det krav på att EU kommissionens gemensamma förutsättningar för prisutvecklingen för kol, olja, naturgas och utsläppsätter ska användas. Prisutvecklingen är relativt hög här vilket har stor påverkan på resultaten i scenarierna. För att Energi myndig heten ska kunna använda scenarierna för andra ändamål än klimatrapporeringen har två extra scenarier tagits fram med en lägre prisnivå för kol, naturgas och utsläppsätter än nivån i de övriga scenarierna. Utöver det har även tre scenarier gjorts för transport sektorn då denna sektor har störst påverkan på CO₂ utsläppen för Sveriges del. Scenarierna utgår från beslutade energi och klimatpolitiska styrmedel i Sverige till och med 30 juni 2016. Samtliga scenarier har tagits fram till 2050 för att studera utfallet över längre sikt. Presentationen av resultaten av scenarioarbetet i denna rapport skiljer sig från tidigare rapporter Energi myndig heten tagit fram över lång siktiga energi scenarier. Den största skillnaden är att Energi myndig heten i den här rapporten inte väljer att lyfta fram ett huvudscenario som tidigare år. Här presente ras istället flera olika scenarier där skillnaderna mellan dem lyfts fram och viktiga parametrar diskuteras.

2013 Scenario introduction, excerpt

Energimyndigheten har i uppdrag att enligt Förordning om klimatrapportering (SFS 2005:626) genomföra prognoser för energisektorn enligt Europaparlamentets och rådets beslut nr 280/2004/EG om en Mekanism för övervakning av utsläpp av växthusgaser inom gemenskapen. Denna rapport innehåller en referensbana fram till och med år 2030, samt två känslighetsscenarier. Prognosen utgår från gällande styrmedel, vilket innebär att rapportens resultat inte ska betraktas som en regelrätt prognos över det framtida energisystemet utan som en konsekvensanalys av gällande styrmedel givet olika förutsättningar som exempelvis ekonomisk tillväxt och bränslepriser. I Energimyndighetens långsiktsprognoiser studeras energisystemets långsiktiga utveckling utifrån beslutade styrmedel och flera antagna förutsättningar. Förutsättningarna för denna långsiktsprognois fastställdes i januari år 2012 och tar sin grund i styrmedel beslutade fram till och med årsskiftet 2011/2012. Arbetet har delvis skett i samband med Naturvårdsverkets uppdrag ”Uppdrag att ge underlag till en svensk färdplan för ett Sverige utan klimatutsläpp 2050” som redovisades i december 2012. För en kortsiktig utveckling av energisystemet hänvisas läsaren till Energimyndighetens kortsiktsprognoiser som sträcker sig två till tre år framåt i tiden och som tas fram två gånger per år. Energimyndighetens långsiktsprognoiser är konsekvensanalyser med tidsperpektiv på 10–20 år som syftar till att beskriva energisystemets framtida utveckling förutsatt en rad antagna förutsättningar. Om någon av dessa förutsättningar förändras ändras också prognosresultatet. Den ekonomiska utvecklingen är ett viktigt antagande för bedömningen av det framtida energibehovet.

Data gaps identified

Electricity use by cars

Metric	Value
Registered passenger cars	5.03 million
Avg. yearly distance per car	12,200 km
Total passenger-car km/year	61.4 billion km
Avg. fuel consumption (current fleet)	4.7 L / 100 km
Total annual fuel used	≈ 2.9 billion L
EV energy consumption rate	180 Wh/km
Required electricity if fully electric	≈ 11.05 TWh/year

Electrification of **all vehicles + work equipment** leads to **~20 TWh/year** increased electricity use and avoids **~7 billion litres/year** of gasoline/diesel.

While a theoretical energy-efficiency model may suggest 25 TWh/year of additional demand, real-world idle losses in legacy equipment—particularly construction and municipal vehicles—are almost entirely removed with electrification. We therefore estimate a more realistic demand increase of **20 TWh/year**, still replacing **~7 billion litres of fuel annually**.