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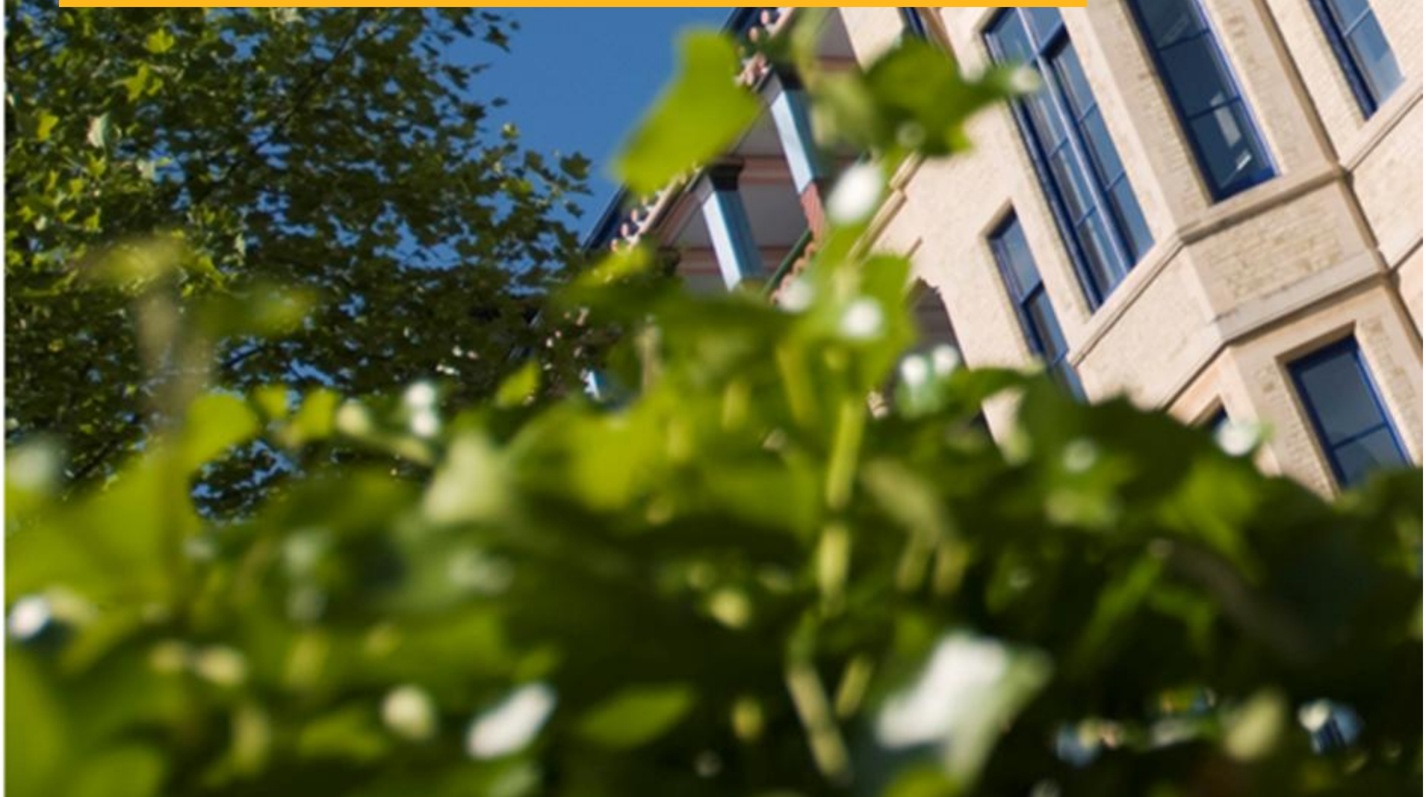
EPRG Working Paper EPRG 2602

Cambridge Working Paper in Economics CWPE 2615

HAVE ZONAL ELECTRICITY PRICES IN SWEDEN CAUSED INDUSTRIAL (RE-)LOCATIONS?

Mara Bălașa and Michael G. Pollitt



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Abstract: There is limited research investigating the impact of zonal electricity prices on industrial location decisions. This paper analyses the consequences of the Swedish 2011 electricity market reform which divided the country into four bidding zones. Such changes are often expected to lead to industrial relocations towards the cheaper electricity zones. We examine the macro and micro levels of this reconfiguration, using country- and firm-level data. Both levels of analysis show an initially limited impact of the reform on industrial location choices, with only one relocation to the northern part of the country. However, we find that the electricity intensities of the existing and emerging industries are different. By distinguishing between these two types of industries, we identify that many up-and-coming ones such as low-carbon steel, green ammonia, green hydrogen, e-methanol as well as data centres are increasingly locating in the bidding zones with lower electricity prices. For these, the share of electricity costs in the total cost of production is much higher compared to the traditional, fossil-based heavy industries. However, even if they are energy-intensive, these industries are not job-intensive at all, such that the location choices of the new firms do not significantly impact the labour market, which also suffers from significant shortages in the northern region. These location decisions may, in time, reduce the electricity surplus in the north of the country, and thus exert upward pressure on the price in the long-term. The findings have implications for understanding industrial (re-)locations, electricity market reconfigurations, and industrial decarbonisation.

Keywords: electricity market reform, industrial decarbonisation, industrial policy, industrial relocation, zonal electricity prices

JEL Classification : O14, R11, Q41, L94

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Funding	Jan Wallanders och Tom Hedelius stiftelse samt Tore Browaldhs stiftelse H24-0020
Publication	March 2026

Have Zonal Electricity Prices in Sweden Caused Industrial (Re-)locations?

Mara Bălașa[1,2,*] and Michael G. Pollitt[1]

1. Introduction

High energy prices impede corporate investment in Europe more than in other major economies (Draghi, 2024) so it is important to understand their dynamics and impact on industrial competitiveness. Market reconfigurations such as splitting the electricity market into multiple bidding zones (BZs) or merging multiple zones impact energy prices. The Swedish government has recently tasked the transmission system operator (TSO) with revisiting the question of whether the Swedish electricity market should maintain four separate wholesale electricity price zones. At the same time, the ENTSO-E Bidding Zone Review has recently recommended the division of the Germany-Luxembourg area to achieve higher economic efficiency. Should this be implemented, there is a fear that industrial relocation would occur towards regions with lower electricity prices, with serious consequences for the labour market due to an expected relocation of jobs. In this context, this paper analyses industrial location and relocation as a result of electricity market reconfiguration.

There is no strong consensus on whether changes in energy prices result in industrial relocation in practice. Some empirical studies – e.g. Saussay & Sato (2024); Panhans et al. (2016); Carlton (1983) – suggest that low electricity prices are indeed causing relocations, and that the effect is stronger for the manufacturing industries. Other strands of research find limited effects altogether – e.g. Nijkamp & Perrels (1988); Pfister (1983). At the same time, not many studies distinguish between firm location and relocation, between existent and emerging industries.

As for the factors influencing location decisions, transport and labour costs used to be seen as the most important by past theories (e.g. Weber, 1909). More recent research shows how different renewable energy conditions at country or region level are seen as increasingly relevant for contemporary location decisions, especially in the case of energy-intensive industries (Samadi et al., 2023). However, it remains an open question what share of electricity costs in the total cost function of a firm is large enough to motivate relocation to regions with more affordable electricity (Nijkamp & Perrels, 1988).

Should electricity markets undergo zonal reconfiguration, this can result in industrial stakeholders facing different electricity prices depending on their location within a country, especially if transmission bottlenecks occur. The prices diverge if there is not enough capacity to transport electricity from the regions that have abundant energy generation to

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[*] The author wishes to thank one anonymous reviewer who provided insightful comments, everyone who took the time to meet and discuss this topic, Örjan Sjöberg for guidance and detailed feedback on an earlier draft, and Rikard Westerberg for guidance. The author also acknowledges financial support from Jan Wallanders och Tom Hedelius stiftelse samt Tore Browaldhs stiftelse, and additional support from Carl Silfvéns Stipendiefond which enabled the extension of this project. The views expressed in this paper are those of the authors and do not necessarily reflect those of the foundations.

those that experience energy scarcity due to higher-cost generation, high consumption, or both. In this context, we ask the following research question:

Have zonal electricity prices in Sweden caused industrial (re)locations?

The 2011 Swedish electricity market reconfiguration is a natural experiment that helps answer the research question and sheds light on industrial location decisions. This reconfiguration increased the number of pricing zones in Sweden from one national price to the current four regional prices. Prices have substantially diverged between the different regions, especially in the past few years, given the abundance of low marginal cost energy in the north of the country and the scarcity in the south, thus making the country a good case study. Assessing how the industries reacted to the changing prices helps draw lessons about electricity market reconfigurations and industrial behaviour.

The results are relevant especially in the context of the latest recommendations to split Germany-Luxembourg into multiple bidding zones. Furthermore, they also relate to recently abandoned government proposal to create multiple zones in Great Britain (Department for Energy Security & Net Zero, 2025). The findings are also important with regards to understanding the future of the green industries and their location decisions, given their significant electricity needs.

The remainder of this paper is organised as follows: Section 2 introduces the policy that reconfigured the Swedish electricity market and notes its effect on the prices. Section 3 reviews the literature, while Section 4 outlines the methodology. The results are reported in Section 5 and discussed in Section 6. Finally, the paper outlines the contributions and limitations in Section 7 and then concludes.

2. Swedish Electricity Policy towards Bidding Zones

2.1 The background: what are bidding zones?

An electricity bidding zone (BZ) is defined as "the largest geographical area within which market participants are able to exchange energy without capacity allocation" (Ofgem, 2014). BZs are meant to reflect the distribution of supply and demand, deemed as a cornerstone of market-based electricity trading, and a prerequisite to reach the full potential of capacity allocation methods (EUR-Lex, 2015).

In general, a zonal reconfiguration is thought to bring benefits, ensuring efficient congestion management and overall spot market efficiency (cf. forward markets). The monetised benefits revolve around spot market welfare gains, i.e. the sum of consumer surplus, producer surplus and congestion rent changes compared to the status quo configuration, as well as redispatch cost savings (ENTSO-E, 2025). The latter occur due to declines in re-dispatch levels, especially between the BZs, because of the market split (Egerer et al., 2015).

Nevertheless, electricity spot prices can diverge across BZs when the existing interconnectors are congested (Figueiredo et al., 2016), and modelling exercises show the possibility of having different price levels as a result of market reconfiguration. These may lead to different regional incentives for investments in supply and demand in the long-run (Egerer et al., 2015). However, it could also be the case that a single price is maintained on the retail side. For instance, until the beginning of 2025, Italy kept a single national price on the buyer side, computed as the average of zonal prices and weighted by the consumption in each zone (IEA, 2023).

A consensus is lacking regarding the impact of a BZ split on market power and forward market liquidity considerations. On the one hand, such a division and smaller zones could adversely impact liquidity and create market power for incumbent generator due to reduced competition (Egerer et al., 2015) (Bjørndal et al., 2003).

On the other hand, BZs can reduce the market power of domestic companies if cross-zonal capacities increase significantly. A higher market concentration does not necessarily imply that market power is abused. Consulted stakeholders did not consider the market power criterion relevant for analysing BZ configuration, suggesting that market concentration and power are not problems even in the smaller BZs as long as the power is not abused (ENTSO-E, 2018).

Reconfiguration could maintain liquidity in forward markets and reduce spot prices through improved local competition if producers and consumers are allowed to write forward contracts based on the quantity-weighted average of the zonal prices (Tangerås & Wolak, 2024). The benefits of a market split can thus include increased competition and transparency, in addition to the provision of clearer investment signals for the transmission network and for generation capacity development (Moretto & Pollitt, 2026).

2.2 The Swedish zonal split

The 2011 Swedish electricity market reform divided the country from one into four BZs, namely SE1 and SE2 in the north, and SE3 and SE4 in the south (Figure 1). The reform aimed to address the large imbalances between local production and consumption. The south of Sweden had excess demand and, since the price was uniform throughout Sweden, the transmission system operator (TSO) regularly limited electricity exports to Denmark (Holmberg & Tangerås, 2023). The limitation of interconnector capacity damaged competition and trade within the internal electricity market, such that the European Commission expressed competition concerns and proposed as a solution splitting the Swedish electricity market into multiple BZs (EUR-Lex, 2010). The emergence of the BZs was thus part of the remedy implemented by the TSO to tackle this matter.

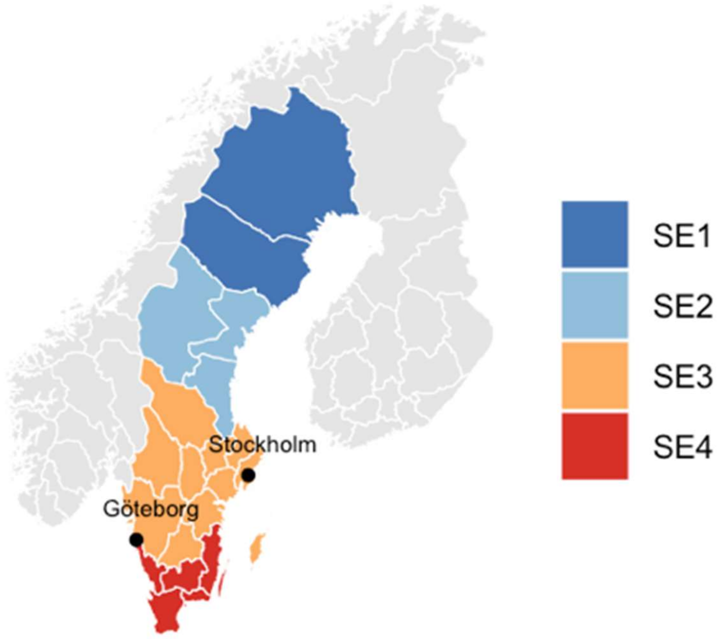

Figure 1: Swedish BZs
Source: Authors based on county delimitations from Svenska Kraftnät (2023)
Notes: Cities with more than 500,000 inhabitants are labelled on the figure. The shaded areas are approximations of the BZs. Some regions (e.g. Kalmar, Dalarna, Västerbotten) are split between multiple BZs, an aspect which is not captured by this figure.[3]

2.3 Consequences of the Swedish reform

In the days right after the market reconfiguration, prices increased across all the zones, with a stronger effect in the two zones in southern Sweden (8% and 6% increase), compared to the increase in the north (4.7%). The market reform was therefore shown to be successful in differentiating territorial-level prices, reflecting the higher economic activity and more concentrated population in the south and the electricity transmission constrains from north to south (Loiacono et al., 2025).

In the years after the reform, between 2012 and 2015, there was an almost perfect electricity spot price convergence between SE1 – SE2, as well as good convergence between SE2 – SE3 and SE3 – SE4, with some arguing that no further investments in interconnector capacity were needed for this reason (Figueiredo et al., 2016).

Nevertheless, more recent electricity spot price data covering a longer time frame show a different picture. Since 2020 (Figure 4) the price in the south (SE3 and SE4) increased significantly compared to the one in the north (SE1 and SE2).

The price divergence from 2020 is associated with a number of events that occurred in Sweden: the closure of the Ringhals 2 nuclear reactor (750 MWe) in December 2019 and the closure of the Ringhals 1 unit (800 MWe) in December 2020 (World Nuclear Association, 2025). Their operational lifetimes were cut short by around five years due to a decision by

[3] The plot was created using R version 4.5.2, packages ggplot2, rnaturalearthdata and dplyr.

Vattenfall due to declining profitability and increased costs, as market conditions had been forecasted to display low electricity prices in the coming years (Vattenfall, 2015).

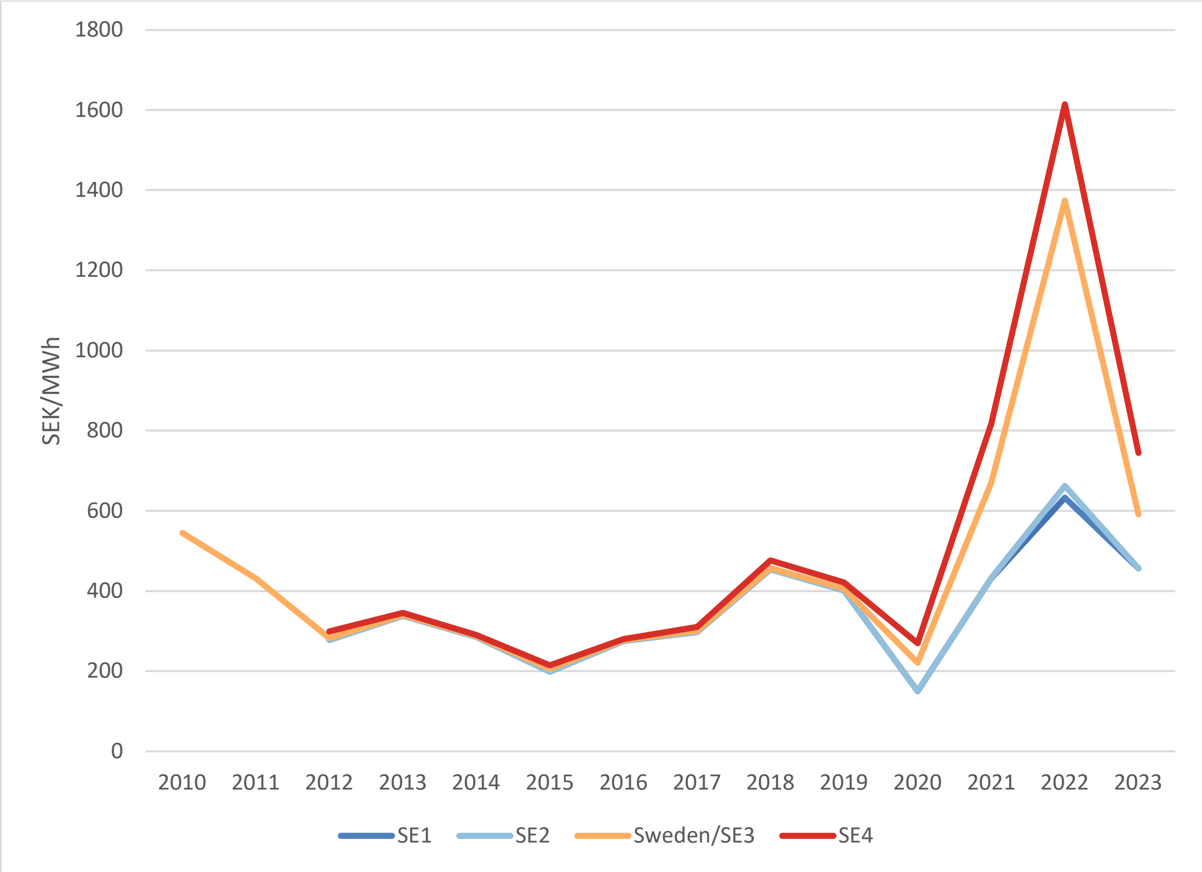

Figure 2: Electricity spot prices, yearly averages, nominal price
Source: Authors based on data from Energimyndigheten (2025)

In the past, overall price increases, especially right after the reform, were argued to be related to the more than 150% increase in exports in the 20 days following the split (Loiacono et al., 2025). Data show how total exports have more than doubled after the market split, from 15 TWh in 2010 to 35 TWh in 2023 (Figure 3). Before 2011, Norway was the main export destination of Swedish electricity. Afterwards, Finland became the largest destination, and the volumes have increased significantly between 2011 and 2013.

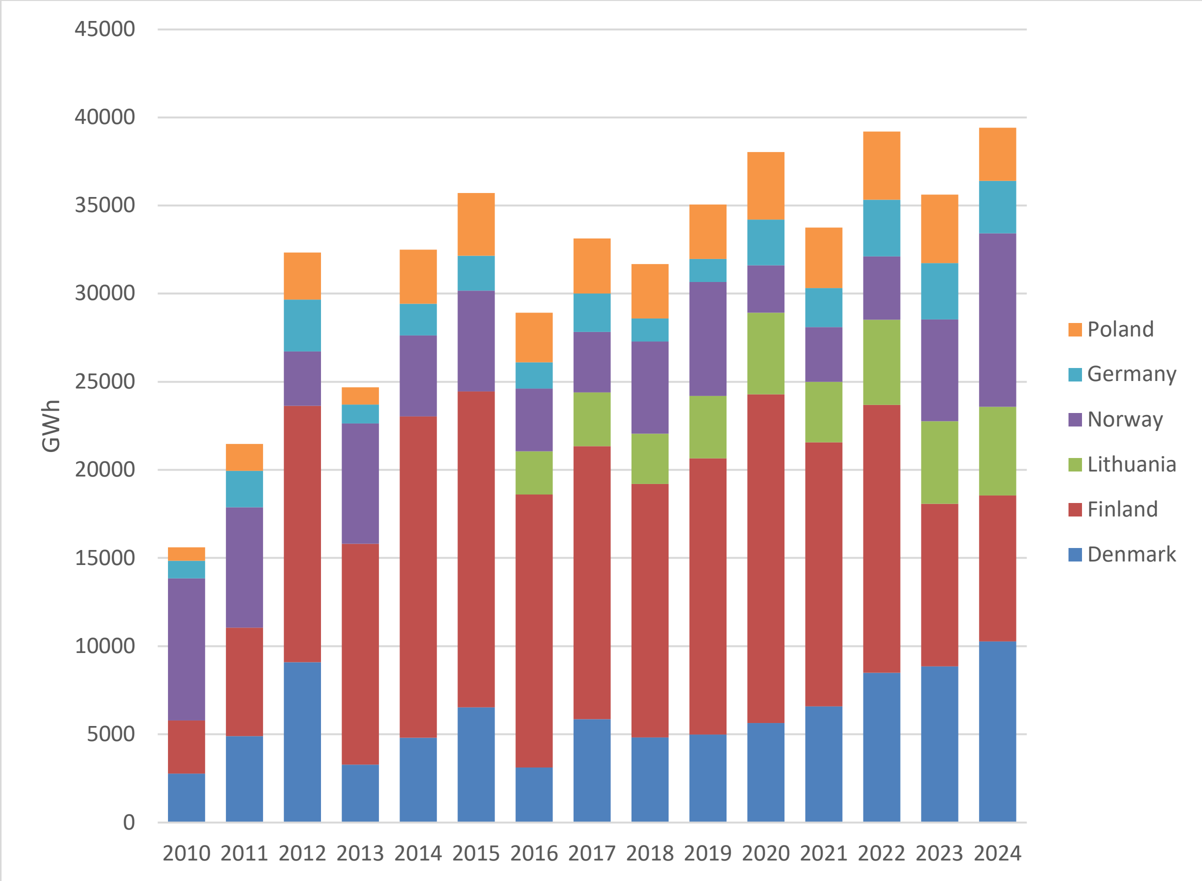

Figure 3: Electricity exports
Source: Authors based on data from Energimyndigheten (2025) for years 2010-2023 and data from World Integrated Trade Solution (2026) for year 2024
Note: A lower number on these negative axes implies a higher level of exports

When zooming into the price composition for high energy consumers, the highest component is the wholesale price of electricity, whereas the lowest is the net energy tax (Figure 4). In Sweden, the energy tax has recently become an instrument to mitigate the increasing energy costs, such that industrial manufacturers and computer/server halls are subject to specific tax relief regulations for their consumption of electricity (Setterwalls, 2022). The government has recently proposed that the current energy tax exemption for electricity consumed in furnaces and metallurgical processes should be extended (Finansdepartementet, 2025).

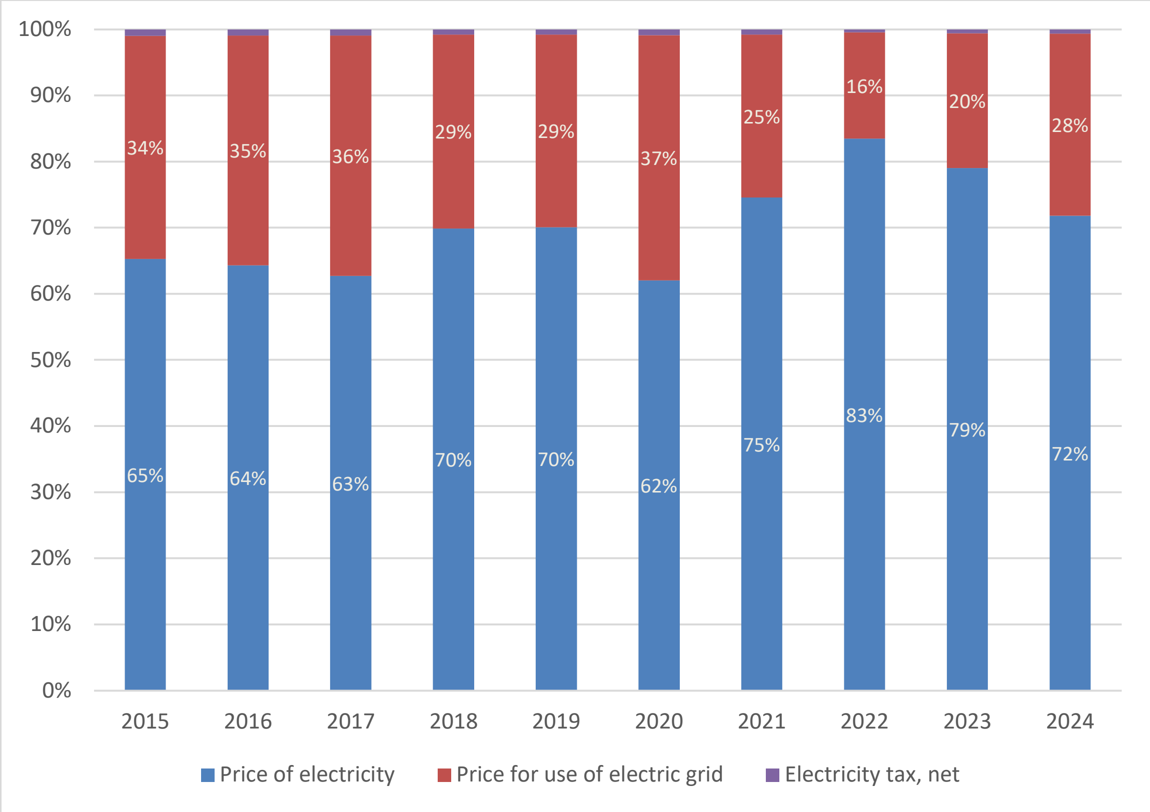

Figure 4: Composition of electricity price for Band ID
Source: Authors using data from Statistikmyndigheten SCB (2026)
Notes: Band ID refers to an annual consumption between 2,000 MWh and 20,000 MWh. The final electricity price includes the only the net electricity tax in the calculation, consistent with the European Commission: Directorate-General for Energy (2025) study. Data breakdown not available before 2015

A recent study by the European Commission (2025) has found an inverse correlation between the electricity intensity and the average prices paid by industrial consumers. The most intensive sectors, the primary aluminium and ferro-alloys and silicon, had the lowest electricity prices. The study argues that this inverse relationship could be due to the fact that large consumers of electricity do not pay lower voltage distribution fees as they are directly connected to the high voltage transmission grid, they have more bargaining power to negotiate and employ hedging strategies, are sometimes exempt from specific taxes and levies, and frequently have high load factors (i.e. desirable loads) which can sometimes adapt their manufacturing processes to exploit periodic demand response opportunities, and maximise off-peak consumption.

2.4 The creation of BZs as an industrial policy

The BZ split can have a role in creating low price regions for industry, which may then result in an agglomeration effect that was discussed in the literature (e.g. Weber, 1909). This can be compared with other industrial policies that aim to achieve this, such as the levy for industry rebate on grid fees paid by German households (Ofgem, 2021), the Dutch SDE++ subsidy scheme which was funded through a tax paid by both businesses and households (de Vries et al., 2024), or the Supercharger package proposed by the UK aiming to compensate the network charging costs of energy intensive industries to 90%. Similarly, in Sweden, the BZ approach is complemented by the favourable taxation regime for the energy intensive industries, as shown in Section 2, a regime that has been introduced in the mid-1950s (Riksrevisionen, 2025).

Furthermore, having different prices within different zones also has consequences in terms of state aid for industrial decarbonisation. For example, the Clean Industrial Deal State Aid Framework introduces a floor for the subsidised electricity. Member States can grant reductions from the wholesale electricity price but covering up to 50% of the yearly annual electricity consumption and a maximum reduction of 50% of the yearly average wholesale price in the respective bidding zone. At the same time, this subsidy must not result in a reduced price below 50 EUR/MWh (EUR-Lex, 2025)

In practice, this implies that consumers in BZs with an average annual wholesale electricity price that exceeds 66.67 EUR/MWh could fully utilize the support to cover the maximum amount of their yearly consumption (50%) without hitting the 50 EUR/MWh price floor[4]. In Sweden, none of the zones would qualify to fully use the electricity price relief as, in 2023, the country's average wholesale electricity price was 49.13 EUR/MWh. The highest price was of 64.88 EUR/MWh, in SE4, followed by one slightly above 50 EUR/MWh in SE3 (Svenskt Näringsliv, 2025). Thus, no consumer in any BZ would be able to use the entire subsidy amount, but those in SE4 would qualify for more support than their counterparts in other BZs given the higher electricity price in SE4 which places them further away from the 50 EUR/MWh floor price.

The BZ market configuration can also offer flexibilities which are conducive to decarbonisation. For example, given the requirements set by Renewable Energy Directive (RED II), the European Commission enacted two delegated acts in 2023 to define the conditions under which hydrogen and other fuels having hydrogen as feedstock can be classified as renewable fuels of non-biological origin (RFNBOs) under EU terminology. The established criteria were meant to ensure that electrolytic hydrogen was produced with renewable electricity, and only that could be classified as RFNBO under the EU regulation (Enerdata, 2024). These criteria are seen as stringent (Fortum, 2025), but exemptions were also provided:

- if the production is located in a BZ with an average renewable electricity share over 90% in the previous calendar year, or

- if the production of hydrogen occurs in a BZ that has a low emission intensity of electricity and at least one power purchase agreement (PPA) is signed to fulfil the temporal and geographical correlation (Erbach & Svensson, 2023),

then the production would still qualify as renewable hydrogen.

In 2023, Sweden fell under these exemptions: its north qualifies in the first case, whereas the southern BZs qualify in the second case, having a carbon intensity below the threshold (Enerdata, 2024). Interestingly, some research points towards how northern Germany could also qualify for the first exemption, should the electricity market be split in that country also (Aurora Energy Research, 2023).

[4] Let p be the price before state aid. The effective price reduction is 0.5*0.5 = 0.25 (i.e. 50% of final price and 50% of consumption). p*(1-0.25) = 0.75p is the price after state aid. 0.75p >= 50 EUR, implying a p >= 66.67.

3. Industrial Location Decisions

3.1 Theory

In the past fossil fuel-based electricity supply could be located close to industrial demand centres, improving the reliability of transmission of electricity and changing input prices which led to productivity gains (Missbach et al., 2024). If anything, this meant that they had access to cheaper electricity given lower grid costs.

At the same time, fossil fuel electricity costs did not vary much by location, as fossils are highly transportable and their trade reduced the effects of heterogeneous availability of primary energy. Nevertheless, electricity and hydrogen are considerably more expensive to transport (Verpoort et al., 2024), such that new factors that may be playing into the location choices now, given the need for fossil-free electricity imposed by the green transition.

Industrial location decisions have been analysed since the beginning of the 20th century. Weber (1909, p. xxvi) notes that the economic causes underlying these choices are a network of complex and diverse elements and are often individual to each specific firm. However, when generalising, the transportation and labour costs are seen as the regional factors of location of every industry. In addition, an agglomeration factor is also introduced by Weber, as it shifts the transportational network to certain points. The author outlines a feedback loop, arguing that the manufacturing processes go where the industry agglomerates, and the industry agglomerates there partly because the manufacturing of machines locates there (p. 209). The main argument is thus that the isolated processes of industrial production will be pulled to their optimal points of transportation costs. Labour is seen as a second locational factor, creating a distortion to the basic transportational network (p. 35).

Energy prices are not included in Weber's theory per se, which speaks exclusively of transportable materials. However, the author highlights that the "forces of nature" (i.e. energy) only influence the theory marginally regarding their role in the location decision (p. 39), relating them to their influence on transportation costs. For instance, unfavourable located water power will not necessarily be excluded from becoming the basis of location (p. 93).

Greenhut (1956) argued that cost and demand factors jointly determine location, discussing the role of an extensive list of factors such as material, labour, transport costs, access to market, and individual preferences of the businesses. Energy was also treated as a potential factor influencing location, albeit not taking centre stage, except for primary aluminium and non-ferrous metals.

Other strands of research also generalise the conditions that constrain locational decisions, be they historical (i.e. raw materials proximity), physical (i.e. infrastructure), socio-economic conditions (i.e. the availability of labour), transport or public regulations. Along these lines, energy prices are seen as a part of the total input cost. Their increase may also influence other cost items such as price and transport rate of production factors, the price of the intermediate and final goods to be shipped by the firm and their transport costs. Depending on the relative share of these in the total production cost, they may influence location decisions (Nijkamp & Perrels, 1988).

Pfister (1983) highlights the importance of the energy cost in the total costs of the firm, arguing that firms may be more inclined to move only if energy costs increase as a share of total costs and everything else remains constant. However, the author also notes that it is the regional differentials in the electricity price that matter, rather than absolute prices, and that the most notable effect of higher energy prices would in fact be shifting production and consumption to less energy-intensive products.

More recent theoretical studies discuss the renewable pull effect, which captures how regions with abundant renewable energy are becoming increasingly attractive for the location of energy-intensive production. This pull factor is caused by the rising cost of fossil fuels, the reduced costs of using renewable energy sources and the emergence of demand for green products, thus leading to the relocation of industrial production (Samadi et al., 2023).

3.2 Empirical findings

Samadi et al. (2023) complement their theoretical framework by noting some possible renewables ‘pull effects’ in the iron, steel and ammonia industries. Their theory is then tested empirically by Colen & Mohnen (2025) who find that the availability of abundant renewable energy is one of the key determinants for the site selection of green direct-reduced iron, ammonia and methanol.

Saussay & Sato (2024) employ a gravity model across 41 countries and find that a 10% increase in the energy price differential between two countries causes a 3.2% rise in cross-border acquisitions towards the lower energy cost country-sector pair. The authors find the effect being strongest for energy intensive industries. Similarly, Panhans et al. (2016) find that firms are responsive to higher energy costs, with relocation being twice as large for high energy users compared to their lower counterparts.

Panhans et al. (2016) study whether there is any effect of variations in electricity prices on European manufacturing firms’ decisions on whether to stay or move. They find that the electricity costs can play a significant role in determining decisions on firms’ relocation destinations, but only in certain cases. In the short to medium run, a strong change in input prices would be required for firms to even consider paying the fixed costs associated with relocation. However, once the assets expire in the long term, the relocation fixed costs are lower and the relocation chance higher.

Moreover, energy costs, and electricity costs in particular, are found to have a “surprisingly” large effect on the location choice of firms, especially for those industries that use significant amounts of energy (Carlton, 1983). High energy prices are seen to have a negative effect on firm-level investment, with manufacturing being particularly sensitive in a panel of 15 European countries (Ratti et al., 2011). However, this effect is larger for smaller firms as larger firms have more resources, capabilities and experience in deploying their resources and achieve higher production efficiency and financial leverage (Sadorsky, 2008).

Nevertheless, there are also studies finding that energy plays little to no role in terms of location. Nijkamp & Perrels (1988) conducted interviews and found that, despite variations in regional electricity prices, the sensitivity of the industries in terms of (re)location choices is almost negligible in the case of the Netherlands. Industrial inertia is thus seen to impact location patterns. When facing increased energy prices within the plants, the Dutch industrial stakeholders aimed to improve their energy efficiency. Moreover, Pfister (1983) found that very few industries are attracted to locations with lower energy prices, namely primary aluminium, certain chemical plants and glass factories.

Not many empirical studies differentiate between new and existing firms, and the focus is mostly on analysing location. However, Krenz (2023) study the relocation of German manufacturing using probit and logit regressions. The study finds regional road infrastructure, the accessibility of regions and the availability of labour force to positively influence the decision to relocate. The distinction between location and relocation is made, as the author argues that the underlying reasons differ, and there is a lack of relocation decision studies compared to locational ones.

Manjón-Antolín & Arauzo-Carod (2009) use a count data model to investigate the differences between location and relocation in the context of Catalonia. They found that the considerations affecting start up rate are different compared to those affecting relocation decisions as follows: neoclassical factors such as (dis)urbanisation economies, industrial diversity and density are statistically significant variables for both startups and relocations. However, they differ in intensity, having much stronger effects on startups compared to relocations. At the same time, institutional factors (which, in this study, are proxied by dummies for the municipalities, provinces and metropolitan areas) do not have significant effects on the decisions. Furthermore, the authors find a positive relation between the number of relocations and number of startups and vice versa. However, the former effect is stronger (i.e. relocations have a stronger effect on startups), consistent with the idea of better information on the potential sites held by relocating firms.

3.3 Null hypotheses

Based on the research findings, we expect the firms to be profit-maximising, such that lower electricity prices would influence their (re)location in the energy-intensive manufacturing sector but only should the benefits of relocation outweigh the other costs. Having a higher electricity intensity could imply that the industrial producers within that sector would be more incentivised to consider a potential relocation to a zone with a lower electricity prices. They might also consider opening or acquiring a new facility in the northern part of the country, should they wish to expand, or shift to parts of the existing production or value added to the north. If they had a plant in the north and in the south, they might switch production to the north.

Moreover, we expect location and relocation decisions to respond differently to different factors (including long-term changes in energy prices), such that they should be analysed separately. Lastly, we expect relocating firms, which have more information and experience, to act as a signal for start-ups, consistent with the literature. Thus, a higher number of relocations would be positively correlated with the number of startups in a region, as per Manjón-Antolín & Arauzo-Carod (2009).

4. Methodology

We conduct an investigation of industrial (re)location patterns in the context of different electricity prices both on a macro or micro level, a method previously outlined by Nijkamp & Perrels (1988). The former requires identifying the electricity intensity (share of electricity input in the production value) of the industrial sectors and compare that against the variation in electricity prices, thus finding the link between industrial location and electricity costs.

The latter implies researching individual firm behaviour, which we do by distinguishing between existing and emerging industries (and hence relocation and location).

Publicly available data by the European Commission (2025) show the energy intensity at industry level in Sweden, thus contributing to the macro-level analysis. This is complemented by data from Statistics Sweden on total final electricity consumption by BZ and on the share of the manufacturing sector in the total consumption by BZ. These allow studying any changes in the total electricity consumption by BZ, as well as the consumption by the heavy industries. If the share of electricity consumption of manufacturing in northern Sweden increases across time relative to the south, that could indicate industrial relocation. Similarly, the same could hold if the share of manufacturing electricity consumption relative to the total electricity consumption increases in the northern BZs.

Furthermore, the micro-level analysis is conducted through analysing firm behaviour. The first step was to meet with several stakeholders to enhance the authors' understanding of the Swedish electricity market and firm behaviour, as well as to be guided towards public resources that supported the research. The second step was to analyse data on firm behaviour, with a focus on relocation and location decisions. The results report exclusively the findings associated with the second step.

This data originates from the European Restructuring Monitor (ERM) of Eurofound (2025) which noted the large-scale restructuring events reported in national media and on company websites. An event is included in this database if "it entails the announced loss or creation of (1) at least 100 jobs or (2) or involves at least 10% of the workforce at sites employing more than 250 people." (Eurofound, 2025). We studied the events occurring between the 1st of December 2011 until the 1st of November 2025, covering the following categories: offshoring, reshoring. Relocation, mergers and acquisitions, business expansion, closure, bankruptcy and internal restructuring.

Offshoring, reshoring, relocation are directly related the relocation decisions of companies, hence why they were included in the analysis. Mergers and acquisitions were also analysed in the data as they could indicate securing the option to relocate, with the intention of moving production up north, a sign of electricity arbitrage. This was motivated by the findings of Saussay & Sato (2024) of an increase in acquisitions when there were energy price differentials, with the strongest effect seen for energy intensive industries. The business expansion category is also included as it could indicate that due to the energy price up north, firms are expanding, which might serve as a locational signal to future startups. Conversely, closures and bankruptcies were included as they could indicate hardships related to profitability despite the more affordable energy up north. To some extent, this also applies to internal restructuring.

5. Results

5.1 Macro-level

Despite the price divergence seen especially after 2020, the final consumption of electricity within each BZ has remained relatively stable (Figure 5)[5].

Focusing on the consumption of energy intensive industries, the share of manufacturing, mining and quarrying as a percentage of total electricity consumption in the respective BZ is much higher in the north compared to the south (Figure 6), but also stays relatively stable throughout the time[6].

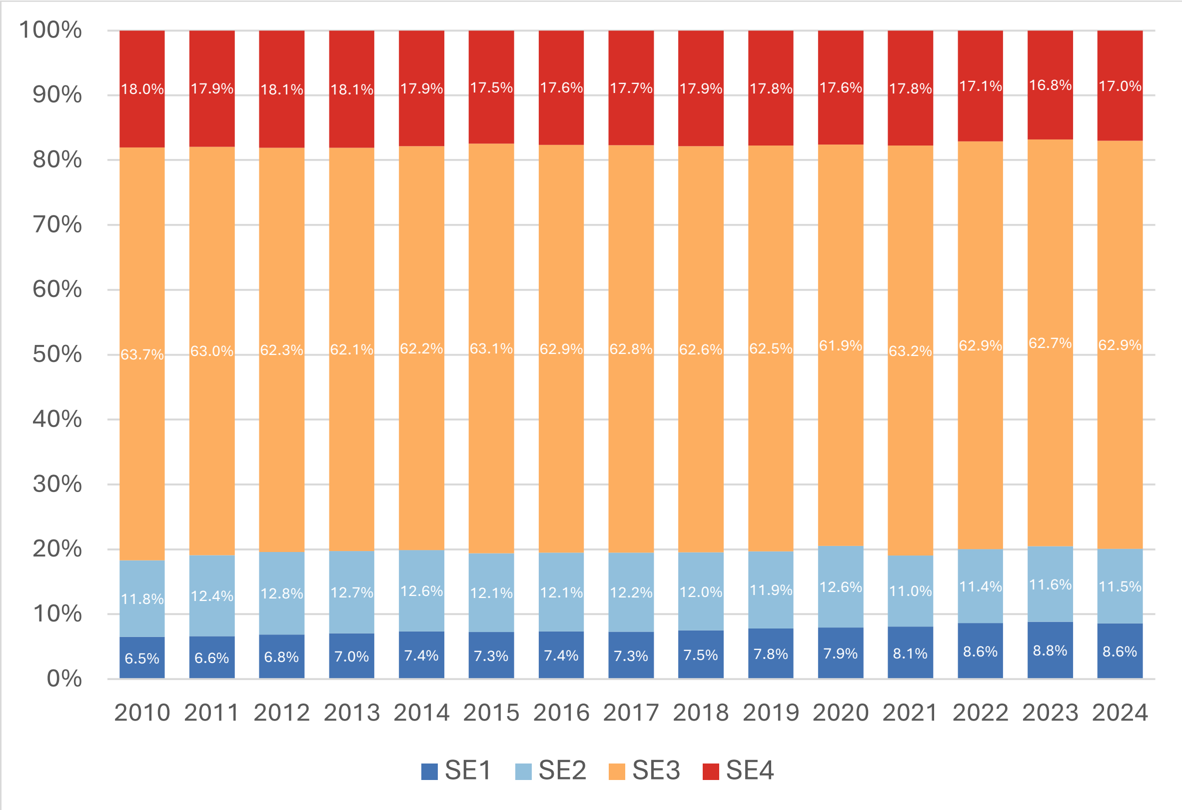

Figure 5: Total final consumption
Source: Authors based on data from Statistics Sweden (2025)
Note: Excludes losses

[5] The consumption has been trending upward for all zones apart from SE3, where there is no trend. There is no evidence of a trend break in 2020.
[6] Overall, the shares have been trending downward in all zones. Outliers were seen in 2020 for SE1, and 2021 for SE2, but the shares have returned to their previous trends thereafter.

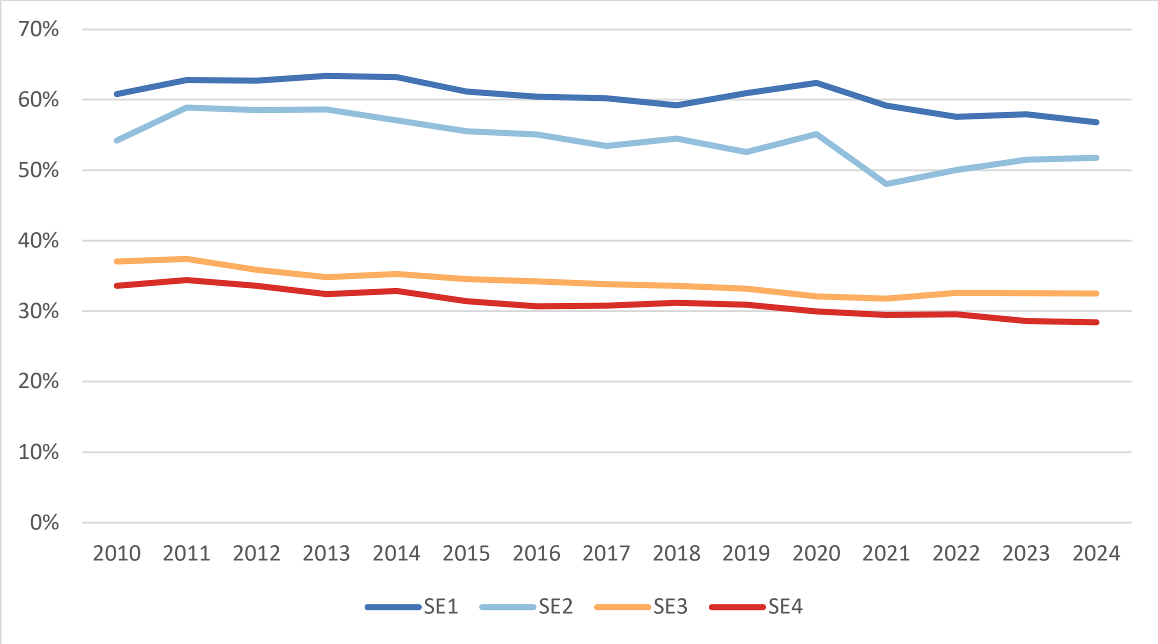

Figure 6: Manufacturing share of total consumption by BZ
Source: Authors based on data from Statistics Sweden (2025)
Notes: Total manufacturing, mining and quarrying electricity consumption in each BZ divided by total electricity consumption in the respective BZ. The 2010-2014 data include categories 5-33 from the Swedish Standard Industrial Classification (SNI 2007); data from 2015 and beyond include categories 5-32

However, when analysing the manufacturing share in each BZ relative to the total consumption of manufacturing in Sweden, SE3 has by far the largest share, which has been between 54% and 57% from 2015 until 2024 (Figure 7)[7]. This implies that, out of all the manufacturing consumption in Sweden, most of it occurs in SE3, followed by SE2. SE1 and SE4 have a comparable share. As in the previous case, these shares are also relatively stable throughout the years, suggesting limited relocations of industries.

[7] A strong increasing trend can be observed in SE1, a moderate decreasing one in SE4 and no trend in SE2 and SE3. 2020 was an outlier for SE2 and SE3, but the shares returned to their previous values thereafter.

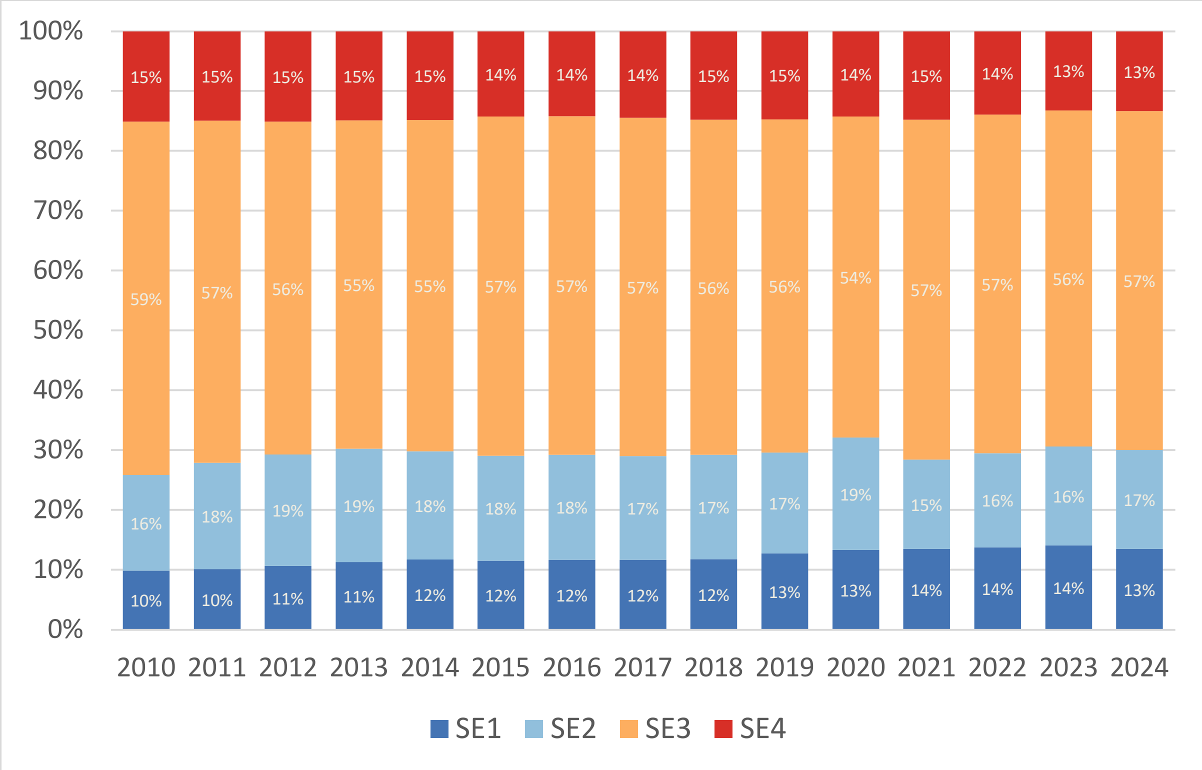

Figure 7: Manufacturing consumption by BZ
Source: Authors based on data from Statistics Sweden (2025)
Notes: Calculated as manufacturing, mining and quarrying in each BZ divided by total manufacturing, mining and quarrying in Sweden. The 2010-2014 data include categories 5-33 from SNI 2007; data from 2015 and beyond include categories 5-32

An important aspect to study is also the electricity intensity of the industries. Due to data availability limitations, the analysis is focused on the energy intensity, which is a proxy for electricity intensity. Traditional industries have experienced a long-term trend of declining energy use (Eurostat, 2025). At a national level, the energy intensity of Swedish manufacturing is relatively low for most sectors apart from cement, lime and plaster. There, it reached 18% in 2019 but decreased to 13% thereafter. The average intensity of the other sectors was 2% in 2021 (Figure 8).

Figure 8: Energy costs as share of total production costs
Source: Authors using data from the European Commission (2025)
Note: Ranked in descending order, based on 2021 values

The cement, lime and plaster industry generally consumes large amounts of fuel. Cement production requires large quantities of fuel especially due to the wet manufacturing process given the need to evaporate water from the raw suspension. Thus, most energy is consumed through firing raw materials into clinker, whereas electricity is seen as secondary energy in the process, representing about 11% of the total net energy consumption (The Cement

Institute, 2026). The electricity consumption in the lime manufacturing is also relatively low, accounting for about 5% of the total energy use (Stork et al., 2014). Energy costs include more than electricity, such the electricity intensity would be even lower compared to the energy one.

Some sectors such as iron and steel, pulp and paper, or clay building materials have experienced significant decreases in their energy intensity between 2014 and 2021. However, other sectors such as cement, lime and plaster, basic chemicals or refractory products have experienced some increases in the share of energy in the final production cost, perhaps outlining differences in energy efficiency measures and results across the sectors. However, overall, the energy costs as a proportion of the total variable costs have been decreasing for Swedish manufacturing, being slightly over 2% in 2023 (**Figure 9**).

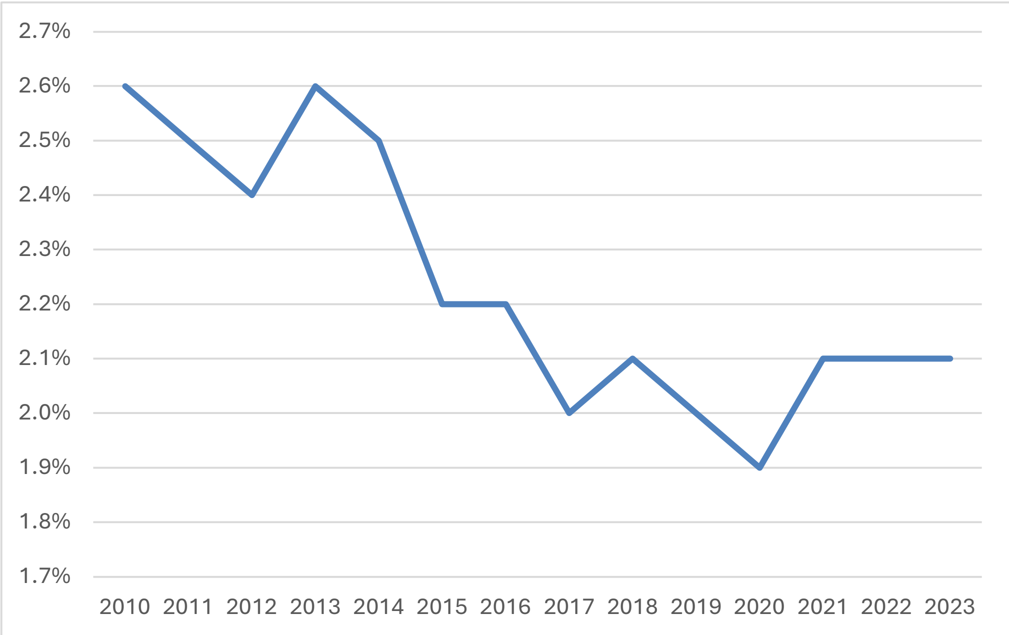

Figure 9: Energy costs in relation to total variable costs for the Swedish manufacturing industry and mines
Source: Authors using data from Energimyndigheten (2026)

One could thus conclude from this data that electricity costs are unlikely to influence the location choice of firms unless all input costs apart from electricity are equal in all BZs (Nijkamp & Perrels, 1988). However, the picture is likely to look differently in the upcoming years due to decarbonisation and the emergence of the new so-called "green" industries. Sweden's climate policy framework adopted in 2017 sets the country's target to become net-zero by 2045. To achieve this, some specific measures are explicitly mentioned, such as an increased uptake of carbon dioxide by forests, biomass-based carbon capture and storage (Naturvårdsverket, 2025).

There is no single fixed decarbonisation pathway that is chosen to reach the binding targets. Investments in new green industries are thus expected as they will contribute to the climate neutrality. For such industries, electrolytic hydrogen is key. This is produced using large amounts of electricity (Bălașa & Sandberg, 2025), such that the energy intensity is likely to increase substantially in the future, should the projects take off.

At the same time, the increasing demand for digital services is contributing to the growing demand for datacentres, which require significant amounts of electricity. This industry currently accounting for up to 1.5% of global electricity use (IEA, 2026) and investments in datacentres are on the rise (Santos, 2025).

Therefore, the results presented so far do not capture the demand profile of the upcoming industries that are being set up, which are detailed later in this section. This is also suggested by Table 1, which presents a range of estimations for future electricity demand, both industrial and total.

<table>
<tr><th>Forecast Year</th><th>Industrial Demand (TWh)</th><th>Total Demand (TWh)</th><th>Source</th></tr>
<tr><td>2024 (actual)</td><td>44</td><td>132</td><td rowspan="2">Energimyndigheten (2025a)</td></tr>
<tr><td>2028</td><td>55.5 – 61.4</td><td>168 – 174</td></tr>
<tr><td rowspan="2">2035</td><td>133</td><td>250</td><td>SKGS (2024)</td></tr>
<tr><td></td><td>280</td><td rowspan="2">Energimyndigheten (2025b)</td></tr>
<tr><td rowspan="2">2045</td><td rowspan="2"></td><td>200 – 340</td></tr>
<tr><td>300</td><td>Government Offices: Ministry of Climate and Enterprise (2024)</td></tr>
</table>

Table 1: Forecast future electricity demand in Sweden
Source: Authors

The surplus in the SE1 has been increasing, while the one in SE2 regions has maintained relatively constant in the recent years. These two zones reached a surplus of 55 TWh in 2024, an increase compared to the previous year's 52 TWh (Figure 10). This significant electricity generation surplus is still causing prices to decrease in those respective BZs. However, the existing generation would be sufficient to meet demand just until 2035 and only in the scenario of a lower electricity demand, under the assumption that the estimated expansion of solar and wind power is realised. For a higher electricity demand scenario, almost 50 TWh will be needed to be added already by 2030 and 155 TWh by 2045 (Energimyndigheten, 2025b). This will have important implications for the electricity price, even in the north of Sweden, and could serve as a barrier to the emerging industries that have electricity as a significant part of their total costs.

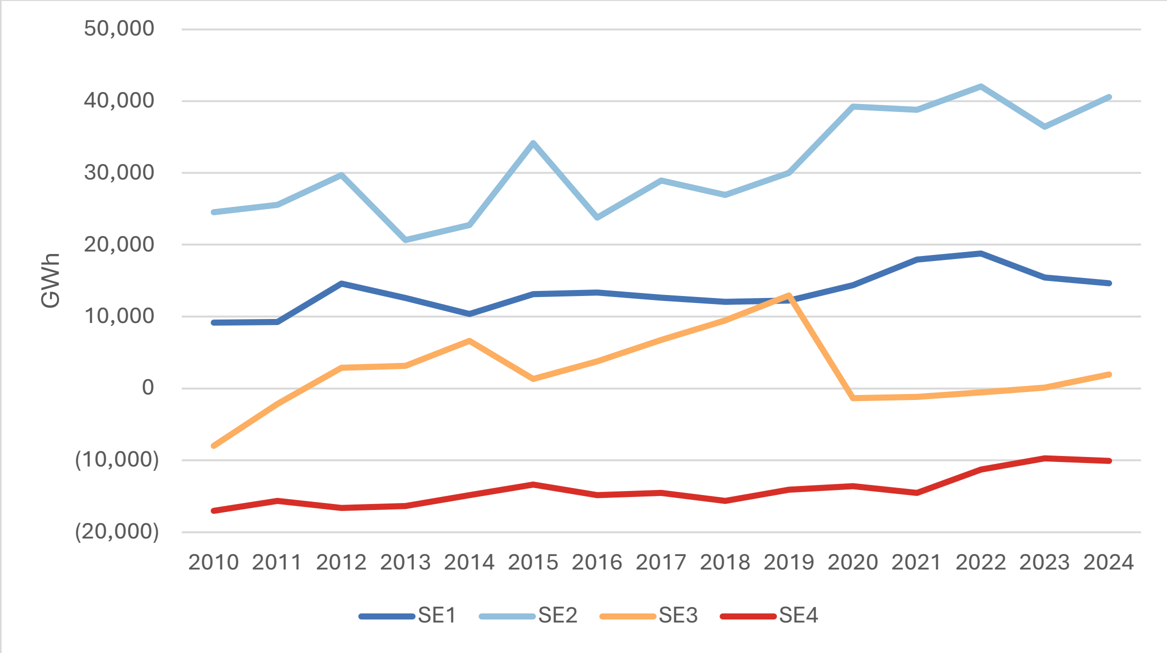

Figure 10: Electricity surplus by BZ
Source: Authors using SCB data

Thus, the macro-level analysis of the existing industries suggests that the electricity-related costs may not have made it worthwhile to relocate even for manufacturing firms, as they may represent too small of a share in the total production costs of the firms. However, it also indicates that the electricity consumption is likely to increase in the future through the emergence of new industries. This speaks to considering the decisions of relocation of existing businesses separately from the location decisions of startups, partly due to their different energy profiles.

5.2 Micro-level

5.2.1. Existing industries

On the micro level, firm-level data show very limited relocations. 616 restructuring events are coded in the data between 1st of December 2011 and 1st of November 2025 for Swedish manufacturing. More than half of the events have been internal restructuring, followed by business expansion and offshoring (Figure 11). Out of these, the ones related to the north of the country, occurring in SE1 and SE2, are summarised in **Table 2** and analysed in detail below, based on the text descriptions found in the Eurofound dataset.

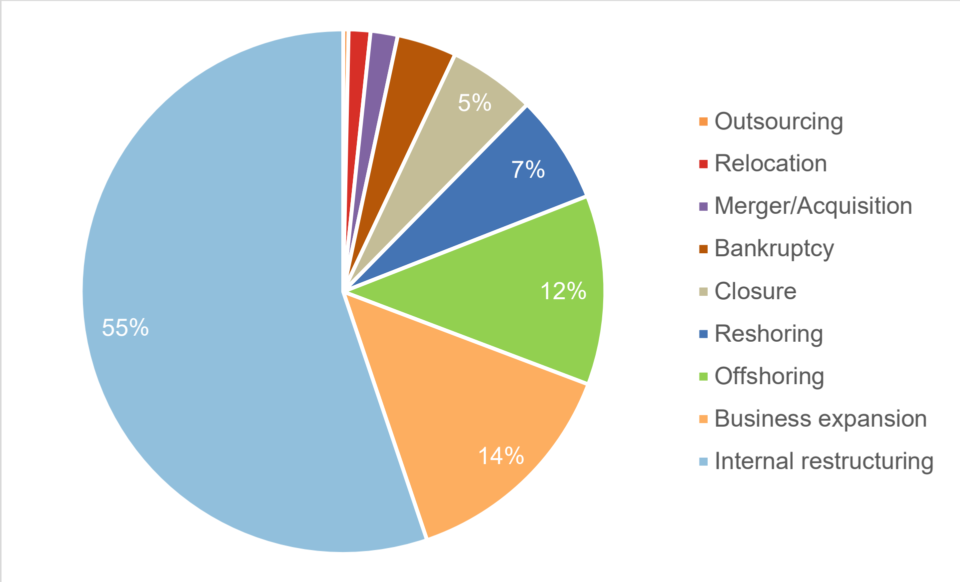

Figure 11: Restructuring Events December 2011 - November 2025
Source: Authors using data from the ERM (2025)

Company	*Production*	*Origin*	*Destination*	*Year*	*Reason*	*Jobs*
			Offshoring			
Element Six	Synthetic diamonds	SE2	South Africa, Ireland	2014	Workforce availability, competitiveness	-175
Cargotec Hiab	Crane manufacturer	SE2	Poland	2014	Cost reduction, competitiveness	-110
Emhart Glass	Glass manufacturer	SE2	Malaysia	2012	Flexibility, cost efficiency, profitability	-160
			Reshoring			
Polarica	Food	Poland	SE1	2017	Environmental – shorter transport times	+3
			Relocation			
Volvo Trucks	Trucks	SE1	SE3	2014	Centralisation of production	-350
Volvo Trucks	Cab trim operations	SE1	SE3	2013	Competitiveness and efficiency	-500
						-700

	M&A					
Arla > Milko	Dairy	-	SE2 (X), SE3	2012	Strengthening supply chains	-200
	Business Expansion					
Hägglunds	Armoured vehicles	SE1	-	2021	Increased demand	+250
Northvolt	Lithium-ion batteries	SE1	-	2019	Preparing for 2021 production	+3000
Volvo Trucks	Truck assembly	SE2	-	2013	Increased demand	+250
	Closure					
Norrskog Wood Products	Wood	SE2*	SE2	2020	Profitability and location	-100
Polarbröd	Flatbread	SE1	-	2020	Accidental fire	-131
SCA	Printing paper	SE2	-	2020	Low demand, COVID19	-800
Metso	Mill lining	SE1	-	2019	Competitiveness	-150
						-155
Fazer	Bakery	SE1	-	2017	Efficiency, profitability	-110
	Bankruptcy					
Northvolt	Lithium-ion batteries	SE1	-	2025	Prolonged financial crisis	-4000
	Internal restructuring					
Hylte Paper	Paper manufacturer	SE3	-	2025	High electricity price, mentioned north as cheaper alternative	-60
Gestamp HardTech	Auto components	SE1	-	2019	Low demand, overcapacity, global changes	-55

Iggesund Paperboard	Paperboard manufacturer	SE2	-	2018	Reduce operational costs	-150
BAE Systems Hägglund	Military vehicles	SE2	-	2016	Fewer orders than expected	-150
Kubal	Aluminium producer	SE2	-	2014	International crisis in aluminium industry	-60
Ericsson	Telecom cables	SE2	-	2013	Declining demand	-354
SSAB	Steel manufacturer	SE1, SE3	-	2012	Efficiency program and profit losses	-450
Iggesund Paperboard	Paperboard manufacturer	SE2	-	2012	Efficiency and high- cost pressure	-100
BAE Systems Hägglund	Military vehicles	SE2	-	2012	Declining demand and profitability	-180

Table 2: Summary of events related to SE1 and SE2
Source: Authors based on data from Eurofound (2025)
*Notes: * denotes a closure as labelled by the data but associated with an opening of another facility, as described in the announcement text. (X) denotes that, following the acquisition, the jobs from SE2 were made redundant. The year corresponds to the date of the announcement. When two numbers are included in the Jobs column, that denotes a range*

Offshoring

35 instances of offshoring are recorded in the studied time period, with three in the north of Sweden. Element Six offshored to South Africa and Ireland citing multiple factors, such as the increasing difficulties in recruitment of workforce at their factory, and the extensive investments needed to upgrade the machinery and become competitive again (Ståhl, 2014).

Finnish crane manufacturer Cargotec Hiab's offshoring from Hudiksvall (SE2) to Poland targeted its R&D and sales departments, due to competitiveness reasons and the need to reduce operational costs.

Lastly, Emhart Glass chose to keep its high-technological parts of production in Sundsvall (SE2) but located other parts of the production in Malaysia. It motivated this decision by the need to be closed to customers and improve flexibility, cost efficiency and profitability (Morris, 2012).

Reshoring

20 events of reshoring were observed in the analysed timeframe. Out of these, 19 reshored in the south of Sweden, some due to difficulties with suppliers abroad, some in order to join the main headquarters of their company, others due to infrastructure considerations. For

example, Multidocker, a material handler, relocated part of its production in 2019 from the Netherlands to Norrköping in SE3, where their HQ are located alongside their innovative part of the activity. The move was motivated by the desire to have production and innovation together to enhance their efficiency in developing product concepts and digitalisation.

Only one reshoring instance occurred in the north of Sweden, namely Polarica, a food company which moved part of its packaging operations from Swidwin, Poland to Haparanda, Sweden (SE1) in 2017. The reason invoked for reshoring was environmental sustainability, aiming to move packaging closer to the place of origin of the berries. No reshoring instance mentioned electricity pricing as an underlying reason.

Relocation

Out of the 4 instances of relocation are catalogued, none relocate production from south to north. Conversely, Volvo Trucks cut 350 jobs from Umeå (SE1) as production relocated to the company's facility in Tuve, Gothenburg (SE3) in 2014. Later on, in 2015, the company relocated cab trim operations from Umeå to Gothenburg, aiming to increase competitiveness by enhancing the efficiency of manufacturing and thus decreasing manufacturing costs.

Mergers and Acquisitions (M&A)

Among the 5 instances of M&A activity recorded in the data, the one by Arla is the only one that has a link with the north of Sweden. The company acquired Milko that had its headquarters in Östersund (SE2). However, the dairy was located in Grådö (SE3) and had to be sold as a condition imposed by the Swedish Competition Authority (Arla, 2012). At the same time, the jobs from SE2 were made redundant and replaced by employees in Stockholm. Thus, this acquisition was not related to electricity price arbitrage, but rather motivated by the desire of Arla to strengthen its milk supply, while Milko was forced to sell due to low milk prices for farmers and critical financial situation(Bouckley, 2011).

Business expansion

There were 42 business expansions under the studied timeframe. Most of them had to do with expanding existing facilities, regardless of the BZ, with high demand often being cited as the main reason. Northvolt, the past flagship project for green transition and re-industrialisation in northern Sweden, aimed to recruit around 3,000 employees before 2025 for its lithium-ion battery production in Skellefteå (SE1).

Closure

16 closures have been recorded. Interestingly, one of them reports closing down a factory, and replacing it with another one in another place. This is however treated as a closure, not a relocation, in the dataset: Norrskog Wood Products announced the closure of its sawmill in Östavall (SE2) by the beginning of 2020 and the investments into a more profitable and better located facility in Hissmofors (SE2), thus remaining in the same BZ.

Other closures occurred in the north of Sweden such as the mill lining manufacturing company Metso that decided to dismiss employees in Ersmark (SE1) in 2020 as it aimed to increase competitiveness and profitability by reviewing its manufacturing capacity. Then, the employees from the site expected relocation to the Trellborg site (SE4). But eventually, in 2024, the producer discontinued its rubber and Poly-Met wear parts manufacturing from Trellborg facility after an assessment that comprised customer proximity, logistics, and efficiency perspectives, choosing to strengthen its production in Lithuania instead (Metso, 2024). Efficiency and profitability were also the reasons invoked for Fazer's bakery closure in Hökmark (SE1) in 2017, with the goal to centralise production in the remaining facilities.

Bankruptcy
Among the 11 recorded bankruptcies, only one is included in the dataset in the north of Sweden, namely Northvolt in Skellefteå. The company filed for bankruptcy in March 2025 after a period of prolonged financial crisis, becoming the largest bankruptcy in Swedish history, according to the dataset description.

Internal restructuring
65 internal restructurings are included in the entire Sweden, and most refer to employee dismissals due to decreasing demand, weak market conditions, falling profits, cost cutting programs, overcapacity or global dynamics. In the north, the redundancies were similarly motivated by high-cost pressures, declining demand, efficiency programs and global tensions, which suggests that these outweighed the advantages brought by the low energy costs.

Hylte Paper, however, dismissed 60 employees out of 270 due to the high electricity prices in the south of Sweden. The CEO declared that, had the company been located in a more northern region, it would have saved around 200 million SEK – the equivalent of around 18.6 million EUR per year – (Bergström, 2025), but did not relocate.

5.2.2 Emerging Industries

The north of Sweden sees a number of significant plans and ongoing projects of electricity-intensive stakeholders such as datacentres or heavy industries whose production is centred around hydrogen obtained through electrolysis powered by renewable energy. Some upcoming electricity-intensive projects planned or currently under development in the north of Sweden are presented in **Table 3**. These were not included in the ERM database, as they are not restructuring events, but rather they either planned for the future, or because they might not have had a large impact on employment initially.

Regarding datacentres, several are locating in the north of Sweden, due to the favourable weather and electricity prices. Out of 110 datacentres listed in Sweden, 14 are in the north, while 47 of them are in Stockholm (Data Center Map, 2026). The location choice of the latter could be motivated by the low-latency need of some datacentres (Umbrex, 2026). However, Bikupa Datacenter, with an operating capacity of 32 MW (HIVE Digital Technologies Ltd, 2024), chose Boden (SE1) as the location of its facility precisely for the accessible renewable energy at a relatively lost cost (Bikupa Datacenter, 2026).

Furthermore, the main decarbonisation pathways for the traditional heavy industries are based on biofuels and feedstock, carbon capture and storage (CCS), electrification and hydrogen (Manuel et al., 2022). These pathways require large amounts of electricity, either directly (through electrification), or indirectly, for instance through the production of hydrogen or through powering the CCS systems. Thus, industrial decarbonisation leads to higher electricity and hydrogen demand and is influenced by electricity market conditions (Raillard-Cazanove et al., 2025).

When setting up new production for green industries, the BZs seem to play more of a role for the location choice. The CEO of Skellefteå Kraft, a major hydropower and wind energy provider, stated that the region offers some of the cheapest prices in the world for electricity and abundant renewable energy, these being the criteria that had motivated Northvolt to establish their battery facility in Skellefteå (Savage, 2025). Moreover, the surplus of renewable electricity was one of the main reasons why Boden was chosen as the location of the Stegra steel plant (Stegra, 2024a). Hybrit's iron sponge and green steel project by SSAB, LKAB and Vattenfall is also placed in SE1, with its demonstration plant expected to consume around 5 TWh per year at full operation, the consumption primarily originating from the production of hydrogen (Hybrit, 2023).

Both Stegra and Hybrit estimated they would each need around 15 TWh of electricity per year for their full production of green steel (Milne, 2024) which together is roughly the same as the total end-user electricity demand in Ireland in 2023 (Central Statistics Office, 2025). Thus, as these requirements are similar to the consumption of a country, the electricity price starts playing a crucial role in the bankability of the projects.

Project	*Location*	*Type*	*Electricity demand/year*	*Year*	*Status*	*Operational jobs*
			SE1			
Stegra[8]	Boden	Green steel	15 TWh	2026	First orders placed	2000[9]
Hybrit[10]	Luleå & Gällivare	Green steel and sponge iron	15 TWh	2026	Large-scale industrialisation phase	200[11]
Bikupa Datacenter[12]	Boden	Datacentre	Not disclosed[13]	2021	Operational	0[14]
Power2 Earth[15]	Luleå	Green ammonia	4-5 TWh	-	Scrapped as it failed to secure grid connection	500[16]
Bothania LinkH2[17]	Luleå	Green hydrogen	0.8 – 2.4 TWh[18]	2027	Pre-FEED stage	150[19]
			SE2			

[8] Stegra (2026).

[9] Operational jobs once plant is running (CINEA, 2025).
[10] Vattenfall (2026b).
[11] Current permanent employed people (Hybrit, 2026), although other LKAB (2020) mention a total of 2000-3000 jobs in renovation and construction over 20 years.
[12] Samuelsson (2024).
[13] Their Swedish operation utilizes approximately 37.5 MW of renewable hydroelectric energy (HIVE Digital Technologies Ltd, 2024).
[14] According to publicly available information, there are zero registered employees (Bolagsfakta, 2026)
[15] Tigerstedt (2025).

[16] Brandin (n.d.).
[17] Piechorowski (2023).
[18] Assuming a baseload production of 8,000 hours/year as per Wappler et al. (2022), for two electrolysers, one of 100MW and one of 300MW.
[19] Brandin (n.d.).

Lhyfe, OX2 and Velarion[20]	Ånge	Green fertilisers cluster	2.4 TWh[21]	TBD	Concept phase	-
Flagship ONE[22]	Örnsköldsvik	E-methanol	0.56 TWh[23]	-	Scrapped due to higher energy and capex costs, lack of offtake	-
Flagship TWO[24]	Sundsvall	E-methanol	1.3 – 1.4 TWh[25]	2027	Granted environmental project	30[26]
Flagship THREE[27]	Umeå	E-methanol	1 – 1.1 TWh[28]	2028	Implementation ready to proceed	30[29]
NorthStarH2[30]	Östersund	E-methanol	1 – 1.1 TWh[31]		Environmental permit application	50 - 100[32]

Table 3: New firm investments in the North of Sweden
Source: Authors

6. Discussion

The macro-level analysis showed a stable electricity demand throughout the years in each BZ from the manufacturing sector, despite some electricity price divergence. Furthermore, it also noted that most Swedish industries are not very energy-intensive, suggesting that the barriers to relocation may be larger than the benefits gained from a lower electricity price.

The micro-level analysis then indicated that existing industries are sticky and do not tend to relocate despite relatively cheaper electricity. There was only one instance of relocation to

[20] OX2 (2024).
[21] Assuming a baseload production of 8,000 hours/year as per Wappler et al. (2022), for a 300 MW electrolyser.
[22] Burgess (2024).
[23] Assuming a baseload production of 8,000 hours/year as per Wappler et al. (2022), for a 70 MW electrolyser.
[24] Liquid Wind (2024).
[25] Assuming a 10-11 MWh electricity consumption per tonne of e-methanol (Cordis, 2021) for a total production of 130,000 tons of e-methanol.
[26] Assuming the same number of workers as the Kassø methanol plant in Denmark (Renshaw, 2026).
[27] Liquid Wind (2025).
[28] Assuming a 10-11 MWh electricity consumption per tonne of e-methanol (Cordis, 2021) for a total production of 100,000 tons of e-methanol.
[29] Ibid.
[30] Uniper (2026).
[31] Assuming a 10-11 MWh electricity consumption per tonne of e-methanol (Cordis, 2021) for a total production of 100,000 tons of e-methanol.
[32] Dumbre (2024).

the north of Sweden in the studied timeframe, a reshoring from Poland. Furthermore, there are examples of manufacturing firms that reshored to Sweden or changed their location within Sweden but located in the southern part of the country. The results are thus consistent with the theoretical expectations of Weber (1909) that firms would locate even in places where the "nature forces" are unfavourable.

The Norrskog Wood Products whose action of closing a factory and opening a new one is labelled in the data as a closure rather than a relocation. This points towards another danger of relocation: the existing production facility could close but no new one would be opened, given hurdles that may appear in the process of setting up the facility in the new location. Therefore, the results are also consistent with the theoretical predictions regarding the importance of other factors of production in addition to energy.

6.1 Barriers to relocation

As shown by our paper, there are several barriers that influence relocation, as other factors apart from energy costs can become significant obstacles that may overweigh the benefits of a low electricity price. The availability of financing is a barrier, with Northvolt being a clear example of this, given its bankruptcy following a prolonged period of financial stress. This seems to apply to both emerging and existing industries, and profitability is often invoked as an underlying reason for cost-cutting programs and internal restructuring, as indicated by the data on existing industries.

The availability of labour is another significant barrier, as it is relatively limited in the north. This is exemplified by the Element Six offshoring from SE2 which cited the availability of labour as one of the reasons. Also, in SE1 the demand for jobs is expected to exceed the supply in many sectors, thus resulting in labour shortages (Brandin, n.d.) This can thus make a relocation difficult to implement, and the finding is consistent with the theoretical predictions regarding the importance of the availability of labour.

To address this, regional initiatives such as the Relocate one financed by European funds aimed to identify ways of attracting workers in the northern region and thus support their migration. This project was, however, depicted as a high-cost failure. It revealed several institutional barriers to migration, such as adult training regulations, the lack of a national system to provide incentives, the monetary costs associated with long-distance migration, or the lack of affordable housing (Eriksson, 2024).

However, the micro-level analysis also showed how emerging industries are increasingly choosing the north of Sweden as their location due to the accessible renewable energy, as they need significant amounts of electricity in their production processes. While energy-intensive, these industries are not labour intensive at all. Some estimates show that in Norbotten, a total of 7,000 jobs will be created through the green transition. However, most of them are argued to come from Stegra and Hybrit (Brandin, n.d.). The other projects, as shown in **Table 3**, create a relatively low number of new jobs. To put this into context, at the end of 2025, the number of people in the Swedish labour force reached 5.7 million (Statistikmyndigheten, 2026b), with 567,174 employed in the mining, quarrying and manufacturing sectors (Statistikmyndigheten, 2026a), which account for about 10% of the total.

The new industries face other barriers in addition to labour. These revolve around high capital costs and lack of offtake agreements due to the green premium of the final products, as exemplified by FlagshipONE. The low-carbon production is estimated to cost more than commercially available equivalents, and the sourcing of green hydrogen is the process has crucial implications for the profitability of these industries (Bălașa & Sandberg, 2025). Furthermore, permitting is another challenge experienced by the emerging industries, which has been delaying the progress of Hybrit (Finwire, 2025), and so is the ability to secure grid connection, which may prevent a project from happening as in the case of Power2Earth.

6.2 The role of PPAs

The emerging green industries as well as data centres setting up in the north of the country consume significant amounts of electricity. Thus, it can be argued that their profitability also hinges on the ability to secure a reliable supply, and a low and stable electricity price. This could be achieved through PPAs, contracts that can provide long-term price stability. These are seen to remain a robust solution to protect against price spikes, help with budgeting and enable savings (Kapral et al., 2024).

Sweden is a key region in Europe for PPAs, accounting for 12% of the total contracted capacity in 2024 (European Commission: Directorate-General for Energy, 2025). A reason for this is attributed to the abundant hydropower that has an affordable price (European Aluminium & RE-Source, 2024). In the Nordics, 35% of the disclosed PPAs in 2025, amounting to 3.3 GW, have been signed by the IT sector through hyperscale operators (Santos, 2025).

The BZ configuration does not necessarily make it easier to sign PPAs directly, but enables a lower electricity price, such that the industrial consumers may have a higher ability of signing PPAs. In this matter, it might be worth distinguishing between traditional and emerging industries. According to the National Bank of Belgium, the energy intensive industries are being challenged by rising energy prices, the cheaper imports from China and the side effects of climate policies (Lemaire, 2025). This may speak to their ability to sign PPAs, compared to emerging heavy industries that rely on green production processes. These could save on costs emerging from climate policies such as the Emissions Trading System.

The existing energy-intensive industries such as aluminium see PPAs as a credit risk as the energy buyer must pay for the electricity for the entire duration (European Aluminium & RE-Source, 2024) even if demand for their product decreases during this time. This has accounting implications and could be labelled as a lease under International Financial Reporting Standards, such that a corporate PPA could be recorded as a liability on the balance sheet, which then impacts gearing ratios or debt covenants (Norton Rose Fulbright, 2017).

For new green industrial projects, however, electricity delivery is central to their strategy (Stegra, 2024c) Using competitive renewable energy secured through PPAs is seen as a way of achieving a competitive levelised cost of production for new green industrial projects (OECD & World Bank, 2024). Thus, PPAs become central to the strategies of these producers, as debt equity investors require long-term visibility on power prices through PPAs (McKinsey, 2024).

Stegra has already signed several PPAs: 6 TWh in total with Uniper for the period 2027-2032 (Stegra, 2024c), 14 TWh in total with Statkraft for the period 2026-2032 (Stegra, 2022), 2.25 TWh with Axpo Nordic between 2027-2029 (Stegra, 2024b), and a frame agreement with Fortum for 2.3 TWh per year, with 1.3 TWh with a five-year hedging horizon from 2026 and

1 TWh as a fixed price for up to nine years from 2027 (Stegra, 2023). Thus, by 2032, the producer will have secured around 30 TWh of energy in total.

Even though most publicly available information on Nordic PPAs does not explicitly specify the source of the renewable energy, a distinction should still be made between the type of energy source backing the PPA. For instance, hydro PPAs generally offer baseload generation as they can produce the same amount of energy without being subject to weather conditions (Future Energy Go, 2022). However, wind contracts are mostly pay as produced, implying that industrial consumers face additional shaping costs as they need to procure electricity from the market when there is no wind. An imbalance risk also occurs due to the different volume amounts produced every hour subject to the wind conditions. The latter can increase the system costs when next day production is different from the day-ahead forecast. Thus, the rule of thumb is to add 10-20% to the PPA contract price to account for these additional risks and get an indication of baseload value (Future Energy Go, 2022).

The contract duration plays a role in the price of a PPA and thus in the profitability of the electricity consumers, with longer durations generally coming at a discount (Santos, 2025). Given that heavy industries incur large capital investments, their preference is usually to have longer term contracts of over 15 years (Copenhagen Economics, 2020).

In practice, the Swedish wind-powered PPAs exhibit tenors ranging between seven and 20 years (Bird & Bird, 2026). The 2024 hydro-powered PPA between Borealis and Vattenfall has a tenor of 10 years (Vattenfall, 2024) and the one between Stegra and Statkraft of 7 years (Statkraft, 2022), while the mixed hydro-wind PPA between Statkraft and Suomen has a duration of 15 years (Statkraft, 2025). One of the longest wind energy PPA's globally was the 29-year fixed volume with the aluminium producer Norsk Hydro from 2018 (Green Investment Group, 2018).

Thus, PPAs seem to be hetereogeneous in duration and, apart from the mixed wind-hydro one, there are not many PPAs signed beyond 2035, which is the period when the surplus is expected to diminish as the green energy-intensive investments are realised. This does not seem to match the preferred duration of the emerging heavy industries.

From a generator perspective, PPAs are often central to investment decisions, being very important for renewable energy projects that do not rely on public support (Ruderer, 2022). Most new wind projects require a PPA in order to advance development and finalise the development (ACORE, 2024). Hydro producers, however, might not have this requirement, since their production is already set up. This could have consequences for the conditions of the PPAs.

6.3 Future developments

In the future, it might not be the case that the north of Sweden will have lower electricity prices compared to the south. Should demand increase and generation lag, prices could increase in coming years. With Stegra and Hybrit progressing, and should other planned projects materialise, there will be a tipping point where the zones balance given the increased demand (IEA, 2025), leading to price spikes unless additional renewable energy is deployed in that area.

A large surplus of electricity drives prices down and disincentivises investments in new electricity supply (Johansson & Almqvist, 2025a). Without additional generation in the north of the country beyond what is planned until 2026, the demand and supply of electricity in that area are expected to balance by 2035 or even reaching a 15 TWh deficit if the investments deemed uncertain at this point in time materialise (SKGS, 2024).

Wind power is still expanding in the north but is driven by previous investment decisions (Johansson & Almqvist, 2025b). Wind turbine orders have been decreasing since 2023, from 1244 MW to 446 MW in 2024 and to no orders in the first quarter of 2025, showing just how the wind expansion is slowing (Johansson & Almqvist, 2025a) due to permitting, electricity pricing and grid status. In 2024, the government rejected 13 offshore wind projects in the Baltic Sea due to security concerns as the wind turbines could interfere with military sensors and defence systems, hindering early warning and response capabilities (Regeringskansliet, 2024).

Furthermore, negative electricity prices have increased in northern zones. The low price of electricity will not be attractive for wind investors, thus impeding additional electricity generation unless future electricity demand drives prices up. At the same time, the grid is exacerbating these pricing challenges, as bottlenecks impede the north-south transfer of electricity at the rate that could help stabilise prices (Johansson & Almqvist, 2025a).

While SE1 and SE2 are often seen as the northern region (i.e. Norland), the two BZs may behave differently in the future and might not be similarly assessed from the point of view of industrial investments. Should the transition from fossil fuels to hydrogen occur, there is a possibility that SE1 becomes a new load centre, such that prices there will become higher and SE2 could even start exporting electricity to both SE1 and SE3 (Zhong & Bollen, 2024). The Swedish TSO's latest network development plan covering 2026 – 2035 mentions a significant electricity consumption increase in SE1 and drastic expansion of wind power in SE2, with the expectation of some northbound power flows from SE2 to SE1 from 2026 onwards (Svenska Kraftnät, 2025), as opposed to the present-day southbound flows.

Future solutions to address this issue will be needed. For example, the Bikupa data centre became the country's largest Frequency Containment Reserve, which implies that it responds quickly to requests to sell their flexible electricity use to ensure a stable power grid frequency. In practice, the data centre can turn off 115,000 computers in one second if needed, in case the network frequency falls below 49.90Hz (Vattenfall, 2026a), such that it contributes to tackling grid bottlenecks.

7. Contributions, Limitations and Further Research

This paper has analysed the extent to which location and relocation decisions are influenced by the existence of splitting BZs. Using data from Sweden, it showed that traditional manufacturing firms were unlikely to relocate to the north of the country despite the lower electricity prices. Then, it outlined why locations and relocations should be assessed separately in the case of high electricity consumers. We drew the distinction between traditional and emerging industries, underlining the importance of the share of electricity costs in their total cost of production. This intensity is higher for the emerging industries, compared to the existing ones, which then results in different location decisions. This supports the view of the existing literature that established and emerging industries behave differently and should thus be assessed separately.

The results are consistent with the theoretical expectations of Weber (1909) that firms would locate even in places where the "nature forces" are unfavourable (i.e. lack of hydro and not enough wind and solar production in the south), and with the theoretical predictions regarding the importance of labour. The results are also consistent with the studies arguing that the share of energy costs in total costs important from the point of view of industrial location (c.f. Nijkamp & Perrels (1988); Pfister (1983)).

Nevertheless, the results of this study also depart from some of the existing literature, especially concerning the hypothesis that startups follow established firms in the location choice. As shown, it is not the case that more startups occur where more relocations occur, as argued by Manjón-Antolín & Arauzo-Carod (2009). In the Swedish case, there are no relocations to northern BZs driven by electricity prices, but there are several low electricity price driven startups. However, these are electricity intensive investments and are not job intensive.

The findings of this paper shed light on the importance of low energy prices for future electricity-intensive industries, showing that the north of the country is deemed as a suitable place for these industries especially in light of the price. We also included a discussion on the barriers to relocation that prevented the traditional industries from moving, as well as on the impact of BZs as industrial policy. This paper thus informs on industrial decarbonisation, industrial policy and sheds light on dynamics behind PPAs.

As for limitations, these have to do primarily with external validity and data availability. Compared to the low energy-intensity of existing manufacturing in Sweden, in other EU Member States, some industries have energy as a much larger share of their total production costs. For example, iron and steel reached 32% in 2019 in Romania, 25% in Greece, or 16% in Hungary, according to the data published by the European Commission (2025). This might have implications for the extent to which the present results could be generalised in countries where energy and specifically electricity plays a much bigger role in the total production costs of manufacturers.

However, northern Sweden has much lower prices than almost all other BZs in Europe and hence the creation of new lower price BZs in other European countries might not generate electricity prices low enough (and with sufficient surplus electricity capacity) to attract energy intensive industry there, given that these BZs will compete with SE1 and SE2. At the same time, the limited availability of labour in the north of Sweden could be related to the colder climate in that area. Should another European country reconfigure its electricity market, this may not necessarily be an impediment to relocation to the same extent as in Sweden, should the geographical differences between the regions not be as pronounced.

In terms of data availability, the categories presented in Table 2 are constrained by the ERM classification scheme, and the ERM database might not include some relocation events, should these not fulfil the criteria for inclusion in the dataset. At the same time, the dataset does not capture instances when firms might have shifted a part of their production towards other zones, or instances when firms might have changed their production patterns towards lower energy-intensity products, as suggested by Pfister (1983). In reality, the range of responses to the changing energy prices may be more varied than what is captured by this study. More granular firm-level data would help capture this, thus becoming an area of further research.

More research could also be conducted to inform how energy network regulation – which determines the network charge part of the electricity bill – may need to change, in light of the future developments presented by our paper. This topic should also be further researched given that the prices started properly diverging only recently. Thus, it could be the case that some more relocations would occur in the future, should this divergence persist in the long run.

8. Conclusion

The electricity market reconfiguration in Sweden did not cause industrial relocations northbound, even after the electricity prices diverged across the BZs. The electricity consumption patterns throughout each BZ did not considerably change throughout time, and the energy intensity of the Swedish traditional industries has been relatively low.

Presently, the excess supply of low-cost renewable energy in the north does attract new investments in emerging green industries and, to a lesser extent, data centres, which have electricity costs as a higher share of their total costs. Thus, a distinction between location and relocation is worthy, between traditional and emerging industries.

The reform has had limited impact on the labour market and should not be viewed as a labour market policy. In terms of the jobs impact of new industry location to the north, the main takeaway is that the industries attracted are electricity-intensive rather than labour-intensive.

Despite the low electricity price and the abundance of renewable energy, new electricity-intensive industries still face struggles up north. These are related to profitability, availability of labour, and low demand, as well as lack of offtakers due to the premium associated with green products, and the failure to secure grid connections or permits. The creation of low-price electricity zones is therefore just a small piece of the industrial location puzzle.

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