2025 Research report summary

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Investing in Electricity Generation for a Sustainable Energy Transition

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Thomas P. Tangerås
Pär Holmberg
Chloé Le Coq

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Summary

Sweden is one of the countries in the world using the most electricity per capita. A well-functioning electricity supply will become increasingly important for Sweden's economic prosperity and competitiveness. Electrification represents the most realistic way of enabling a large-scale consumption of fossil-free energy and fulfilling Sweden's goal of achieving climate neutrality by 2045.

A sustainable energy transition relies on an ecological, reliable, and cost-effective energy supply. Increases in electricity prices may cause distributional effects that justify protective measures to ensure a sustainable transition for both industry and society at large.

Achieving a sustainable energy transition represents a major challenge with uncertain outcomes. For a small, open economy such as Sweden, this challenge is further complicated by the strong influence of international factors. This raises several key questions regarding Sweden's electricity supply. What will the future demand for electricity be? How much does electricity generation cost? To what extent can the market implement the energy transition? What challenges must be addressed to achieve a sustainable energy transition? What kind of role should the government assume in driving this transition?

What will the future demand for electricity be?

Future electricity demand is highly uncertain. The transition of the Swedish industry and the electrification of road transport could increase electricity consumption by more than 50 percent if economic activity is maintained at the current scale. Electricity consumption could

increase by another 40 percent if fossil fuels in aviation and shipping are replaced by domestically produced green electrofuels. Further increases of approximately 60 percent may result from electricity-intensive activities in new sectors and the expansion of existing industries.

Low-cost renewable electricity offers a competitive advantage in producing green hydrogen for fossil-free steel and electrofuels. However, subsidies for green hydrogen in other countries and competition from conventional products pose fundamental economic challenges. The energy transition in Sweden will be much more limited if green steel and electrofuels are unable to compete in the global market.

How much does electricity generation cost?

Assessing current and projected costs provides a clear ranking of various types of electricity generation, despite some uncertainty in the cost estimates. Onshore wind power is the cheapest, followed by relatively low-cost capacity expansions in existing nuclear and hydropower facilities. In contrast, solar and offshore wind power are more expensive, while new fossil-free thermal power, including nuclear power, entails the highest average costs.

To what extent can the market sustain the energy transition?

An energy transition based on market terms is primarily driven by how much consumers are willing to pay for electricity compared to its production costs. The most important signals determining the profitability of market-based investments are the spot prices on the power exchange. The locational spot prices across Sweden's four bidding zones indicate where investments are the most profitable.

One challenge for wind power is that plants often produce electricity simultaneously, which drives down prices and reduces revenues – a phenomenon known as the cannibalization effect. This issue also affects solar power. Yet, simulation results suggest that large-scale investment in onshore wind is profitable due to low and declining costs, even under cannibalization. Solar power in southern Sweden appears economically viable. These conclusions are supported by data on current production and spot prices. Simulations indicate that if the energy-intensive industry can sustain electricity prices near the current average, the market could drive an energy transition that nearly eliminates greenhouse gas emissions while simultaneously maintaining industrial activity at the current level. In the simulations, conversion of energy use in existing industries and electrification of road transport rely primarily on onshore wind power and solar power in southern Sweden to some extent. Additionally, upgrades of existing hydro and nuclear power are shown to be economically viable.

Some thermal generation could also be profitable, particularly at critical high-demand locations and near industries with substantial heat demand. Offshore wind power continues to improve and is projected to be cost-competitive by the 2030s, particularly in southern Sweden. Large-scale nuclear power is more profitable in continental Europe, where electricity prices are significantly higher than in Sweden. Cost projections suggest that at least 20 new large reactors would need to be built across Europe before this technology becomes economically viable in Sweden. The outlook for small modular reactors is uncertain, but their potential suitability for combined heat and power plants could make them an attractive option in specific contexts.

What are the challenges for a sustainable energy transition?

Major challenges for achieving a sustainable energy transition are market failures that prevent electricity prices from adequately reflecting the wider welfare-economic benefits and costs of electricity supply in terms of environmental sustainability, reliability, and cost efficiency.

Internal bottlenecks occasionally create imbalances inside bidding zones that the power exchange cannot resolve. A reconfiguration of bidding zones would alleviate the problems, although local network tariffs might still be necessary to manage remaining bottlenecks. Furthermore, generation and consumption units should be compensated through market-based mechanisms for the ancillary services they provide while being held accountable for any costs they impose on the power system.

Thermal power contributes more to the stability of the electricity system than wind and solar power. Yet calculations show that these system effects are not sufficient to alter the ranking of costs for different technologies. Meanwhile, the continuous decline in battery costs is steadily reducing the costs of ancillary services. Still, implementing market-based compensation could improve the profitability of thermal power in major Swedish cities.

Wind power may cause disturbances for local communities and have local impacts. With municipalities having a veto right over local wind power projects, compensation mechanisms may be needed to support welfare-enhancing investments. These could include voluntary agreements between project developers and residents or direct payments to municipalities. Ideally, such schemes would cover all types of facilities and be financed by those responsible for the associated local costs. Calculations indicate that such compensation would have only a minor impact on the overall cost of wind power.

What kind of role should the government assume in the energy transition?

The government should prioritize establishing a clear and effective regulatory framework for the electricity market, giving stakeholders strong incentives to make welfare-efficient decisions. The Swedish government's efforts must operate on two key fronts: the national and the European level.

GOVERNMENT ACTION AT THE NATIONAL LEVEL

A pressing issue is the potential decline in hydropower production under the current regulatory framework, even when capacity expansions are economically viable. To address this problem, the government should explore opportunities to increase hydropower generation while minimizing its environmental impact. Similarly, it is crucial to find solutions that enable offshore wind power expansion in the Baltic Sea without compromising Swedish defense capabilities. Both actions will play a vital role in diversifying Sweden's energy supply.

Another challenge lies in the high costs of new nuclear power, which necessitates close monitoring of ongoing developments while at the same time improving market conditions. For instance, introducing a regulatory framework to optimize heat waste management would increase the profitability of small reactors. Furthermore, costs could be reduced if Sweden could import and export nuclear waste.

In exceptional circumstances, and only after evaluating the welfare-economic rationale, could targeted support be justified to correct market externalities. For instance, subsidies for new technologies may generate valuable learning effects. Such effects, however, are difficult to quantify, and there is a risk that government support might be excessive. This appears to be the case with the proposal for financing new nuclear power presented during 2024.

Developments in the electricity market are already contributing to making the energy supply more efficient by increasing the value of flexible electricity generation and consumption. To further capitalize on these benefits, the taxation system for electricity should be reviewed, as its current design distorts price signals and deters investments in flexibility.

A key responsibility of the government is to maintain and expand the electricity transmission network. Doing so not only facilitates investment decisions but also improves the efficiency of the electricity market, increases system reliability, and reduces electricity price volatility. At the same time, grid expansion at lower voltage levels will be needed for the energy transition, a responsibility that falls to regional and local grid operators.

GOVERNMENT ACTION AT THE EUROPEAN LEVEL

Mitigating political and regulatory risks for domestic investors is crucial to encourage investments in all forms of electricity generation. However, these efforts should be pursued within a European framework to ensure consistency and collaboration among member states. In the nuclear sector, a harmonized EU-wide regulatory framework for nuclear power is needed to enable the construction of standardized reactors.

Rising emission costs pose a significant risk to energy-intensive industries in Sweden (and Europe), potentially leading to closures or relocations. Such outcomes would undermine the effectiveness of climate policy and inflict substantial economic losses on European citizens. Addressing these challenges in an efficient manner requires a common policy to enhance the competitiveness of the European energy-intensive industries. The EU border adjustment tariff is one step in this direction. Another solution is to implement economic support schemes for electricity production, which may help reduce the costs for companies related to the energy transition and thus offset structural change. Such support should primarily be provided through a common framework, ensuring fair competition across the EU. Additionally, deeper integration of European energy markets is essential to improve the efficiency of energy supply.

National targets and stricter measures beyond EU requirements can result in inefficiencies and impose excessive costs for taxpayers and electricity consumers. The Swedish government's planning target for electricity supply illustrates this problem by exceeding what is needed to meet the country's climate goals. Likewise, Sweden's ambition to achieve climate neutrality five years ahead of other EU nations is likely to be inefficient. This costly endeavor may increase emissions elsewhere in Europe, resulting in minimal or negligible net climate benefits despite significant costs.

About the authors

Thomas P. Tangerås, Professor of Economics, Mälardalen University, and Senior Research Fellow, Research Institute of Industrial Economics (IFN).

Pär Holmberg, Associate Professor of Economics and Senior Research Fellow, Research Institute of Industrial Economics (IFN).

Chloé Le Coq, Professor of Economics, University of Paris Panthéon-Assas, and Research Fellow, Stockholm Institute of Transition Economics (SITE), Stockholm School of Economics.