

12. Climate transition policies and non-household electricity prices – impact assessment across the European Union¹

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Abstract: Non-household electricity prices across the EU are examined in relation to climate-transition policies and energy-market pressures. Covering all 27 Member States during the 2013–2021 period, the chapter builds panel models with fixed country effects and a broad pool of variables linked to EU ETS prices, fiscal effects, taxes, renewable energy, energy productivity, import dependency and material prices. The annual EU ETS auction price, ETS-related fiscal variables, energy taxes, environmental taxes and renewable-energy shares yield no statistically significant influence on non-household electricity prices. By contrast, the prices of key conventional and strategic materials, including uranium, crude oil, coal and lignite, are strongly associated with electricity costs. The chapter suggests that industrial energy affordability depends heavily on input-material markets, while clean-energy policy effects remained limited during the analysed period.

Keywords: decarbonisation, electricity prices, EU ETS, energy taxes, strategic materials

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Introduction

The European Commission (2021) acknowledges that rising global energy prices represent a major concern and stresses that a faster transition to clean energy would be the best antidote to high energy prices, as it helps to cope with future price volatility while complying with the European Green Deal and meeting climate goals. Although low-carbon transition policies have been blamed for driving energy price rises, they constitute the only strategy for boosting energy market efficiency and resilience (Rudinger, 2021).

A similar viewpoint is shared by representatives of the Centre for European Reform (Cornago, 2022), who warn about the misconception that implementing a coercive tool such as carbon pricing to stay on the desired path towards climate neutrality may fuel high energy prices. They recommend that EU Member States maintain the smooth functioning of the EU emissions trading system as a valuable tool for making industrial polluters pay and using the auctioning revenues to reduce dependence on fossil fuels.

Our chapter makes several important contributions to the existing literature. Firstly, we develop a comprehensive framework for determining electricity prices by focusing on the mechanisms implemented at EU level in order to facilitate the smooth but sustainable transition to low-carbon economy. Thus, we establish and empirically validate a model that specifies the electricity price for the non-household sector as a function of several variables that proxy for the climate transition strategies, as well as of some widely accepted price drivers (fuel prices, ETS allowance price).

Secondly, we focus exclusively on the last completed stage of the ETS mechanism (the 3rd one) and develop a baseline model comprising its entire period of application (2013–2021).

Thirdly, we generate useful insights in terms of policy implications and recommendations that policymakers must consider in their efforts to lower the price of energy while complying with the European Green Deal.

The structure of the chapter is as follows. The second section reviews the results of previously-related studies. The third section describes the methodology and the data used in the study. In the fourth section, the empirical results are presented and discussed. In the last section, we summarise the main findings and highlight their theoretical and practical implications.

12.1. Policy and literature overview

Climate policy generally focuses on reducing greenhouse gas emissions responsible for global warming. This primarily includes policies targeting energy production, transport, industrial processes, and land use. While acknowledging the inevitability of some climate impacts, these policies also aim to increase adaptive capacity, ensuring that communities and ecosystems can cope with changing climate conditions. One of the key directions of climate policy involves promoting the integration of renewable energy sources into the electricity grid (Farghali et al., 2023). Policies that encourage the adoption of clean energy technologies by fiscal instruments and innovations can therefore impact electricity prices (Hosan et al., 2023). Initially, the costs of switching to cleaner technologies may be reflected in electricity rates, but in the long term, these investments should contribute to more stable and potentially lower prices. Although there may be short-term financial impacts, the long-term goal of climate policy and the transition to carbon neutrality is to create a more sustainable and resilient energy system. Proactive policy design, technological innovations, and consumer engagement are key factors in ensuring that the transition contributes to both climate goals and electricity affordability for consumers.

In 2015, the European Commission published its Energy Union Strategy as a key component of the new vision of the Economic Union (European Commission, 2015). This project aims to build an energy union that gives EU consumers – households and businesses – secure, sustainable, competitive, and affordable energy. It is based on five closely related and mutually reinforcing dimensions: (1) security, solidarity, and trust; 2) a fully integrated internal energy market; 3) energy efficiency; 4) climate action, decarbonising the economy; and 5) research, innovation, and competitiveness. In 2020 and 2021, some important strategies, (action) plans, and other initiatives were also adopted under the auspices of the European Green Deal, including the Fit for 55 package. Moreover, at that time the European Commission proposed revising important directives with a significant impact on the energy sector and market, for instance, the Energy Taxation and Emissions Trading Scheme (EU ETS). All these new adopted regulations pose threats not only to established fossil fuel suppliers but also renewable suppliers.

According to Eurostat (2023), the price of energy in the EU depends on a range of different supply and demand conditions, including the geopolitical situation, the national energy mix, import diversification, network costs, environmental protection costs, severe weather conditions, or levels of excise and taxation. From the structure of components point of view, the most important factors influencing electricity prices are conventional fuel prices, renewable

energy prices, environmental taxes, carbon prices based on the cap and trade market, and the prices of raw materials, including rare-earth elements, used in the energy industry.

One of the most controversial relationships analysed in recent years concerns the high impact of EU ETS auction prices on electricity prices, especially since phase 3 (2013–2020). In its recent report, the International Energy Agency (IEA, 2023) indicated that approximately 23% of energy-related emissions worldwide are now covered by a carbon price of some type. Nevertheless, most carbon prices remain below the level required to meet the goals of the Paris Agreement. In fact, the price difference between 2013 and 2021 was the highest among all prices and costs that affect the energy market. However, after the 2023 reform of Phase 4 of the EU ETS (2021–2028), which assumes many key changes, questions arose about the future of the European cap-and-trade mechanism since 2029 (Marchewka-Bartkowiak, 2023). This uncertainty has already generated proposals to withdraw from market-based pricing of CO₂ emissions (Verbruggen, 2021), or to continue the EU ETS. Suggested changes include: implementing appropriate limits (ESMA, 2022), in the face of possible phenomena that may emerge in its endgame, such as changing the structure of investors or problems with liquidity (Quemin & Pahle, 2023); extending the sectoral scheme to all entities subject to the ‘polluter pays’ principle (Pollitt & Dolph, 2021); merging the EU ETS with other similar schemes worldwide (Verde and Borghesi, 2022); integrating the trading of public ‘positive’ emission allowances with private ‘negative’ emission certificates (Burke & Gambhir, 2022).

12.2. Model setting and variables

In order to cover all 27 EU countries throughout the 2013–2021 period, which represents the third stage of the EU ETS, our study used panel data comprising an initial dataset of 22 candidate variables (Table 12.1).

The EU ETS annual average auction price is included in the analysis as a tool of low-carbon transition policies, alongside with two additional variables that account for the fiscal effects of the EU ETS mechanism: the EU ETS annual budgetary revenues and the annual expenditure from the ETS revenues spent on climate, renewable energy, and energy efficiency investments. Environmental taxes represent another climate policy tool used to catalyse energy efficiency and mitigate environmental problems (Sackitey, 2023).

Table 12.1. Candidate variables considered

Variable	Description	Source
Dependent variable		
Electricity price for non-household consumers	annual average national price in Euro per kWh, applicable to the medium non-household consumption band	Eurostat
Variables related to the EU ETS prices and other energy regulatory costs (independent variables)		
European Union Emission Trading System (EU ETS) carbon pricing data	carbon price determined by supply and demand of trading emissions allowances on the spot market	European Energy Exchange
ETS budgetary revenues	amount of auctioning ETS budgetary revenues	European Commission
ETS reported expenditures on climate and energy	amount of ETS auctioning revenues spent on climate and energy	European Commission
Environmental taxes	taxes on goods that have a harmful effect on the environment	Eurostat
Energy taxes	a component of the environmental taxes, representing only the amount of energy taxes (including CO2 taxes)	Eurostat
Variables related to selected energy market prices (independent variables)		
the prices of selected conventional materials used in the energy sector		
Crude Oil Price: Brent	Annual amount for Europe	Federal Reserve Economic Data
Bituminous Coal/Lignite Surface Mining Index	Producer Price Index by Industry	
Global price of Natural gas	Annual average amount	
the prices of selected raw, strategic materials used in the energy sector		

Variable	Description	Source
Global price of Aluminium	Annual average amount	Federal Reserve Economic Data
Carbon and Graphite Product Manufacturing Index	Producer Price Index by Industry	
Global price of Copper	Annual average amount	
Global price of Nickel	Annual average amount	
Global price of Uranium	Annual average amount	
Global price of Zinc	Annual average amount	
Compounds of Precious Metals, of Rare-Earth Metals index	Import Price Index	
Platinum price	Annual average amount	
Variables related to the transition to low-carbon economy (independent variables)		
Energy productivity	the amount of economic output that is produced per unit of gross available energy	Eurostat
Energy efficiency	final energy consumption used for monitoring the progress towards Europe 2020 - 2030 targets	
Final energy consumption by non-households	covers the annual energy consumption of end-users from commercial and public services	
Energy import dependency	shows the share of total energy needs of a country met by imports from other countries	
Share of energy from renewable sources	renewable energy sources for electricity generation	
		Macrotrends.net

Source: own elaboration.

Conventional energy minerals (oil, coal, natural gas) and the raw, strategic materials (such as aluminium, copper, nickel, uranium, zinc, rare earths etc) represent indicators closely linked in theory and practice with the developments on the energy market.

A first stage to discriminate between the potential statistical combinations of the 22 candidate independent variables consists in generating the correlation matrix and retaining in the further regression only those that exhibit a correlation smaller than 0.5. Given that the time dimension of the panel data is very brief (nine observations per country), the data series were not tested for unit roots.

We estimate eight panel models with cross-sectional (country) fixed effects for the dependent variable *electricity prices for non-household consumers* using the pool of independent variables that resulted from the correlation analysis. All models were checked with VIF and the results are not affected by multicollinearity.

12.3. Empirical results and interpretation

The estimation of the determinants of electricity price for non-household consumers is summarised in Table 12.2, which presents the estimates (coefficients and *p*-values) for the eight alternative models.

Regression results (models 1 to 8) provide a consistent depiction of the determinants of electricity price for non-household consumers, despite employing different combinations of independent variables. The *R*-squared indicates high values, with all the estimated models explaining around 87% of the variation in the electricity price. This price seems to be influenced by the prices of conventional and strategic materials and less by the ETS variables and others related to the transition to a low-carbon economy (except for energy productivity). A plausible explanation suggested by Ahamada and Kirat (2015) is that electricity producers in European countries are facing uncertainties regarding the future of the EU ETS mechanism. Consequently, they adopt a prudent ‘wait-and-see’ attitude rather than transmitting its effect to the prices for non-household electricity. Thus, none of the ETS-related variables exerts a significant impact on the dependent variable. This is also true for the variables related to the transitioning to a low-carbon economy. An increase in energy productivity raises electricity prices for non-household consumers, the relationship being statistically significant at 5% across all estimated models.

Table 12.2. Model estimates

Independent variables	Model 1		Model 2		Model 3		Model 4	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Intercept	0.034296	0.0508	0.033790	0.0547	0.027078	0.1622	0.026600	0.1692
EU ETS carbon pricing	-0.000063	0.3368	-0.000060	0.3475	-0.000049	0.4678	-0.000046	0.4917
ETS budgetary revenues	0.000000	0.8436	-	-	0.000000	0.8903	-	-
ETS expenditures on climate and energy	-	-	0.000000	0.864	-	-	0.000000	0.9332
Energy taxes	0.001693	0.2877	0.001720	0.279	-	-	-	-
Environmental taxes	-	-	-	-	0.002005	0.1705	0.002038	0.164
Energy productivity	0.002189	0.0195	0.002184	0.0201	0.002473	0.0123	0.002469	0.0127
Energy import dependency	0.000089	0.4186	0.000090	0.4102	0.000094	0.3942	0.000094	0.3876
Share of energy from renewable sources	-0.000018	0.9449	-0.000021	0.9382	-0.000028	0.9159	-0.000029	0.912
Energy consumption by households	-0.000002	0.1381	-0.000002	0.1912	-0.000002	0.1342	-0.000002	0.1801
Carbon/graphite price	-0.000006	0.741	-0.000006	0.7495	-0.000006	0.7379	-0.000006	0.745
Crude oil price	0.000156	0	0.000155	0	0.000158	0	0.000157	0
Uranium price	0.000747	0	0.000745	0	0.000745	0	0.000742	0
No. of observations	241		240		241		240	
R-squared	87.02%		86.96%		87.07%		87.01%	

Independent variables	Model 5		Model 6		Model 7		Model 8	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Intercept	-0.303541	0	-0.301593	0	-0.310169	0	-0.308195	0
EU ETS carbon pricing	-0.000087	0.18	-0.000083	0.1927	-0.000074	0.2654	-0.000070	0.2877
ETS budgetary revenues	0.000001	0.6936	-	-	0.000000	0.738	-	-
ETS expenditures on climate and energy	-	-	0.000001	0.741	-	-	0.000000	0.7987
Energy taxes	0.000982	0.5335	0.001030	0.5127	-	-	-	-
Environmental taxes	-	-	-	-	0.001383	0.338	0.001426	0.3238
Energy productivity	0.002095	0.023	0.002091	0.0237	0.002319	0.017	0.002317	0.0173
Energy import dependency	0.000069	0.5228	0.000073	0.5001	0.000073	0.4993	0.000076	0.4796
Share of energy from renewable sources	0.000089	0.7379	0.000083	0.7533	0.000077	0.7708	0.000073	0.7838
Energy consumption by households	-0.000002	0.1665	-0.000001	0.2319	-0.000002	0.162	-0.000001	0.2209
Carbon/graphite price	-0.000064	0.0082	-0.000063	0.0091	-0.000064	0.0081	-0.000063	0.0089
Bituminous coal and lignite price	0.002022	0	0.002005	0	0.002024	0	0.002008	0
Uranium price	0.000606	0.0001	0.000604	0.0001	0.000606	0.0001	0.000605	0.0001
No. of observations	241		240		241		240	
R-squared	87.40%		87.34%		87.44%		87.38%	

Source: authors' estimations

Our findings align with the existing literature in several aspects. Commercial consumers may experience more fluctuating demand based on production cycles and operational needs (An et al., 2022; Dalen & Larsen, 2015). Hence, different usage patterns can result in various influences on pricing. Moreover, regulatory frameworks and policies are tailored to specific challenges (Rokicki et al., 2021). Non-household consumers might be subject to different regulations related to market competition and industrial competitiveness. Industries with high energy intensity, such as manufacturing or heavy machinery, may be more directly impacted by changes in the prices of conventional and non-conventional materials, which are critical for their production processes.

In this regard, our outcomes indicate that prices of conventional and strategic materials appear to be the main determinants of electricity price as follows: uranium price exerts a positive impact on the dependent variable, statistically significant at 1% across all estimated models; the crude oil price (included in four models) and its counterpart variable, the price of bituminous coal and lignite (included in the other four models), both have a positive impact on the dependent variable, statistically significant at 1% across all estimated models; finally, the price of carbon and graphite exerts a negative impact on the electricity price for non-household consumers, statistically significant at 1% in half of the estimated models, but insignificant in the rest of the models.

Conclusions

The study identifies and analyses a broad array of factors related to the energy market, climate policies and mechanisms for achieving carbon neutrality that may influence electricity prices for non-households.

The results are nuanced in terms of the tools used within the low-carbon transition framework. The annual average auction price of the EU ETS and its fiscal effect represented by the annual expenditure of ETS revenues on climate, renewable energy and energy efficiency investments exert no impact on the prices of the non-household sector. Energy and environmental taxes or the use of renewable energy follow the same pattern, and are not reflected in non-household electricity prices.

Our findings demonstrate that the prices of graphite and carbon, uranium, and bituminous coal and lignite as critical metals for the decarbonisation of the energy sector are statistically significant determinants of the electricity price. Thus, higher prices of core energy materials are passed through into electricity prices.

Thus, it can be concluded that electricity prices reflect the evolving transition to a low-carbon economy, since electricity producers appear to include the price

of key factors in their production cost functions. This confirms the empirical identification of a transmission mechanism from clean energy policies and measures taken to transition energy to the price of electricity, although its influence (documented for the period 2013–2021) remains weak.

On the basis of the above outcomes, we recommend that policymakers prioritise and incentivise the development and adoption of renewable energy technologies. Increased investment in solar, wind, and other sustainable sources can contribute to a more diversified and environmentally friendly energy mix, potentially reducing reliance dependence on conventional and strategic materials. Additionally, implementing robust energy efficiency programmes for industrial sectors is crucial. By encouraging the adoption of energy-efficient technologies and practices, policymakers can mitigate the impact of rising prices of conventional materials, particularly in energy-intensive sectors.

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