

# Changes in Household Electricity Prices Following the Expansion of Renewable Energy

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## 1. Introduction

With the net-zero objectives and rising global electricity demand, renewable energy, especially solar and wind, has gained significant attention across EU countries. Rapid growth in the renewable energy sector has substantially reduced CAPEX (capital expenditures) and LCOE (Levelized Cost Of Energy) for renewable technologies [1]. Therefore, proponents of renewable energy have anticipated that these developments could dramatically reduce overall electricity prices, especially in the household sector. However, household retail electricity prices in many EU countries have remained high, or even increased, as renewable generation capacity expanded.

This paper investigates how changes in renewable energy capacity are associated with household electricity prices, decomposing prices into three components: energy and supply, network cost, and taxes. The result indicates that household electricity prices, particularly the energy and supply and network cost components, are significantly affected by renewable energy expansion, partly due to curtailment and re-dispatch driven by the variability of renewable generation. However, taxes, including renewable levies and capacity charge, do not exhibit a significant trend with respect to the renewable energy ratio.

In addition, compared with the HICP (Harmonized Index of Consumer Prices), household electricity prices increase faster than the overall inflation rate. This suggests that factors beyond general price inflation, potentially including renewable energy expansion, may have contributed to the rise in household electricity prices.

## 2. Method

Household electricity prices, broken down into energy and supply, network costs, taxes, as well as renewable energy capacity data are taken from Eurostat, the statistical office of the European Union, since 2017 to 2024 [2]. Data for the HICP are also obtained from Eurostat [3].

In order to assess whether trends in the same direction are observed across heterogeneous power-system contexts, six countries (Germany, France, Spain, Norway, Poland and Denmark) with markedly different energy mixes were selected.

## 3. Results and Discussion

### 3.1 Household electricity prices

Figure 1 illustrates the relationship between household electricity prices and the renewable energy ratio since 2017. Overall, household electricity prices tend to increase as the renewable energy ratio rises across the countries examined. This trend is particularly pronounced in Germany, France, Poland, and Denmark shown in blue, orange, light blue, and green, respectively.

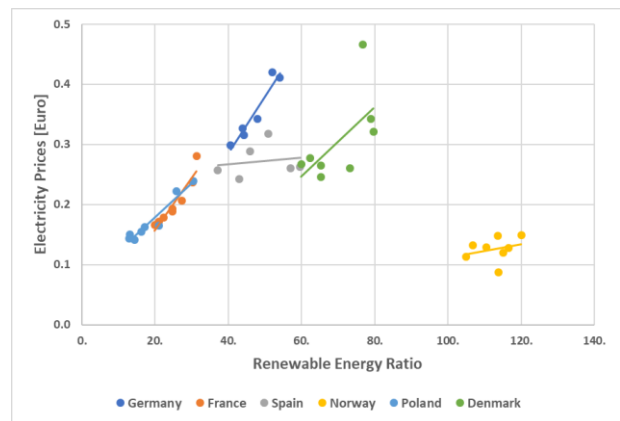


Figure 1. Changes in household electricity prices by renewable energy ratio since 2017.

However, these trends may be confounded by external shocks. For example, wholesale prices spiked sharply in 2022 following the Russia-Ukraine War. Therefore, this study conducts a further examination of household electricity prices by decomposing them into their constituent cost components.

### 3.2 Energy and supply, network costs, and taxes

According to the Eurostat database, household electricity prices consist of three components: energy and supply, which covers the costs of producing, procuring, and balancing electricity; network costs, which reflect the costs of operating and maintaining transmission and distribution networks; and taxes, including VAT, renewable taxes, capacity charge, environmental taxes, and nuclear taxes.

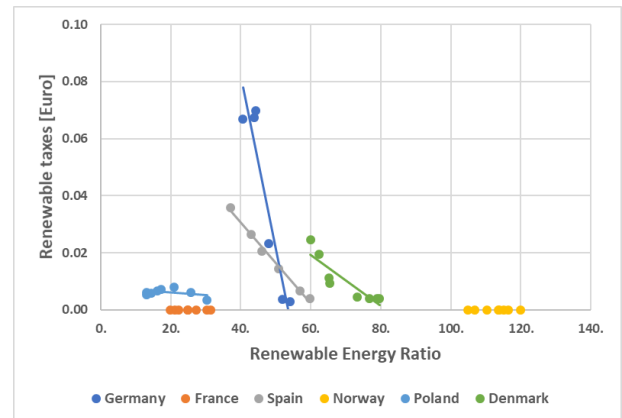
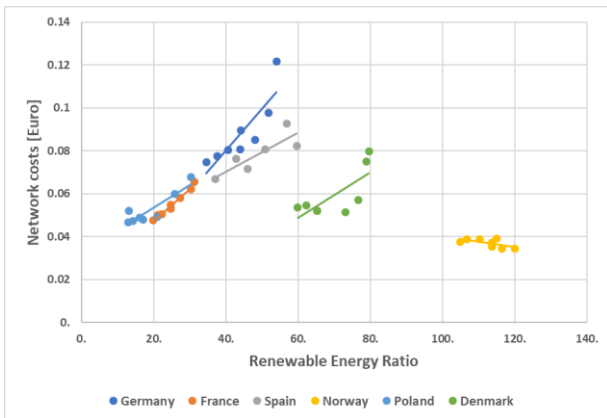
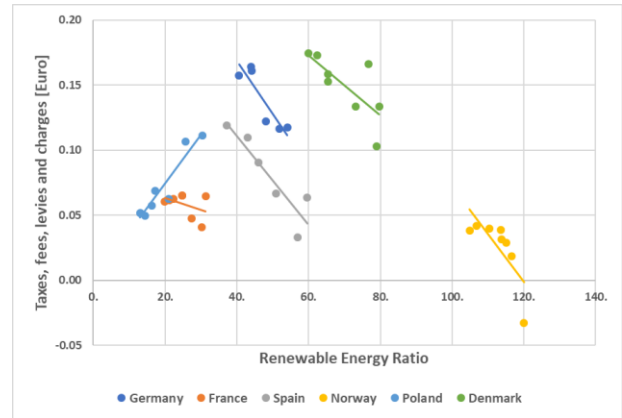
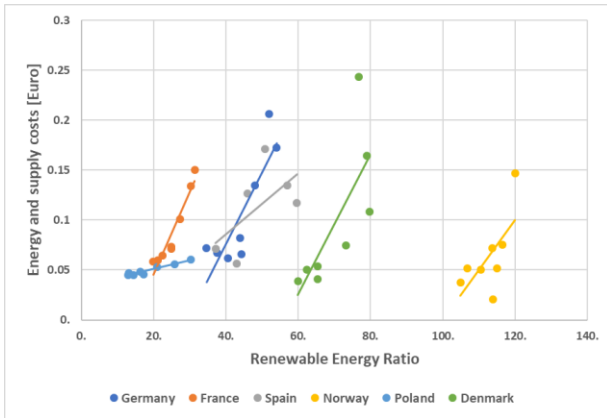


Figure 2. Changes in energy and supply (top), and network costs (bottom) as a function of the renewable energy ratio since 2017.

Figure 2 presents how each component of household electricity prices varies with the renewable energy ratio. Overall, both the energy and supply and network cost components tend to increase as the renewable energy ratio rises across countries, and the underlying mechanisms are discussed in Figure 3.

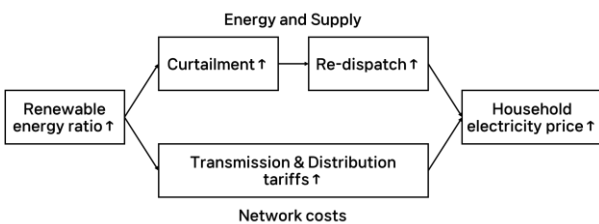


Figure 3. Mechanisms for increasing household electricity price with renewable energy ratio.

From the energy and supply perspective, higher renewable penetration is associated with more frequent curtailment, which can in turn increase the need for re-dispatch and balancing actions; these system operations may contribute to higher household electricity prices.

From the network cost perspective, renewable energy is often deployed as distributed generation, with geographically dispersed connection points across the

Figure 4. Changes in total taxes (top), and renewable taxes (bottom) as a function of the renewable energy ratio since 2017.

grid, which can increase the need for grid connection, reinforcement, and operational adjustments in transmission and distribution (T&D) networks. As a result, regulated network tariffs may rise, thereby increasing household electricity prices

However, taxes tend to decline as the renewable energy ratio rises. As shown in Figure 4, this reduction is largely driven by a decrease in renewable energy related taxes and levies, which are intended to promote renewable energy deployment and improve efficiency. Taken together, these trends suggest that reductions in renewable levies may have been used to help stabilize household electricity bills amid increase in the energy and supply and network cost components.

### 3.3 Harmonized Index of Consumer Prices

Figure 5 illustrates how the HICP, a standardized index of consumer prices across EU states, changes with the renewable energy ratio. Overall, the HICP tends to increase as the renewable energy ratio rises across countries. When considered alongside the household electricity price trends, it suggests that household electricity prices have increased faster than the general inflation rate. This may reflect additional upward pressures arising from the energy and supply and network cost.

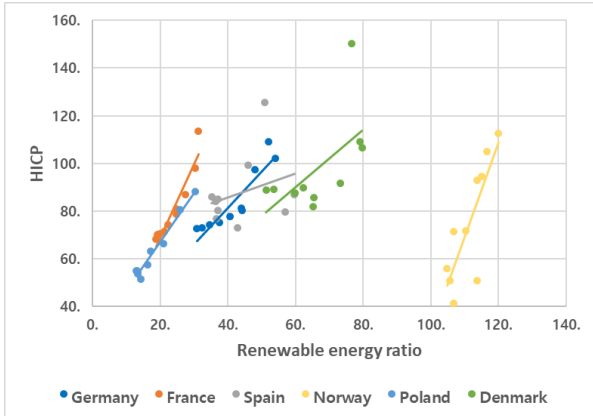


Figure 5. Changes in the HICP as a function of the renewable energy ratio since 2015.

#### 4. Conclusions

Despite the declines in renewable energy CAPEX and LCOE driven by rapid growth in the renewable energy industry, household electricity prices have remained high in many EU countries. This paper highlights two factors that may contribute to upward pressure on household electricity prices: (i) the viability of renewable generation increase curtailment and the need for re-dispatch and balancing actions, and (ii) expanding renewable deployment, often characterized by distributed connection points, can raise transmission and distribution tariffs through additional network investment and operational requirements. Additionally, the observed increases in household electricity prices appear to outpace the average inflation rate across EU states, as reflected by the HICP.

As further work, the following will be addressed: (i) a multiple regression analysis will be conducted using country-level panel data to quantify the relationship between renewable energy expansion and household electricity prices; and (ii) the regression results will be applied to the Korea context to estimate future household electricity prices.

#### REFERENCES

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