THE ROLE OF ENERGY STORAGE WITH RENEWABLE ENERGY INTEGRATION: EVIDENCE FROM THE EUROPEAN UNION

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Overview

The increasing concern of an environmentally friendly atmosphere has led many of the industrialised countries to reduce their conventional energy use and to finance renewable energy (RE). The European Union (EU) for instance has a renewable energy target of 20% of the total energy consumption by 2020 and further agreed upon minimum renewable energy target of 27% by 2030 (European Commission, 2017). Although RE sources are increasingly supported—high capital cost, increasing electricity prices, the potential difficulty of integration into the conventional electric grids due to intermittency, and issues in RE integration policies (large amount of subsidies) have created a delay and difficulties in achieving renewable energy targets (Frondel, Ritter, Schmidt, & Vance, 2010; Schmalensee, 2011). Higher electricity prices and increasing levels of electricity import dependency can be seen as two main issues highlighted for the EU countries with RE integration. For example, Denmark and Germany have the world's highest domestic electricity prices, whereas Italy and the UK are among the countries which have highest industrial electricity prices in the world (IEA, 2016). Additionally, net electricity imports in Italy was 46.52 TWh which was approximately 15% of the annual electricity generation (Eurostat, 2016). To remedy these issues created by RE integration, many countries are increasingly using energy storages and have targets to increase the use of energy storage capacities at an alarming rate (IEA, 2017).

Therefore this paper aims to quantify the effects of RE integration and energy storage addition on electricity imports and price. We also estimate what percentage of energy storage capacity a country should maintain to reverse the unfavourable trends in order to reach RE targets. When considering electricity prices, two significantly different price settings can be observed, namely, the domestic and industrial prices. Increase in domestic electricity prices will reduce the living standard of the general public and it can affect political stability of those countries. Industrial electricity price increase negatively impacts on economic development. When industrial prices are high the ability of the firms to compete in the goods market reduces as the exports becoming expensive. Therefore countries make an increasing effort to maintain industrial electricity prices at a low level. Further, fluctuating and unpredictable nature of RE supplies can increase the electricity exports and imports among interconnected countries such as EU. When countries rely more on imported electricity there are always risks of restricting supply due to political objectives, failure in the interconnectors, macro-economic instability of the supplying country, and collapse of the EU. Import dependency may also create free-riders where some countries will get the benefits of the union without contributing a fair share (Meyer & Gore, 2015). Similarly, electricity export may also become a risk when countries rely on profits from exported electricity to recover the capital and operational cost for RE plants. When the demand for electricity export is not strong, the plant factor of the existing power plants becomes less and revenue will be lost. This creates a considerable economic impact for energy exporters.

Methods

A stylised model was developed to estimate the impacts of RE integration and to test whether the countries can recover from the issues created by the RE integration through energy storage capacity. Since the focus in on three impacts, we set up a model with three dependent variables namely, net electricity imports (TWh) - $\boldsymbol{Y_1}$, domestic electricity price (pence/kWh) - $\boldsymbol{Y_2}$, industrial electricity price (pence/kWh) -$\boldsymbol{Y_3}$, and the two independent variables are annual RE generated (TWh)- $\boldsymbol{X_1}$, energy storage capacity (GW) - $\boldsymbol{X_2}$. A multivariate panel data regression technique is used for this model covering the period 1990 to 2015. We employ this model for 17 EU countries out of 28, subject to the data availability as per IEA dataset, U.S. Department of Energy and EU commission.

Results

1. <u>Results for all 17 EU nations</u>

With increasing RE integration net electricity imports, domestic electricity prices, and industrial electricity prices shows an increasing trend. However, when energy storage capacity increases, net electricity imports reduced, while retail electricity prices (both domestic and industrial) remained stable over the sample.

2. Results for EU countries which had more than 7% of energy storage share[1] (Austria, Spain, Italy, UK, Ireland, Poland, Portugal, Belgium, France)

With increasing RE integration net electricity imports and domestic electricity prices show an increasing trend and unlike in previous results industrial electricity price remains stable. For any increment in energy storage, both net imports and industry prices showed a downward trend.

3. Results for EU countries which had more than 10% of energy storage share (Austria, Italy, UK, Ireland, Poland, Portugal, Belgium, France)

For any further increment in energy storage, net electricity imports decline and both electricity prices fall, making the trend of all variables conducive.

4. Results for EU countries which had more than 3GW of energy storage capacity (Austria, Italy, UK, Portugal, France, Germany)

Interestingly this time the increasing integration of RE had no adverse effects on electricity imports and industrial prices. Furthermore, at this level of energy storage, any additional capacity again reduced both import dependence and electricity prices (domestic as well as industrial).

Summary of the results for RE integration (X_1)

	For all 17 countries	Energy storage share > 7%	Energy storage share > 10%	Energy storage capacity > 3GW
Net electricity imports - $\boldsymbol{Y_1}$	Increase	Increase	Increase	Stable
Domestic electricity price - $\boldsymbol{Y_2}$	Increase	Increase	Increase	Increase
Industrial electricity price -$\boldsymbol{Y_3}$	Increase	Stable	Stable	Stable

Summary of the results for energy storage capacity (X2)

	For all 17 countries	Energy storage share > 7%	Energy storage share > 10%	Energy storage capacity > 3GW
Net electricity imports - $\boldsymbol{Y_1}$	Decrease	Decrease	Decrease	Decrease
Domestic electricity price - $\boldsymbol{Y_2}$	Stable	Stable	Decrease	Decrease
Industrial electricity price -$\boldsymbol{Y_3}$	Stable	Decrease	Decrease	Decrease

Conclusions

Increasing renewable energy capacity without sufficient energy storage, increase the net electricity imports and prices among the EU. When maintaining adequate amount of energy storage levels, these trends become favourable and create the opportunity to achieve the RE targets. Further the study finds that at least 7% of energy storage share should be maintained in order to keep the industrial electricity price stable with RE addition. Similarly, a minimum of 10% energy storage share should be maintained in order to reduce both electricity imports and prices (domestic and industrial) with energy storage increment.

References

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[1] Energy storage share = energy storage capacity/ RE capacity