



## **D2.3 Report on the empirical case study analyses emphasising the challenges in the very short-term, short-term and long-term electricity markets in Europe with high shares of RES-E penetration**

**Aurore Flament, Ruben Verhaegen, Tiffany Chow**

May 2015

Version: Final

Dissemination level: Public

Agreement n.:

IEE/13/593/SI2.674874

Duration

April 2014 – September 2016

Co-ordinator:

SINTEF Energi AS

Supported by:



Co-funded by the Intelligent Energy Europe  
Programme of the European Union



---

### **LEGAL DISCLAIMER**

*The sole responsibility for the content of this report lies with the Market4RES consortium. It does not necessarily reflect the opinion of the European Union. Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained herein.*

---



## Executive summary

Considering the recent supply mix shifts from fossil-fuel generation to renewable generation and the desire to improve energy security and economic efficiency, analyzing the design of the current integrated European electricity market that was designed based on technologies and policy objectives of the 1990s and investigating whether it is still well-optimised becomes key. Renewable sources of energy present in fact unique characteristics that create unique challenges in an Energy-only market, and influence the performance and outcomes of electricity markets.

This report assesses empirically the challenges and issues for the short-term, medium and long-term electricity markets through a selection of case studies that cover three different market regions with different RES-E penetration levels in the European electricity market (the Nordel system, Central-Western European system and the Iberian system).

The analysis reveals that with increasing shares of RES-E:

- **average spot and futures prices tend to fall** (phenomenon that can be explained by the “merit-order effect”). There appears to be a positive correlation between price trends and RES-E share percentage, though other factors are also important in setting spot and futures prices;
- **negative prices occur more frequently** on the spot market due to the intermittency of these energy sources. Germany for instance experienced 297 hours of negative prices on its day-ahead market (EPEXSPOT) since 2008, hitting a low of -500 €/MWh in 2009. Three major elements can explain the occurrence of negative prices: the high production subsidies and the lack of appropriate market incentives to address negative market prices, the limited flexibility of conventional power plants, the must-run conditions of conventional power plants;
- **price volatility tends to increase;**
- **RES-E curtailment is sometimes needed** to manage oversupply and system security. Spain in particular makes extensive use of curtailment due to its high wind production levels, lack of interconnection to neighboring markets (particularly France and Portugal), must-run conditions of some non-RES units, and low demand levels at off-peak times.

When looking at the impact of market coupling on electricity prices, it can be noticed that:

- **market coupling optimises the spot prices** and flows between interconnectors since generators benefit from increased export capacity and consumers from more import capacity. Moreover, there is a noticeable convergence of average monthly and yearly futures prices after the CWE market coupling announcement. Market coupling must however be paired with sufficient interconnection capacity to realise its full effect;
- **volatility on the spot markets increases when interconnectivity is low** and real price volatility decreases only come with huge investments in infrastructure. On the futures market, the analysis revealed that monthly futures price volatility within and between countries in the Central-Western European (CWE) region decreases after the market coupling in September 2010;



- **Interconnection capacity in addition to flexible operation units can help promote spot price stability** during high production periods. Increased RES-E with more interconnections tends to lead to lower and more stable prices. Higher interconnection capacity and average export volumes leads to lower monthly futures prices.

Finally, the analysis of nuclear maintenance and phase-out events and of the relationships of commodity prices reveals that:

- **building interconnection capacity is a key to ensuring security of domestic supply and stable spot price levels** during low production periods. The announcement of the shutdown of a nuclear plant temporarily drives yearly futures prices up, but other factors such as higher shares of RES-E and the possibility to import cheaper energy from neighbouring countries through interconnectors play a greater role in influencing prices in the long term;
- if there is some **observable correlation between the TTF Gas prices and the day-ahead market prices**, at least for the Netherlands, the correlation between the European Brent oil prices and day-ahead market prices is nearly not existent. Monthly futures natural gas prices are mostly positively correlated with the monthly futures power prices.

The last section of the report examines best practices in international markets of relevance and with transferability potential to the European market. Measures such as advanced RES-E forecasting techniques, wind participation enablement and shorter dispatch intervals for the short-term markets can be found in the United-States, California and Australia respectively to address the increasing renewable shares. Measures in the United-States to address market coupling and increase economic efficiency include nodal pricing systems, complex bids possibilities and the pool type trading system. Security of supply is addressed in California and Brazil through specific capacity remuneration mechanisms and in India through a pricing system linked to frequency.

To conclude, several measures can be used to better adapt markets for the modern environment such as increasing interconnection capacity, demand-side response, increasing the flexibility of the system, improving forecasting techniques and optimizing the interplay of intraday, balancing and day-ahead markets.