# Post-2020 framework for a liberalised electricity market with a large share of renewable energy sources

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Market RES

# Post-2020 framework for a liberalised electricity market with a large share of renewable energy sources

A study on the potential evolution of the Target Model for the integration of EU markets that will enable a sustainable, functioning and secure power system with large amounts of renewables

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# FOREWORD FROM THE COORDINATOR

*Setting the 2020 climate and energy targets in 2007 was an important milestone, indicating a paradigm shift for the European power industry, which used to be one of the most conservative sectors. Massive efforts were made to promote an accelerated integration of Renewable Energy Sources (RES) in Europe. The support schemes for RES technologies have been a success story, resulting in considerable volumes of RES added to the generation mix.*

*The market interventions on this scale have however led to some adverse effects of the financial subsidies and significant penetration of electricity from renewable energy sources (RES-E). This highlights the need to modify the existing European electricity market design in order to guarantee sustainable framework conditions in the long-term, both for the market-compatible integration of further RES-E technologies and for the maintenance of adequate levels of firm electricity generation capacity.*

*Finalising Market4RES today, we conclude that our expectations and hypothesis made some years ago during the preparation phase of the project proved to be correct and the selected research approach was adequate to the challenge.*

*An effective market design should provide sufficient investment signals to accommodate a high share of renewables while achieving the required level of security of supply. Which market design can be effective in achieving these two European Union energy policy goals? More specifically, should renewable sources continue to be supported, and if so, which mechanisms should be applied? Will capacity remuneration mechanisms be a necessity in the future? How should balancing markets be adjusted for higher shares of renewables? These are some of the questions we tried to answer. The research, which was conducted by the partners throughout the course of the project, has truly demonstrated the complexity of the issue and again showed that there are no easy solutions to this challenge.*

*After two and a half challenging years, we are happy to be able to share our results and conclusions. We hope that the Market4RES recommendations will contribute to the understanding of these complex issues and inspire European stakeholders and policymakers in shaping the future European power industry.*

Andrei Morch
SINTEF Energy Research

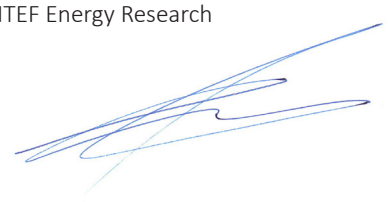


Photo: Thinkstock

# EXECUTIVE SUMMARY AND POLICY RECOMMENDATIONS

## HARMONISATION AND INTEGRATION OF EUROPEAN ELECTRICITY MARKETS

In 2008, the European Electricity Regulatory Forum decided to develop a European Union-wide Target Model (TM) and a roadmap for the integration of electricity markets. The TM encompasses the harmonisation of market rules in order to facilitate cross-border trading across all periods (day-ahead, intra-day, balancing and forward markets). This harmonization brings opportunities and challenges to make high penetration of renewable energy in the power system compatible with the satisfactory functioning of electricity markets in Europe.

## INCREASING SHARE OF RES-GENERATION AND THE NEED FOR FURTHER MARKET REFORMS

Today, roughly a third of power generation in Europe comes from renewable energy sources. This is, to a large degree, a result of support to renewable power generation. Support mechanisms such as feed-in-tariffs (FIT) have provided a fixed income per MWh produced and priority dispatch has significantly reduced the risk for curtailment of RES generation. These instruments were designed to meet the intended policy objectives, in particular reducing $CO_2$ emissions from fossil-fuel generation.

However, a current challenge is that power producers are finding it increasingly difficult to recover their investment costs without additional support instruments due to low wholesale electricity prices. This has raised concerns about the development of security of supply. Low prices are caused by several factors, including an increasing penetration rate of renewable generation with low marginal costs, and low $CO_2$ prices. Another challenge is that electricity prices have become more volatile, and some existing support schemes incentivise generation even at times when electricity prices are negative.

A European discussion has emerged on how to improve electricity market design further. A key point in these discussions is how to reform support instruments for renewables in order to reduce interference with short-term market signals and limit public support to new generation assets.

## KEY MARKET FEATURES FOR SUCCESSFUL INTEGRATION OF RES

The need for redesigning RES support schemes is mirrored by the need for making markets more fit for RES. The Market4RES project has assessed the key design features which are critical for the successful participation and integration of renewable electricity producers in a fully liberalised and competitive European market across all periods (day-ahead, intraday and balancing). The project arrived to the following conclusions (which also are summarized in Figure 1).

**Faster markets:** the timing of markets should evolve to reflect faster changes in system conditions, which are largely caused by weather patterns. The point in time when transmission system operators (TSOs) receive the generation schedule should be pushed as close as possible to real time, giving market players with variable generation the option to self-balance their deviations via the market. This would increase the value of existing renewable generation, and reduce the need for capacity that is flexible on short notice (e.g. only a few minutes before real time).

**FIGURE 1**
**Key market features for successful integration of RES in all market timeframes**


Source: WindEurope

**Larger markets:** in order to couple cross-border markets at all periods (day-ahead, intraday, balancing), the available transmission capacity for trading should be clearly defined. TSOs should use more sophisticated methods (flow-based transmission capacity allocation) and make use of a Common European Grid Model, which takes into account the relationship between commercial flows and physical congestion on affected transmission network elements, maximizing the use of existing infrastructure.

**Smaller products:** smaller periods for electricity trading products are positive for the participation of variable renewable generation units. However, they should be combined with other products to find a balance between liquidity in the markets and the cost of implementation.

**Efficient pricing:** the prices should be transparent and should not be artificially kept from revealing scarcity. This means that price volatility and spikes should be seen as positive outcomes of a market that signals when investments are needed, either in capacity or in flexibility.

**Level playing field:** the design and rules should establish a level playing field for all market players. This includes market access, increased transparency of operation procedures, and a polluter pays principle.

The ongoing work on harmonisation of balancing responsibilities for all market parties should be accompanied by rules for trading closer to real time and fair market access. Having an intraday market with a short gate closure time and a sufficient level of liquidity is fundamental.

Also, in order to achieve a level playing field, priority dispatch to conventional generators must be eliminated. A reform of the EU emission trade scheme (ETS) is needed to restore a meaningful price for $CO_2$ and thus ensure polluters pay for the full costs of generating electricity with the technology and fuel of their choice. Lastly, continued support to conventional technologies needs to be addressed in parallel with reform of market design rules and the revision of State Aid Guidelines for Environment and Energy.

## DAY-AHEAD MARKET

**Locational pricing:** Market4RES recommends either a zonal (one price per TSO control area) or a hybrid zonal (several/some price areas per TSO control area) pricing scheme.

**Administrative reliability pricing:** with higher shares of varying renewable generation, Market4RES recommends having an administratively set price during capacity shortage conditions in addition to the reserve requirements needed for reliability. To the extent possible, this price should reflect the value that curtailed demand puts on electric energy.

**Gate closure:** the project recommends establishing a well-functioning intraday market rather than pushing the day-ahead market closer to real time.

## INTRADAY MARKET

**Market period:** after a comparative evaluation of different alternatives, the project concluded that a combination of continuous trading with discrete auctions (a hybrid solution) could be the best design variant.

**Enlarging the geographic scope:** when coupling cross-border intraday markets, regional auctions should be introduced on a large scale. To do so, more regional coordination and some harmonisation on auction timings and gate closure times would be required.

**Increasing liquidity:** Market4RES recommends increasing liquidity in the market by introducing intraday auctions. Obligatory unit bidding also seems to play a significant role in increasing liquidity by encouraging renewable generators to adjust their position to avoid significant balancing costs. The relatively low utilisation of cross-border capacity in the intraday suggests that the reassessments of network conditions after day-ahead gate closure time should be improved. The introduction of an intraday auction could also improve liquidity by attracting market players who would otherwise not have access to continuous trading.

**Product design:** Market4RES recommends the introduction of more granular (e.g. 15-minute) products as in the German market. This would allow participants to refine their schedules more often, thereby limiting deviation from their real production compared to an hourly basis.

## BALANCING MARKET

With respect to market designs for balancing markets, the Market4RES project recommends the following designs:

**Procurement of balancing reserves:**

- Separated procurement of balancing capacity and balancing energy products is a preferable market design option;
- Separated procurement of upward and downward balancing capacity would contribute to increased balancing market efficiency;
- There should be no technology-specific products on the market;
- Smaller minimum bid size should be required and the aggregation of several units should be facilitated;
- Compared to pay-as-bid pricing, marginal pricing should lead to more efficient balancing markets.

**Imbalance settlement arrangements:** Imbalance settlement periods should be shorter in order to make the calculation of imbalance price more cost-reflective. Single imbalance pricing typically leads to higher efficiency in electricity balancing.

**Global coherence among market designs implemented**

- Only imbalances occurring after the closure of the intraday market should be balanced by TSOs within the balancing market period;
- Bids activated for purposes other than balancing should not determine imbalance volumes and/or prices.

# DEMAND PARTICIPATION

Demand-response should be one of the central topics addressed by the European Commission in its legislative proposals to redesign the electricity market, expected in the second half of 2016.

**Design options for demand participation in short-term markets:** the most important mechanism to promote demand-side response (DSR) is to expose consumers to electricity prices through their contract with their supplier, which requires real-time metering of actual consumption. This can be applied for day-ahead market prices but also for shorter time horizons. Independent demand-response aggregators can be important for developing additional demand-response resources. The qualitative assessment carried out in the project concludes that both implicit and explicit schemes should be allowed.

**Quantitative analysis of the impacts of demand flexibility in short-term markets:** the analysis shows that demand flexibility considerably reduces the need for running expensive peak units. The studies also show results for the impacts on generation mix, costs and profits, market prices, $CO_2$ emissions, and cross-border market integration.

**Participation in long-term markets: Three steps in building a DSR-capable market design are recommended:**

- Explicit participation of demand in all markets;
- Adapted governance framework to make it possible for DSR aggregators to fully compete with suppliers;
- Policy-makers may want to foster DSR through specific support schemes, and remove barriers for DSR participation.

An assessment of implicit vs. explicit participation in capacity markets for DSR has been carried out in the project. It is concluded that neither of the options should be strictly preferred.Both should be allowed if capacity markets exist to make room for all types of demand-response products and market arrangements.

# RES SUPPORT SCHEMES

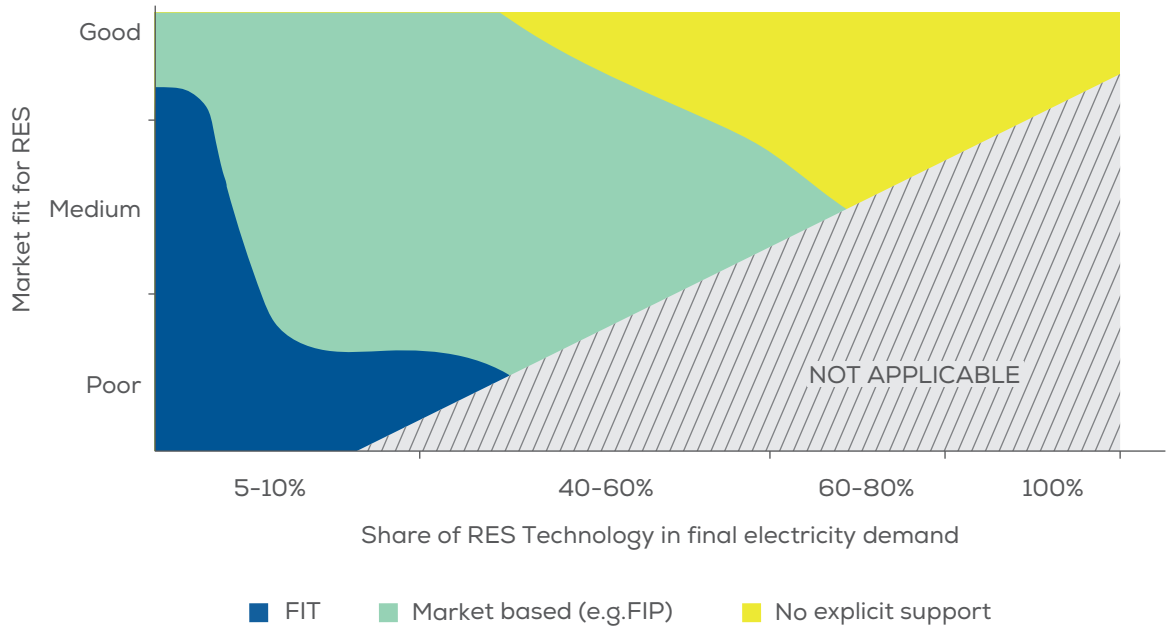
**Assessment:** Market4RES project partners have assessed RES support schemes using the following criteria: efficiency, effectiveness, robustness, implementability and risks for investors. The assessment is carried out both for short-term impacts on markets, and for the long-term impacts of schemes. Market4RES recommends that design options should be of a market nature (i.e. tenders/auctions) in order to increase their efficiency and reduce the possibility that authorities control support payments. The following schemes performed well in the assessments overall: feed-in premiums (set in auction), and long-term clean energy or capacity auctions. The following schemes did not perform well: feed-in tariff, net metering of demand and generation, nor support based solely on the provision of grid support services.

**Discussion:** clean capacity auctions performed very well in the assessment, both with respect to minimise interference with short-term market signal and its long-term impacts. However, a floating version of feed-in premiums reduces risk for investors with respect to future income (bringing down financing costs) and coincides better with the new State Aid Guidelines for Environment and Energy.

**Recommendations:** the Market4RES project recommends a floating feed-in premium. The total price is set through a tender/auction. The premium on top of the electricity price is the difference between the strike price (result of the tender) and a reference market price (expected average electricity price over a period of time). This reference price might be regularly adjusted (e.g. every 2-3 years) to shield producers from long term price uncertainty. At the same time, incentives are provided to optimize generation profiles (could be important e.g. for site selection, technology development, and some short term flexibility).

To ensure an efficient short-term price signal, one of the following should be implemented: a) the supported volume is not reduced in cases when renewable generation units intentionally reduce output production to support the system operation (e.g. to provide downwards regulation

**FIGURE 2**
**Market schemes depending on RES penetration & market conditions**




Source: WindEurope

services), or b) the volume produced at times when market prices are negative is not supported. Technology-specific tenders should be permitted; tenders should not apply to all market parties (e.g. small players to be excluded).

**Roadmap towards 2020 and beyond:** an illustrative representation of a potential support schemes evolution has been developed. In this conceptual model, two dimensions are stipulated: technology maturity, represented by their market share, and the degree to which the market is adapted to account for the specific characteristics of the technology. In the early stage of market deployment, new technologies are generally expensive and not yet competitive. Nevertheless, if they represent a long-term cost reduction potential, they should be supported with instruments that reduce investment risk as much as possible to accelerate deployment at an appropriate cost for society. Producers should be exposed to prices only when the market is well adapted for this new technology. As the technology matures and increases its share in the energy mix, it is important to adjust the market instrument, reducing the overall support but also making it more dependent on market dynamics. The better the market situation, the faster this transition can be made. In well-functioning markets, and with further technology development, RES production could eventually be financed without explicit support schemes.

The Market4RES project recommends that the European Commission Guidelines on State Aid Support for Environment and Energy should be extended after 2020, in line with the current framework, building on both increasing experience from tender systems and premium-based schemes.

## CAPACITY MARKETS

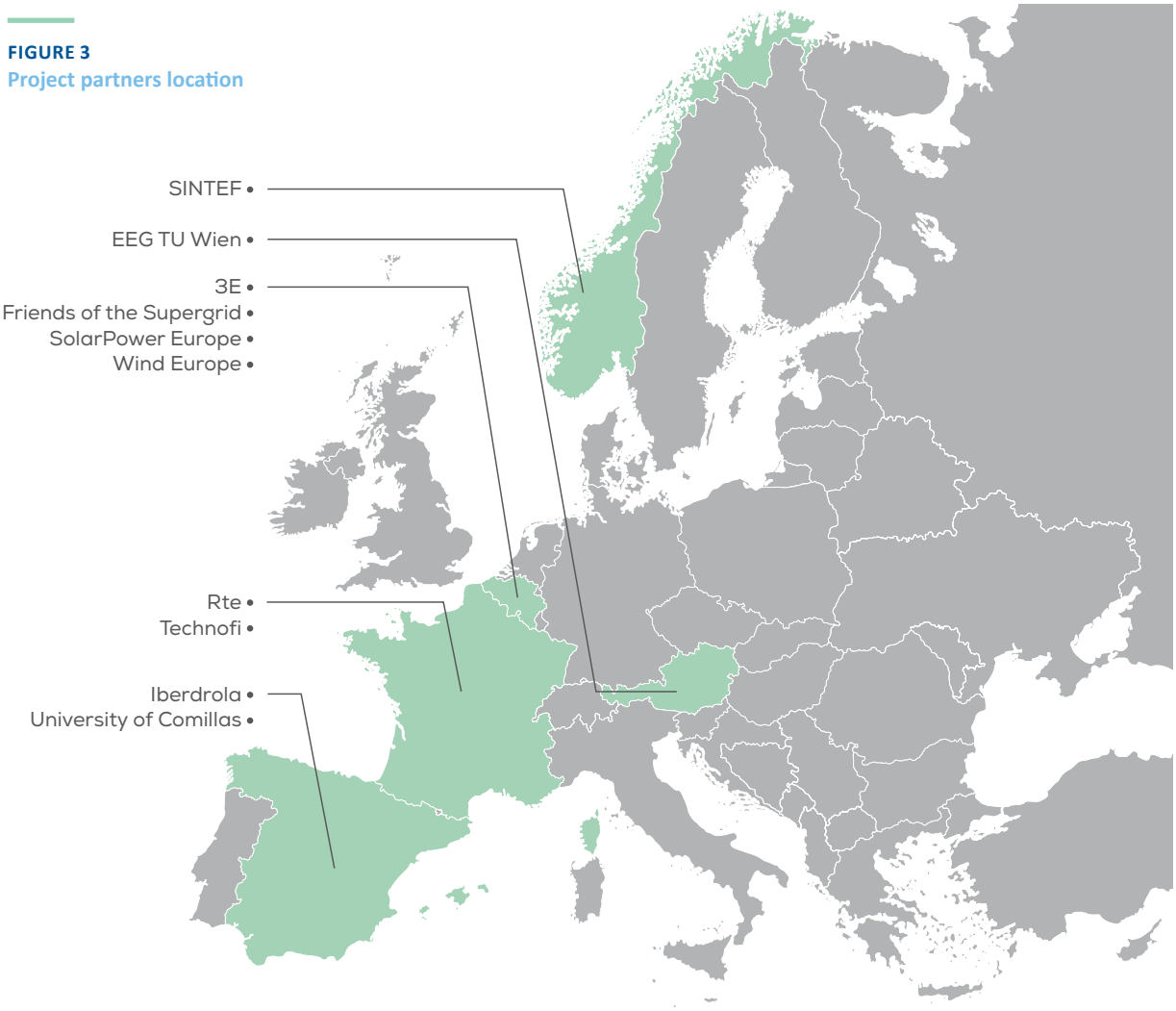
A fully functional energy market is undoubtedly the desired scenario when workable. The Market4RES project does not take a position on whether capacity remuneration mechanisms are needed. However, we have assessed preferable design options for such mechanisms in case a robust and regional system-adequacy assessment concludes that a capacity remuneration mechanism is required.

**The product:** a financial option with a high strike price is recommended. This gives a provision of certainty to investors in firm capacity and adequate incentives for agents to participate in short-term markets.

**Procurement:** it is recommended that a price-quantity curve is used to set the procured amount, and that the procurement take place through a centralized auction.

**Cross-border competition:** the existing foreign capacities and interconnectors are already contributing to the security of supply in a country if it imports electricity during times of peak load. However, additional generation capacity in foreign countries would not give any further help if the transmission lines connecting these countries (direct and indirect routes) were congested. Several options to include interconnections in capacity markets are discussed in the project and it is concluded that an accurate mechanism corresponds to the simultaneous explicit participation of interconnections and foreign generators or demand-response entities. However, legal limitations for the implementation of the explicit participation of both generation and transmission capacity within current EU regulations are identified. Considering those obstacles, a pragmatic approach consists of implementing the explicit participation in interconnections only, which is the solution selected in the United Kingdom and accepted by the Commission.

**FIGURE 3**
**Project partners location**




Source: WindEurope

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Photo: WindEurope

Market4RES is a EU-funded project that investigates the potential evolution of the current design of the European electricity market, the so-called Target Model, in a way that allows the sustainable integration of large amounts of renewable sources. This publication sets guidelines for policy makers in the implementation of electricity market design.


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