

## Overview

This study aims to create a structured analysis of the variety of market reform proposals that emerged in reaction to the current energy crisis. The energy crisis resulting from the Russian invasion of Ukraine has had a significant impact on the European Union. The EU's reliance on Russian gas led to European natural gas prices reaching levels ten times higher than the previous decade's average, which, in turn, caused a shock in the electricity sector, resulting in prices rising over fifteen times the previous decade's average. This led to a discussion around potential windfall profits for some technologies, such as nuclear, hydro, and variable renewable energy sources, which may have benefitted from the unexpected high prices. For residential consumers, energy prices soared, challenging especially households at risk of energy poverty. At the same time, these high prices triggered industrial closures and reduced outputs. To address this situation, European countries implemented various short-term interventions, but the President of the European Commission also announced a structural market reform to protect consumers and promote the transition to renewables, reducing Europe's energy dependence<sup>1</sup>.

Recently, academics, think tanks, private companies, and governments have provided recommendations and concrete proposals regarding the market reform. In March 2023, the European Commission published a proposal to modify certain aspects of the market structure to protect consumers, improve predictability of energy prices, facilitate investments in renewables, and ensure the deployment of non-fossil flexibility [1]. This proposal aims to enhance access to and liquidity of long-term markets through Power Purchase Agreements (PPA), introducing two-sided Contracts for Differences (CfD) as the preferential mechanism to provide public support to, e.g., variable renewable energy and nuclear. The proposal also argues for the expansion and redesign of capacity markets to aid low carbon flexibility, such as Demand Response and storage technologies.

This study aims to classify and characterize the main academic, Member State and stakeholders proposals related to the electricity market reform needed to adapt the market to the energy transition, with variable renewable energy sources as the backbone of the system and the requirement of hybrid markets with larger cooperation between the public and private spheres [2], meaning more involvement of government planning and tendering [3]. While the proposal is a starting point for discussion, modifications based on the contrast with academic's proposals to the EU proposal and input from Member States may occur. Over the last months, different reports and papers have come out aiming to deal with the overall market design or specific policies or market mechanisms. However, the divergent ideas and ongoing discussion has not provided yet with an overview of the situation, main points of disagreements nor the existing gaps and stakeholder behaviors that policy changes might generate.

## Method

This paper aims to analyze and compare different market proposals that have emerged in the last two years to facilitate the integration of renewable energy sources in the transition to a fully decarbonized energy system. To do so, we employ the formal evaluation framework to provide a systematic comparison regarding the policy objectives, scope and design variables that arise from the different market design proposals [2]. We summarize the main similarities and differences between these proposals to highlight potential gaps in knowledge and the potential consequences of implementing reforms without considering interactions between these policy instruments and markets. Our goal is to assess future lines of research that are not fully understood or quantified at present, as policies may have unintended consequences or non-studied feedback loops [4].

## Results

Academic consensus exists on some of the main market failures that need to be addressed in this reform. While the short-term market efficiently dispatches resources, the energy-only market does not provide the right incentives to install renewable energy sources, which are very capital-intensive, hence, sensitive to the cost of capital [5]. Most scholars agree that the need to de-risk this type of investment is crucial [6]. On the consumer side, the lack of liquid long-term markets has left consumers without the capacity to hedge

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their consumption against risks [7] nor benefit from VRE costs reduction. Additionally, analysts agree on the lack of consumer protection against price spikes over longer periods.

However, there are significant differences in the degree of market intervention, the remuneration schemes, and the role of Contracts for Difference (CfDs) and PPAs in the various proposals. While some proposals aim to maintain the current market structure and advocate for limited reforms on specific elements [7], others argue for a complete shift to specific long-term contracts by technology with the state as the only buyer, forcing all assets to sign such contracts in competitive tenders [5].

Regarding the access of consumers to the benefits provided by variable renewable energy sources, some proposals aim to open the door to market mechanisms allowing consumers to purchase Power Purchase Agreements (PPAs) and enhance a more liquid long-term market [7]. However, some studies state that PPAs will not be able to deliver the required investments at the scale and time required for the system, but being a valuable resource for active and large private agents [3], [8]. Other proposals suggest that governments should be the only buyer and enhance competition through auctions [5], while authors propose the government as the only seller of these CfDs products back to consumers [9]. The design of CfDs can generate incentives to sub-optimally invest or dispatch assets, or not sufficiently de-risk investment, ultimately increasing total system costs. Proposals for CfD design can vary based on their physical or financial structure, the usage of a yardstick or not as a reference for generation, and volume de-risking over time [5]–[7], [9]. The formal evaluation framework will provide a systematic comparison regarding their policy objectives and scope of the different market design proposals.

Although the degree of detail of the proposed market designs and policy mechanisms is increasing, we observe the following caveats. The proposals tend to be highly qualitative with simple quantitative examples that tend to disregard real-life market features already described in the scientific literature. Indeed, many of the assumptions of these simplified market models do not always hold in real markets, such as the absence of risk aversion of investors [10], the technical performance of different types of technologies under similar contract schemes, real behavior of agents, or market manipulation [11]. Changes in the rules can generate unintended consequences or non-studied feedback loops [4].

In the full paper, we provide a systematic overview of the conceptual similarities and disagreements between the different energy market reform proposals. In addition, this paper aims to conceptualize the unknown responses and results of these policies to present our understanding of the existing knowledge gaps existing in the debate around the electricity market design for the transition to a carbon free power system.

## Conclusions

The current energy crisis in Europe has put the current electricity market design under a magnifying glass, with the debate focusing on the effectiveness of the European Market Design to provide affordable electricity to all consumers while triggering sufficient investments in low-carbon electricity generation. While there is general agreement on issues such as the failure of future markets, the need to de-risk renewable investment, and the need for consumer protection, there is still debate regarding the role and degree of state intervention and the specifics of policy mechanisms. However, these changes could potentially have unintended impacts that have not been thoroughly analyzed and are often described in a mostly qualitative manner. In this paper, we identify new research avenues that must be addressed urgently to support a redesign of Europe's electricity market fit for a net-zero energy system.

## References

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