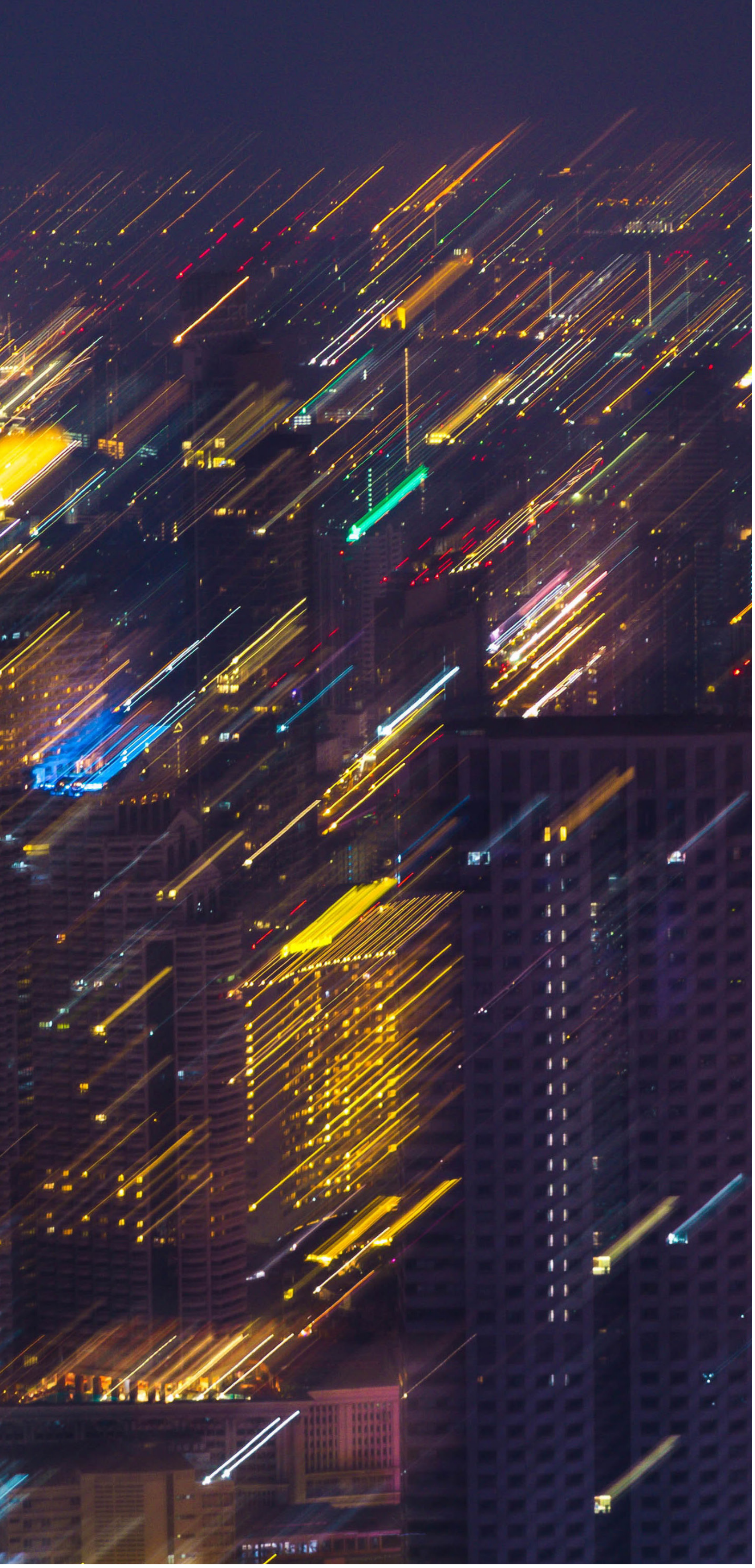

Power price crisis in the EU:

Unveiling current policy responses and proposing a balanced regulatory remedy

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Power price crisis in the EU: Unveiling current policy responses and proposing a balanced regulatory remedy

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Abstract

For several months, electricity prices in the European Union (EU) have been at sustained and unprecedentedly high levels. This situation has caused national governments to introduce temporary measures aimed at limiting the increase in end-user electricity bills. A number of governments argue that this situation calls for a wider reform of electricity markets in the EU — beyond the mere introduction of temporary measures. Their central message is that the price paid for electricity by consumers shall be linked to the average cost of generation, instead of being set by the marginal generation technology (often gas-fired plants) as it is today. It is, however, unclear how governments plan to reach this objective without overhauling the fundamentals of electricity market design and without affecting the power system efficiency both in the short run and long run. Thus, we start by reporting, interpreting, and assessing what has been publicly said about the need for a wider electricity market reform.

Then, we review the measures that have actually been introduced by Member States. We particularly discuss and criticize the two kinds of national measures that have been implemented but go beyond the European Commission (EC)'s recommendations: taxing of (alleged) windfall profits and mandating auctions for bilateral contracts. We also discuss two other potential measures that have been brought up in many of the conversations held over the last weeks and thus might be pursued, but which we do not consider as efficient approaches either: volume-restricted auctions for renewable energy source (RES) and negotiated long-term contracts on behalf of consumers.

Finally, we develop policy and regulatory recommendations. We start by supporting the measures proposed by the EC: the introduction or extension of energy poverty measures, the reduction of taxes and levies in the bill, and the acceleration of RES deployment. However, since the economic and socio-political situation is diverse across the EU, we explore alternatives for the Member States in which those measures are considered insufficient or even infeasible. We suggest that regulators could design and run auctions to purchase a long-term financial product on behalf of selected tranches of end users (deemed unable to withstand periods of sustained high prices). This would account for the fact that many financial instruments that might improve efficiency does not currently exist. The goal of this financial derivative, that we call "stability options", is to fulfil the objective of hedging those tranches of end users from extreme and long-lasting price shocks (keeping the monthly bills within acceptable limits), while respecting the basic market competition rules, avoiding any distortion of the short-term market price signal, and more importantly, without hurting the regulatory credibility of the European internal market.

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1. INTRODUCTION

Since the end of the summer 2021, Europe's energy prices reached sustained, unprecedented, and largely unexpected levels. These high energy prices had immediate economic impacts, reflected for instance in significant increases of inflation rates. Concretely, the Euro area annual inflation was 5.0% in December 2021. Energy, one of the main components of the basket of goods and services used to compute this inflation rate, recorded in December an annual growth rate of 25.9% (Eurostat, 2022). At the start of February 2022, the Italian Minister for Ecological Transition declared that the increase in the cost of energy risks outweighs the entire package of the EU Recovery and Resilience Facility[1] for 2022 (Pira, 2022).

In this note, we focus on the discussion around electricity pricing. Figure 1 shows the daily day-ahead electricity prices from 01/01/2021 until 01/20/2022 for a selection of Member States. Electricity prices rose steadily with a peak, at least so far, in late December 2021. The main driver behind high electricity prices has been high natural gas prices, as discussed in depth by the European Union Agency for the Cooperation of Energy Regulators (ACER, 2021a). In that regard, reforms of the gas market and even CO_2 markets have also been demanded in the EU — see e.g., Tesio et al. (2022) — but we do not go deeper into these issues in this note. The reason behind the correlation in the price of electricity and gas is that in the reference day-ahead electricity market, the price is set by the marginal unit, which in many Member States is often natural gas. And, as we discuss in more detail later, in a well-functioning electricity market, with rising marginal costs of the marginal unit, electricity prices rise. Similarly, electricity prices fall when the marginal costs of the marginal unit fall. As Figure 1 shows, the wholesale electricity price increase has not been homogeneous across Member States. These differences are mainly due to the different levels of gas dependency and of electricity interconnection with neighboring countries.

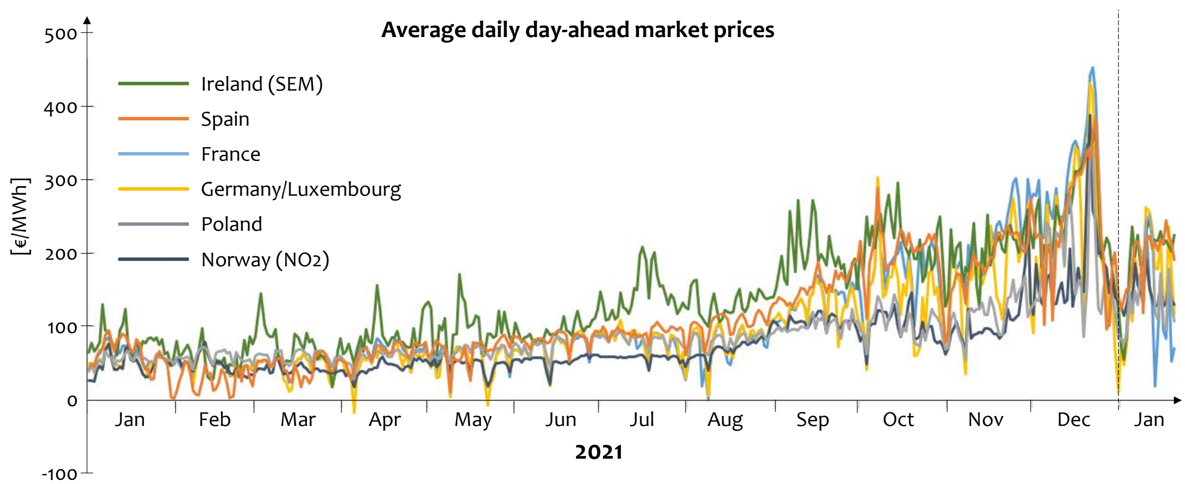

Figure 1: Average daily spot prices in some EU Member States from 01/01/2021 to 01/20/2022[2].

[1] The aim of the Recovery and Resilience Facility (European Commission, 2021a) is to mitigate the economic and social impact of the COVID-19 pandemic. It allows the Commission to raise funds to help Member States implement reforms and investments that are in line with the EU's priorities and that address the challenges identified in country-specific recommendations under the European Semester framework of economic and social policy coordination. It makes available €723.8 billion (in current prices) in loans (€385.8 billion) and grants (€338 billion) for that purpose.

[2] Own elaboration with data retrieved from ENTSO-E (2022).

The dependency between the gas price and the electricity price is shown in more detail in Figure 2 (left). For each year, the figure displays a "violin" plot representing the distribution function of day-ahead prices across Europe. In essence, the height of the violin represents the range of prices observed each year, while the width of the violin represents the (relative) frequency of occurrence of a given price level. The black dot represents the annual average cost of producing electricity with gas. The initial expectation was that gas prices would recover their usual levels sometime in spring. However, at the time of writing, the European Central Bank highlights that forward gas markets feature high prices until early 2023 (Figure 2, right). This expectation is also reflected by strongly increased prices of electricity futures contracts (Starn, 2021).

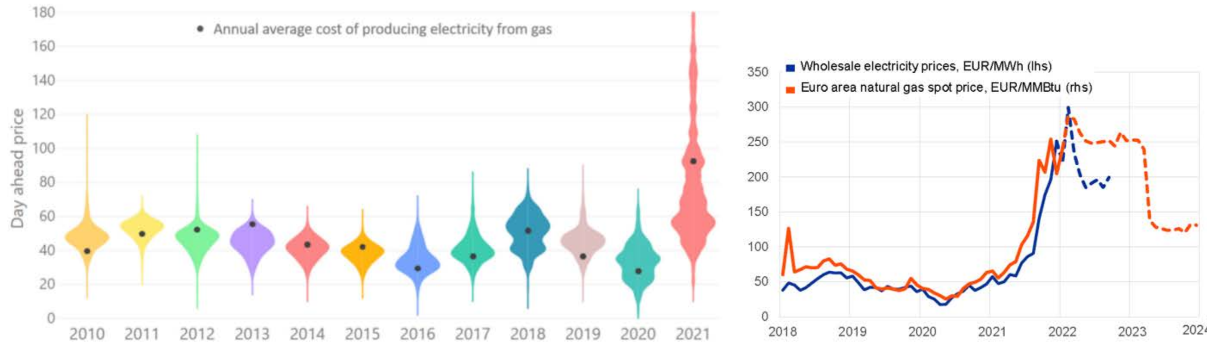

Figure 2: Left- Electricity day-ahead prices distribution compared to the cost of producing electricity with gas in Europe (2010–2021) (ACER, 2021a). Right- Past and projected future wholesale prices for electricity and natural gas in Europe (Schnabel, 2022).

During the last quarter of 2021, under the expectation that the electricity price levels would return to "normal" in the course of early 2022, most national governments introduced temporary measures to mitigate the impact of the high prices on consumers. While the vast majority of these measures (i.e., energy tax cuts and direct subsidies for households) are in line with the ones recommended by the European Commission (2021b), the governments of a few Member States (for instance France, Spain, and Romania) defended regulations that go beyond these guidelines. They claim that the EU recommended measures are insufficient and ask for deeper electricity market reforms, questioning important elements of the fundamental basis on which the current EU markets are built.

The claims do not only ask to explore ways in which end-user electricity price volatility could be diminished, but even alternative mechanisms "to link the price paid by the consumers with the average production cost of electricity." As we later detail, these claims are accompanied with the firm assertion that this could be done "within the limits of the European legislative framework and the EU internal energy market," although the declared desire is to amend a couple of key articles of the EU Directive. However, until now, it is not possible to find any public reference putting forward a sound proposal about how any of these (vague) alternative mechanisms could be practically put in place.

This note is divided into the following sections: in Section 2, we report the main claims related to the electricity pricing reform that we have been able to gather (further detailed in Annex A) and a brief review of the temporary measures proposed and/or implemented across the EU. Based on numerous off-the-record conversations held with diverse EU electricity market stakeholders (market agents, regulators, and academics), in Section 3, our effort centers on bringing in and critically reviewing the potential implications of different solutions beyond the toolbox measures that have been and might be under consideration. In Section 4, we prescribe first-best measures. In Section 5, we propose a balanced regulatory remedy in case first-best measures are deemed insufficient, politically infeasible, or economically unsustainable. This alternative consists of a centralized auction of long-duration call options, which we term “stability options.” In this auction, the regulator acts as the buyer on behalf of selected tranches of end users. Stability options serve as a protection in times of sustained high prices to prevent monthly bills from trespassing certain boundaries. These financial contracts respect the basic market rules, avoiding any distortion of the short-term price signal and harm to the regulatory credibility of the EU’s internal electricity market. Finally, we end with a concluding summary.

2. WHAT HAS BEEN SAID AND DONE?

This section consists of two parts. First, we briefly summarize the public calls for wider market reforms of the EU electricity market. A more extensive and detailed recap of the relevant political statements can be found in Annex A. Second, we describe the national measures that have been proposed and implemented as a response to the sustained high prices.

2.1 What has been said

The initial call for wider EU market reforms, as a reaction to the sustained high prices, came on September 2021 from the Spanish ministers of economy and energy (Calviño and Ribera, 2021). Among other ideas, they stood up for the "need to reform the wholesale electricity market" since "with today's market design, consumers are not participating in the benefits provided by a cheaper renewable generation mix" as "fossil fuel plants still set the price." They defended their own national measures, e.g., the introduction of a tax on windfall profits (discussed in more detail later), by stating that "other countries have adopted measures that are less orthodox, and the [European] Commission has maintained a prudent approach."[3] Some weeks later, the equivalent French ministers (Le Maire and Pompili, 2021) called for a review of the European gas and electricity markets, arguing that the "disconnection between electricity prices and actual production costs is particularly hard to understand in France." In early October, the Spanish and French ministers, together with their colleagues from the Czech Republic, Greece, and Romania published a common statement (Calviño et al., 2021) in which, among other suggestions, they argued in favor of reforming "the wholesale electricity market…to better establish a link between the price paid by the consumers, and the average production cost of electricity in national production mixes."

On October 13, the European Commission (2021b) reacted with the communication "Tackling rising energy prices: A toolbox for action and support," suggesting a set of measures, in line with the existing EU rules, to mitigate the impact of high prices on end-users' bills (from direct income support to tax reductions). The EC also tasked ACER to carry out an assessment of the current wholesale electricity market design by April 2022. About one week later, the Austrian, German, Danish, Estonian, Finnish, Irish, Luxembourgish, Latvian, and Dutch governments (2021a) supported the position of the EC and published a joint statement titled "Energy Prices in the EU- ACER Report", countering the statements from the Spanish, French, Czech, Greek and Romanian ministers. On November 15, ACER (2021a) submitted to the EC its preliminary assessment of Europe's high energy prices and the current wholesale electricity market design. In the assessment, ACER argues that "alternative market design approaches (e.g., price caps or technology dependent average prices) may risk jeopardizing some of the benefits from EU energy market integration."

On December 2, the preliminary ACER assessment was discussed at the Energy Council meeting with all EU energy ministers in Brussels. One day ahead of this meeting, the French, Greek, Italian, Romanian, and Spanish governments (2021) published another joint statement. Besides other recommendations, they proposed "to amend article 5 of the Electricity Directive in order to allow Member States to enforce regulatory mechanisms, designed at EU level, ensuring that final consumers pay electricity prices that reflect the costs of the generation mix used to serve their consumption."

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[3] We speculate that the country the Spanish ministers refer to is France, which has had the ARENH mechanism in place since 2011. We discuss the ARENH mechanism in more detail later in this section.

They alleged that these mechanisms would be "based on financial transfers between producers and consumers, [and] would have no effect on the functioning of the wholesale market." "Alternatively or simultaneously," they also proposed "to amend article 9 of the Electricity Directive… to allow Member States to enforce services of general economic interest designed to ensure to final consumers an access to a zero emissions and competitive electricity supply that reflects underlying generation costs."

The opposite camp, represented by the Austrian, German Danish, Estonian, Finnish, Irish, Luxembourgish, Latvian, and Dutch governments (2021b), published a second joint statement on the same day. In that statement, they repeated their support for the EC's stance, arguing that the energy price spike must be addressed "within the current European framework for climate and energy." These governments added that they could not "support any measure that would represent a departure from the competitive principles of our electricity and gas market design." Finally, during the Energy Council meeting, Kadri Simson, the EU Commissioner for Energy, echoed the core message of ACER's Preliminary Assessment, recalling the "risks that alternative pricing mechanisms could pose to cost-efficient decarbonization, cross-border exchanges, and security of supply" (European Commission, 2021d).

The very same day we had to send this version of our document to the MITEI editor for publication, we got to know about a web article report issued on February 18 by Kyra Taylor (2022), in which she leaked a draft communication from the European Commission (2022). In it, two of the annexes develop what in our view can be considered as at least remarkable (if not *jaw-dropping*). These guidelines are certainly not much aligned with the ones promoted in the toolbox the EC published in October. In a nutshell:

- Annex 1 "Guidance on Application of Article 5 of the Electricity Directive during current situation," raises "reasons to intervene in price setting in response to current energy market situation." It is argued that "Regulated prices should be cost-reflective," but then it is stated that "It is however important that even if regulated prices might be below what is needed to cover wholesale market costs during one specific short term period, they must be cost-reflective taking into account a duly justified longer period."
- It is stated that "To finance support measures in this current crisis, Member States may want to capture a part of this additional infra-marginal rent by specific fiscal measures. However, such a measure would need to be carefully designed to avoid unnecessary market distortions." Annex 3 "Guidance on the application of intra-marginal *(sic)* profit fiscal measures" focuses on discussing how these distortions could supposedly be avoided.

At the time of this writing, at such short notice and also taking into account that it is draft, we consider that entering into a discussion on the potential implications of the guidelines developed in this communication would go beyond the scope of the already long one we develop in this document. But certainly, this draft is an open door to major changes in the way the EU electricity market has been ruled to date. We are not necessarily against the existence of a regulated default tariff, as soon as it is sufficiently guaranteed that the embedded energy price it is not just cost reflective, but fully market-price reflective. We do discuss below the "capture of infra-marginal rents".

In any case, we expect that our discussions in this paper add insights worth-considering in the (hopefully open) debate.

2.2 What has been done

The Bruegel (2021) dataset gives an excellent up-to-date overview of the national measures so-far concretely implemented in response to the energy crisis. This dataset covers 17 EU Member States and Great Britain. Relying on this dataset and other public sources, we reviewed and divided the measures into two groups: the ones compliant and those not compliant with the EC's toolbox. In the following, we briefly describe the two groups, focusing on the latter as we assume that these are more closely related to the call for market reform.

2.2.1 National measures within the scope of the EU toolbox

The "toolbox-compliant" measures alleviate end-users' high electricity bills in most cases directly and are (deemed to be) temporary. The most common response to the high prices is the introduction or extension of measures against energy poverty.[4] The design of these measures differs by Member State. Besides interventions targeting energy poverty, other measures have been introduced that directly impact electricity bills of (nearly) all consumers (often even industrial ones). Examples are reduced energy taxes, levies, or value added tax (VAT);[5] and electricity bill discounts (via suppliers). Especially the reduction of energy taxes, levies, or VAT was widely used.[6]

Generally, these measures are within the sovereign power of a Member State and financed directly or indirectly via the state budget. In some cases, part of the measures is backed by the increased revenue from the Carbon Emissions Trading Rights System (EU ETS), e.g., Germany, Greece, Italy, and Spain.

Notwithstanding these temporary measures being extremely important and the best response to mitigate the impact of the high prices on consumers, we only briefly come back to these measures when formulating our recommendations in Section 4 as we do not deem these to fundamentally impact the market design.

2.2.2 National measures beyond the EU toolbox

We distinguish two types of measures that we deem outside of the EU toolbox and, in general, outside of the EU legislation: the taxation/capture of (alleged) windfall profits and mandated long-term contracts. Regarding the latter, besides being mandated, the prices of these long-term contracts might not be necessarily set at "competitive levels" or obtained via sufficiently competitive mechanisms. In that sense, such long-term contracts could also be seen as an attempt to tax windfall profits.

[4] Bruegel reports examples from Belgium, Cyprus, Czech Republic, Estonia, France, Greece, Ireland, Italy, Latvia, Lithuania, Poland, Romania, Spain, and the Netherlands.

[5] Bruegel reports examples from Belgium, Cyprus, Czech Republic, Estonia, Germany, Ireland, Italy, Portugal, Spain, and the Netherlands.

[6] Some Member States also reduced network charges (e.g., Cyprus, Estonia, and Portugal). In principle it could be interpreted that such measure is somehow equivalent to reducing levies, as some levies are recuperated via network charges in several Member States. However, if this is not the case, and unless it is guaranteed that it is not an exemption but just a deferment of the payment, we consider it not to be a toolbox-compliant measure as it implies the under-recovery of the actual costs of providing the service.

"Windfall profit" taxes

Spain and Romania introduced a tax on alleged windfall profits, which is thought to be temporary. A similar measure has been discussed in Italy.

In Spain, the Royal Decree-Law of September 14, 2021 (RDL 17/2021) included a mechanism to reduce the income of non-carbon-emitting plants. The publication of the regulation immediately faced contestation from the affected generators, who argued that the regulation was a violation of the fundamental European legislation and announced that they would appeal it at the European courts (Euractive, 2021). It is important to recall that contrary to the French, Romanian, and even Italian cases, where the main utilities are largely controlled by the state, the Spanish utilities are privately owned. Soon after the mechanism was enforced, as described below in Box 1, the Government backtracked and amended the implementation of the windfall tax twice. Finally, after weeks of turmoil, in which the regulatory stability of the country was severely put into question, the material impact of the measure (the Government initially claimed that it would allow the collection of 2,600 million euros) is reportedly expected to be negligible (Allen, 2021; Argus, 2021).[7] Box 1 provides more background on the design of the windfall profit tax and its evolution.

Box 1: The Spanish windfall profit tax

> The initial windfall profit tax, as introduced by the RDL 17/2021, was settled monthly and based on the energy generated by the plant, the cost of natural gas in MIBGAS (any gas price exceeding €20/MWh) and the number of hours in a month where combined cycle gas turbines set the price.[8] The formula to calculate the cutback, based on the monthly income of the plants, severely interfered with the efficient dispatch of the plants (in off-peak hours, during which the price happened to be below the threshold, affected plants, if producing, would face a net loss). Also, generators argued that they were not actually benefitting from the price increase as they had already committed in annual contracts most of their output via their own retailing company. The government, on the 20th of September, tried to save the measure by clarifying that generation (already) committed through long-term bilateral contracts (signed before the entry into force of the Royal Decree) was exempt. However, this exemption did at first not apply to internal contracts between generators and retailers vertically integrated within the same holding. One month later, the government stepped back again and published another Royal Decree-Law (RDL 23/2021), clarifying that intra-company supply would also be exempted if sold at fixed forward prices — although all companies subject to the mechanism would now have to disclose their hedging information to the national regulatory authority, CNMC.

In Romania, the Ordinance 118/2021 that came into force on November 1st, 2021, also included a windfall profit tax for non-emitting power generators (Breugel, 2021). More precisely, from November 1, 2021, until March 31, 2022, sales from renewable electricity, hydro, and nuclear power generation at prices above 450 LEI/MWh (app. 90 €/MWh) are taxed ex-post at 80%. However, it is worth pointing out that the Romanian government owns more than 80% of both Hidroelectrica and Nuclearelectrica.

In Italy, at the time of this writing, no windfall tax has been introduced. However, in early January 2022, Deputy Minister of the Economy Laura Castelli argued that the current measures taken in Italy are not sufficient (La Repubblica, 2022). She stated that "those who have obtained stellar profits from the

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[7] The government, in the Ministerial Order to set the regulated charges for 2022, stated when referring to the "windfall" levy that "it has been deemed appropriate not to consider any income in application of the principle of accounting prudence."

[8] Roughly speaking, the regulation established a formula relating gas and electricity spot prices. The non-carbon-emitting plants had to return the monthly income obtained in the electricity market considered in excess to the one they would have obtained (according to formula) if the gas price would have been capped at €20/MWh.

increases of recent months (producers, suppliers, intermediaries), without having an increase in their costs, must be asked for a solidarity contribution.". Giancarlo Giorgetti, minister of economic development, stated that "we should tax extra-profits."

Mandated bilateral contracts

France, Spain, Bulgaria, Portugal, and Italy have discussed or implemented measures including mandatory contracting between generators and retailers or industrial consumers.

In the case of France, mandated long-term contracts are not new. Since 2011 "alternative" (so-called "non-historic") energy suppliers have access to about a quarter of *Électricité de France* (EDF)'s nuclear electricity production (up to 100 TWh) at an administratively fixed price. The underlying objective is to guarantee that any French customer can actually buy a portion of its consumption, backed by the large nuclear fleet of EDF, at a below-market price level. This mechanism is called ARENH and aims to be in place until 2025. In 2011, the French Energy Regulatory Commission (CRE) set the regulated price at €40/MWh, which rose slightly to €42/MWh in 2021. To fulfill the promise of limiting the increase in regulated tariffs to 4% for 2022 (Reuters, 2021), the government decided in January 2022 that EDF has to offer an additional 20TWh via the ARENH mechanism over the period from April 1 to December 31, 2022, at a price of 46.2 €/MWh (EDF, 2022a). Contracts procured under ARENH cannot strictly be considered as "long-term forwards," since at the start of each year, buyers can decide the volume of electricity that they want to have access to for the upcoming year. To this extent, ARENH somehow works as an option (without premium payment), since if the forward market price is deemed to be below the regulated price, qualified buyers can renounce their commitment. In fact, there is a precedent showing that under certain circumstances they can retroactively chose not to buy via ARENH after having committed before.[9] More information about ARENH can be found in Box 2.

Box 2: The French ARENH mechanism

Lévêque (2011) explains that the idea behind ARENH was to mitigate the effects of market concentration and to stimulate innovation, both in retail (short and medium term) and wholesale (long term), while still allowing French consumers to benefit from nuclear rents. "Allowing French consumers to benefit from nuclear rents" can only be interpreted as consumers not paying the full market value of the nuclear output. Lévêque argued that in spirit, ARENH disregards the principle of non-segmentation of markets and betrays the principle of free movement of goods within the EU. Notwithstanding, the introduction of ARENH in 2011 was accepted by the European Commission (2012) as a transitory measure (supposedly until 2025) to put an end to a regulation that was at the time considered more harmful: the regulated electricity tariffs for large and medium-sized energy consumers. ARENH was at that time officially justified as a way to promote competition in the retail market, in such a way that "alternative" retailers could compete in a level playing field. In that sense, it was assumed that EDF could somehow be taking advantage of their dominant position, and that if the government's intention was to sell nuclear energy at prices below market levels, the new retailers would also need to be able to do so. Figure 3 shows the historically requested volumes via the ARENH mechanism. In the last years, in which the demand exceeded supply, the ARENH volume was allocated pro rata.

[9] As described by Romaní (2021), in 2020, with wholesale market prices plummeting due to the pandemic, some marketers asked to renounce the volume of electricity committed to via ARENH alleging force majeure. In the end, the Paris Commercial Court suspended the contracts.

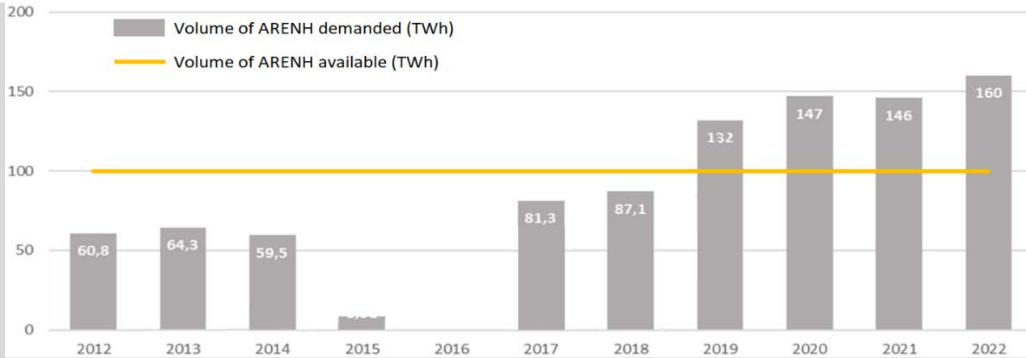

Figure 3: Evolution of the demanded volumes of ARENH (Courtage Energies, 2022)

The introduction of ARENH has important consequences. The dominant position of EDF, in both the generation and retail market, leads alternative retailers to strategically behave as price followers. As a result, they do not need to fully stick to the price levels determined by the ARENH contract to gain new customers, so they can obtain a direct benefit. Along these lines, Ambec and Crampes (2019) as also predicted by Lévêque (2011), report that instead of consumers seeing lower prices, alternative suppliers opportunistically benefit from the arbitrage made possible by ARENH. They also argue that these suppliers do not actively pursue a long-term strategy to consolidate their position in the market, and they do not promote investments in production assets outside of subsidized renewables. To this extent, the mechanism works as a direct subsidy not only for French end users, but also for these alternative retailers.

Jean-Bernard Lévy, CEO of EDF, has repeatedly declared that ARENH "is a poison, not only for EDF, but also for the market" (Moyon, 2020). In the current energy price crisis, there is no apparent intention to argue that the extension of ARENH, as decided on January 2022, has any motivation other than lowering end user-prices in France at the expense of EDF's balance sheet. EDF's public discontent with this extension, and the direct drop of its shares when announced, is therefore no surprise (Mallet and De Clercq, 2022; Capital, 2022).

Finally, with the French government being the majority (84%) shareholder of EDF (EDF, 2022b), the question arises of to what extent the extension of the ARENH mechanism does not clash with the basic principles of the internal market and the State Aid rules currently in force (even more than what it already did). One way of avoiding a violation of the relevant EU rules is by finding a way to justify the mechanism as a service of general economic interest (Frontier Economics, 2020). Although it is not possible to find any further public explanation of the reference made in the non-paper by the French, Greek, Italian, Romanian and Spanish Governments (2021) from December, this appears to be the reason why Article 9 of Directive (EU) 2019/944, in which public service obligations in the general economic interest are defined, is one of the two articles that the governments of France, Greece, Italy, Romania, and Spain proposed to amend.

The Spanish government included in the RDL 17/2021 a proposal to organize mandatory power auctions for dominant players (Iberdrola, Endesa, Naturgy, and EDP). Under the scheme, these companies will be obliged to offer a substantial volume from their "emissions-free controllable generation"—effectively nuclear and hydro plants—through long-term contracts. In principle, at the time of this writing, it is widely assumed that the buyers in the auction will be smaller power suppliers and industrial clients. But it is an open question of how the government will manage to impede the participation of other potentially interested stakeholders (e.g., traders) in the auction, since in principle such a barrier would also be against the basic EU regulations (as described later, it looks like the Bulgarian and Portuguese governments did it to a certain extent, and there is no news yet about any objection from the relevant EU institutions). According to the wording of the RDL 17/2021, even though these auctions are supposed to be "carried out in a competitive, transparent, and non-discriminatory manner"—apart from the fact that the incumbents have to sell and their retail branch cannot be the buyer—the Secretary of State for Energy will determine the "maximum percentages that each buyer can acquire." The first auction was intended to take place before the end of 2022 with Iberdrola obliged to sell 7.32TWh, Endesa 6.74TWh, Naturgy 1.41TWh, and EDP 364GWh. These mandated auctions have been quickly contested by the incumbents (Argus, 2021).

Bulgaria organized direct sales from the Kozloduy Nuclear Power Plant (NPP), a subsidiary of the state-owned Bulgarian Energy Holding EAD, to small and medium-sized companies in September 2021 for delivery during October, November, and December. 300 MW of baseload capacity were tendered, representing about a third of the operational capacity. The starting price in the auction was significantly lower than the market price —around 95 €/MWh (compared to the average on the Bulgarian power exchange in September of 125.3 €/MWh). However, due to the high interest in the purchase of these long-term contracts the final average price reached 121.3 €/MWh (Serbia Energy, 2021; Newsbeezer, 2021).

In Portugal, the national energy regulator (ERSE) announced the introduction of extraordinary Special Regime Production auctions on October 18, 2021 (ERSE, 2021). In these auctions, monthly contracts of a certain volume of renewable electricity, sourced by the supplier of last resort from third party project promoters under guaranteed feed-in tariffs (>10 years), can be bought exclusively by smaller unhedged suppliers or industrial consumers. ERSE set the starting price at 90 €/MWh, a value much lower than the price in the Portuguese wholesale market during the relevant period. Three auctions have taken place so far. In the latest auction, 50 MW with delivery in February 2022 and 50 MW with delivery in March 2022 were auctioned. Similar to the Bulgarian case, due to high interest (the demand doubled the available supply), the weighted average price of the awarded purchases was significantly higher than the starting price (158.76 €/MWh and 140.53 €/MWh for delivery in, respectively, February and March; Sanlez, 2022). In early February, a fourth auction was announced to take place on February 17 during which another 50 MW for delivery in March will be auctioned (Silva, 2022).

Finally, in Italy, in the same communication in early January 2022, Deputy Minister of the Economy Laura Castelli also proposed to set up a fund for long-term renewable electricity supply agreements, claiming that these represent an effective tool to guarantee companies having access to energy at competitive prices and avoid exposure of companies to similar future scenarios (La Repubblica, 2022). At the time of writing, no more information is available about the exact implementation details of this proposal.

3. ASSESSING WHAT HAS BEEN DONE AND WHAT MIGHT BE UNDER CONSIDERATION

Although in the few weeks prior to this writing a few mechanisms have started being promoted (e.g., the mandated auctions later discussed in Section 3.2), in the official political correspondence, as reported in the previous section, it was not possible to infer how core messages, such as "the end-user electricity price shall reflect average rather than marginal costs," were supposed to be put into practice. Even more complicated is to understand how the required adjustments to the market design could be consistent with what is in place today. The fundamentals of microeconomics show that it is challenging, if not impossible, to devise a way to reform the regulation to achieve the declared objective of linking market prices to average production costs. This is true in markets of any kind, with no exception of the EU's internal electricity market, unless market agents are compelled to sell electricity at a price below the actual opportunity cost.

An initial interpretation (e.g., Liboreiro and de Filippis, 2021) is that this claim implied a demand for imposing a pay-as-bid pricing mechanism in the wholesale power markets operated by the power exchanges. However, as illustrated in Section 2 and Annex A, we have not been able to find any sound reference published in the last months in which any market stakeholder or government argues in favor of implementing any sort of pay-as-bid mechanism in the auctions run by power exchanges.[10]

This claim—making end-user prices reflect average generation costs—can to a certain extent be attained by the introduction of a windfall profit tax or by mandating bilateral contracts. Regarding the former, the revenues from the tax can be redistributed to make end-user prices come closer to average costs. Regarding the latter, the prices of the long-term contracts can be set administratively as in the French case or clearing prices in the mandated auctions can be tempered by limiting the participation on the buyers' side as it appears to be the case in Spain, Bulgaria, and Portugal. More precisely, since buyers could have had the ability to put prices down by taking advantage of the lack of competition (monopsony); the mechanism is seen (hoped) by some as a potential "solution" to grant both industrial consumers and "alternative" (non-incumbent) retailers with contracts at below-market prices.[11]

In the remainder of this section, we first turn back to the basic microeconomic fundamentals of power markets to discuss why the introduction of windfall profit taxes or mandated bilateral contracts are not a good idea. Second, we discuss two other potential measures that we have learned to be under consideration in the many conversations held in the last weeks, and thus might be pursued: volume-restricted RES auctions and negotiated long-term contracts on behalf of consumers. Similarly, we do not recommend these two potential measures.

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[10] See also the discussion by Pototschnig et al. (2022). In any case, it has to be recalled that pay-as-bid has been already in use in the electricity markets in the EU for decades, since the bilateral contracting that takes place in the over-the-counter markets is nothing but the result of a pay-as-bid negotiation. The counterparties consider the actual market value of the energy in these negotiated contracts.

[11] A counterargument to defend any of these measures is the claim from alternative retailers that the current situation of extremely high prices is allowing incumbents to offer end users retail contracts at prices below the ones that are being traded in forward markets. The incumbents can do so because of their deeper financial pockets and natural hedges via vertical integration. At the same time, the government is deemed to give implicit consent as it is willing to moderate electricity bills. The small retailers' allegation is thus that by allowing for a sort of predatory pricing by the incumbents (or even promoting it behind the scenes), they are not able to compete, so they will lose important shares of their retail customers that are switching back to the incumbents. Such trends can have long term consequences on retail competition as switching rates, under normal circumstances, are relatively low.

3.1 Assessment based on basic economic fundamentals of what has been done

Besides being completely incompatible with the existing regulations governing EU electricity markets, a windfall profit tax and mandatory bilateral contracts with insufficient competition on the demand side have serious negative implications.

In this section, we outline the basic economic fundamentals that reveal the inherent main inefficiencies resulting from these measures. We divide this discussion in two parts: static and dynamic implications of such interventions.

3.1.1 Static issues of windfall taxes and mandated auctions without sufficient competition

Windfall profit taxes entail a transfer of rents (unexpected for generators, leading to severe dynamic issues as discussed in the next section); and if not properly implemented (as it was the case in Spain), they can affect the efficiency of the short-term economic dispatch. More precisely, in the Spanish case, non-carbon-emitting plants had to return the monthly income obtained in the electricity market considered in excess to the one they would have obtained (according to a formula) if the gas price was capped at €20/MWh. This monthly settlement led to a disincentive to generate during hours with relatively low power prices, even though the prices during these hours could still be higher than marginal costs.

Until the draft communication of the European Commission (2022) was leaked (Taylor, 2022), a windfall profit tax, since it appeared to be a flagrant intervention that could be revoked in court, appeared to be sidelined by the implementation of mandated energy releases without sufficient competition guarantees. One reason that might be behind the current preference for this "alternative solution" could be the expectation that it might be not so flagrant, i.e. more likely to overcome the EU Commission and/or courts disapproval. While the implementation of these auctions has the appearance of a competitive solution, it can be shown to lead to significant distortions.

In the draft from the European Commission it can be read that:

> *Regulated retail prices in the current situation should provide space to ensure that markets can work well for consumer in the longer term. This means their introduction should be accompanied by measures to achieve effective competition and a methodology for assessing progress with regard to those measures … However, these could include:*
>
> *(…)*
>
> - *measures on dominant producers to make forward contracts available on a fair basis (e.g. on same terms as to their supply arm).*

It is obviously not possible for us to assess the full implications of what it is understood by "fair", so it is not easy to develop a sufficiently sound judgement of it. In Annex B of this document, we develop a simple illustration of the basic economic principles that evidence how, for the case of these mandated auctions 1) the only way to achieve the pursued aim (i.e., get prices below market levels for a portion of consumers) entails finding some way to restrict competition on the demand side (e.g., not allowing part of the demand side or financial institutions to participate, something that should not be allowed by the European regulators), and 2) the result might not just be a transfer of rents between generators and some consumers, but a loss of rents for the group of consumers not benefitting from the exclusive access to the auctions and, what is even worse, a non-recoverable welfare loss for the whole system.

3.1.2 Dynamic issues with the interventions

Long-term investments, such as investments in renewables and other generation assets, entail risks. These risks are a disincentive to invest. The greater the risk, the greater the return on capital that investors will require to make the investment. One such risk is what economists refer to as regulatory risk—the risk that the regulatory environment will change during the life of the investment. More important than any short-term distortion is that any retroactive measure, such as the introduction of a windfall profit tax or the mandate to offer bilateral contracts for existing assets, damages the regulatory credibility and potentially the trust in the entire EU regulatory compound.[12] This is particularly relevant if applied to privately-owned companies. An increase of perceived risks will lead to higher financing costs which are especially relevant as renewables are highly capital intensive. This will slow the energy transition and make it more costly. Regarding the former, even minor delays in investments in renewables can lead to significant increased emissions and local pollution in the next decade—see e.g., Gillingham et al. (2020).[13] Regarding the latter, even minor changes to the cost of capital translate into cost impacts of billions of euros in the financing of the European energy transition —see e.g., Polzin et al. (2021). The increased (long-term) costs for consumers, who are ultimately footing the bill, will be a multiple of the short-term financial "relief" that they could receive through such measures today.

Investors in a power system governed by market rules risk their funds in the expectation/hope that the scenarios in which their investments result in profits are more probable than the ones in which losses are borne. These profits, particularly when they happen to be high, stimulate other investments, which adds to the overall competitive pressure resulting in a downward pressure on prices and inframarginal rents. Effort should focus on further improving the existing market design and reducing the various barriers for new entrants, rather than discouraging new entry via the introduction of windfall profit taxes or mandatory auctions. In the same way that the low prices experienced in the previous months/years were not a valid justification to implement capacity remuneration mechanisms (which can be perfectly justified for other reasons as discussed in Joskow, 2008[14]), by no means could taxing profits (considered by some to be excessive) be upheld.[15]

[12] Mandating auctions implies an indirect way of expropriation, as also argued by the Spanish incumbents (Argus, 2021).

[13] Gillingham et al. (2020) analyze potential impacts of delays in investment in clean energy technologies in the context of the COVID-19 pandemic. They find, in the case of the U.S., that even just pushing back all renewable electricity generation investments by one year would outweigh the emissions reductions (-15%) and avoided deaths (200 per month) from March to June of 2020.

[14] A counterargument that has been given by some of the people with which we have discussed the matter is that low market prices have been an explicit or implicit justification for the implementation of capacity mechanisms in Europe. So according to this point of view, to "complete" the market from both sides (supply and demand), some sort of hedging to protect end users from high prices should also be allowed.

[15] More fundamental, it is difficult to know what profits are "windfall" profits. While it is undoubtedly the case that renewables are at this moment earning larger short-term rents than expected at the time of their investment, long-term investments are made with the expectation that the sum of the short-term rents over the lifetime of the asset exceed the initial cost of the investment. Unless policy makers are willing to commit to refunding these taxes in the future if short-term profits fall short of expectations, investors will require a larger expected return to make similar long-term investments in the future.

3.2 What might be under consideration

It is worth discussing two other relevant approaches that we suspect are being seriously considered by some policy makers to reduce end user prices (at least in the short run): volume-restricted auctions for renewable energy sources (RES) and negotiated long-term contracts on behalf of consumers.

3.2.1 Volume-restricted RES auctions

In the last few years, regulated auctions have become the main tool to promote the deployment of RES across Europe. In several jurisdictions (not only in the EU, but also in other continents), clearing prices have been well below expectations.[16] These results have fueled the belief of some that the current wholesale market mechanisms do not work properly.

It is not easy to understand the drivers behind these prices. If it is true that they happen to be lower than the prices that an investor in a RES-E project could get by being directly exposed to market prices, then it should be concluded that there are entry barriers for merchant investments. In fact, merchant investments in RES, and in general in any generation technology, are currently rare.

For instance, in the case of Spain, the large (and vertically-integrated) incumbents publicly argued that there was no longer need for implementing any sort of auction mechanism for RES. They stated that the RES targets could be easily fulfilled by just letting the market work, since RES no longer need any subsidy to be profitable (Rack, 2020). Indeed, it is a fact that in a number of Member States, the number of RES projects currently under consideration, but not yet actually under development, largely outweigh any minimally reasonable capacity that might be needed in the next decades.[17] On the other hand, new entrants willing to invest in RES installations argue that there is a significant lack of liquidity in the long-term market, so they were not able to compete with the (largely vertically integrated) incumbents, since it was not possible to find counterparties willing to sign long-term power purchase agreements (PPAs) at "reasonable" prices.[18]

An important factor behind these low prices could be the difficulty to get access to the transmission (and distribution) network.[19] If there is an unmanageable list of projects willing to connect, the auctions can be used as a tool to offer the winners priority. In this context, auctions for RES appear as a chance for governments to sign long-term contracts at prices reflecting the (in principle) lower long-run marginal cost of the technology, which, at least for the moment, can be lower than the expected revenues from market prices.

Restricting access to the network as a tool to get lower prices, by giving priority to the auction winners fighting for access in an extremely competitive context, can be interpreted as (at least) "testing the

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[16] For instance, in Poland, the prices resulting from a mixed PV-wind auction held on December 2021, ranged between €30.5/MWh and €61/MWh (Enerdata, 2022). In the auction held in Portugal in August 2020, prices of the winning wind were estimated to be even down to €11.14/MWh (AleaSoft Energy Forecasting, 2020).

[17] For instance, Mrs. Ribera, the Spanish minister, declared in a press conference on December 14, 2021, that at that moment there were "150 gigawatts of renewable power with access and connection permits for evacuation to the grid … when the forecasts are that Spain needs to install around 35 by 2025, around 60 by 2030, that is, 150 is an amount far above what has never been considered necessary or viable" (Council of Ministers, 2021).

[18] According to the Spanish National Regulatory Authority, 65% of the energy is supplied by the three largest retailers (vertically integrated in a larger holding), and only "30% of the energy in the entire market is supplied by traders not belonging to vertically integrated groups" (CNMC, 2019).

[19] See for example the case of Spain (Esteller, 2021) and the Netherlands (Alliander, 2021).

limits of third-party access requirements." Article 6 of Directive (EU) 2019/944 states that the only allowed exception for not granting access is when network system operators may lack the necessary capacity to connect a new grid user. Duly substantiated reasons shall be given for such refusal and are based on objective and technically and economically justified criteria. Nothing is written in Article 6 about possibilities to grant priority to certain projects, and under what conditions.[20] Surprisingly, amendments to Article 6 were not discussed in the political communications as described in Section 2 and Annex A of this note.

3.2.2 Negotiated long-term contracts on behalf of consumers

A very tempting option for governments to lower prices in the short run would be to hurry and negotiate some sort of long-term contracting with specific generators (e.g., nuclear plants) or incumbents (e.g., ten-year long contracts as mentioned in Annex A).[21] In our view, the current context of abnormally and sustained high market prices would be the worst moment to enter into such a commitment, and particularly if there is no way (time and manner) to fully open the negotiation to every potential (existing, i.e., already installed or future) counterparty to maximize competition. A bilaterally negotiated price, absent from competitive pressures, would necessarily end up being a bad deal for consumers in the medium to long run. The governments could be relieved by seeing a decrease of prices in the short run, but consumers would pay the bill in the middle to long term when prices normalize again.[22]

Another important issue with such long-term contracts, conditional upon their design, is that they can distort the short-term dispatch. For example, by underwriting a PPA paid out based on the volume of electricity produced, power plants have no incentive to ramp down at times of low prices driven by high-RES infeed. A distorted dispatch will induce additional costs on top of the costs for the long-term contract itself. This is a similar issue to what happened with feed-in tariffs and premiums for RES. In that case, the RES generators had no incentive to curtail when prices became negative (or up to the point when the absolute value of the negative price becomes greater than the subsidy pay-out per MWh in the case of a premium).

[20] We leave it over to energy law specialists to assess the compliance of such practice with Article 6.

[21] It seems that in Slovakia something in that trend took place in February 2022 with the dominant power producer agreeing with the government to set baseload prices for delivery in 2023 and 2024 at 61.21 €/MWh for a volume of 6.15 TWh (Lopatka and Hovet, 2022). Another example of a negotiated price for a long-term contract on behalf of consumers could be Hinkley Point C. With the difference that Hinkley Point C still needs to be built. Alan Morse, the head of the UK Audit Office, stated that "the Department [for Business, Energy, and Industrial Strategy] has committed electricity consumers and taxpayers to a high cost and risky deal in a changing energy marketplace" (National Audit Office, 2017).

[22] In the energy sector, there is a long record of these sorts of contracts that later turned into a significant burden for end users. They are included in the category of the so-called legacy contracts, currently now a big issue in a good number of jurisdictions.

4. First-best recommendations

In this section, we provide our recommendations. Our first recommendations are fully in line with the EC's toolbox published on the October 13, 2021 ("Tackling rising energy prices: A toolbox for action and support").

The introduction or extension of energy-poverty assistance programs are of utmost importance. Lessons can be learned from the measures that were implemented during the first year of the COVID-19 crisis and important IT investments to enable those measures are already done —see e.g., Mastropietro et al. (2021). Solutions are similar, even though in the case of the COVID-19 crisis the issue was not high energy prices (rather the opposite), but increased residential consumption due to lockdowns and decreased purchasing power due to the economic impacts of the measures accompanying the pandemic. Important in this regard is that the incentives for vulnerable consumers to respond to short-term price signals should be kept in place, while these same consumers shall be shielded from affordability issues. Examples of tools to obtain these objectives are vouchers (energy or more general) or support for energy efficiency measures, rather than a direct reduction of the electricity rate (in €/kWh).

The reduction of levies in the electricity bill (or better, a more suitable and cost-causality-based allocation of them among energy users all of kinds —see e.g., Batlle (2011)), would be a desirable measure that should be maintained even after the unwinding of the energy crisis.[23] It is well-known that due to very high levies allocated to the electricity bill, the competition between energy carriers has been distorted in many countries hindering electrification.

Costs for energy poverty measures need to be allocated, and the reduced revenues from the reduction of levies, or other measures such as a VAT reduction or energy taxes lead to less income for the state budget. Levies can be spread over other energy carriers, such as gas but this cost shift might be politically hard to do as gas prices are also very high. If not, just as with the other measures, the costs need to be assumed by the state budget. At a later stage, when (and hopefully if) prices are normalized again, some of these foregone revenues might be recuperated again by the state. Managing sustained high prices in this way might not be equally feasible in every Member State. We discuss an alternative solution in the next section.

In the middle to longer run, the focus should be on further improving the existing market design and reducing the various barriers for new entrants, rather than discouraging new entry via the introduction of windfall profit taxes, mandatory auctions, or alike.[24]

[23] A regulation in line with the measure proposed in this paper, the so-called National Fund for the Sustainability of the Electrical System (FNSSE), is about to be implemented in Spain (Spanish Government, 2020)

[24] For a discussion about open issues in the EU electricity market design, see Meeus (2020). Schittekatte et al. (2021) discuss in detail entry barriers in EU electricity markets. For a broader overview of the current state of power market design in different jurisdictions around the world, see Glachant et al. (2021).

5. A REGULATORY REMEDY TO COMPLETE THE MARKET MECHANISM

In this section, we propose an alternative solution in case the first-best solution is deemed politically infeasible or economically unsustainable. This section consists of two parts. First, we discuss the current lack of hedging instruments that go beyond two or three years, since our proposal intends to fill up that gap in long-term contracts. We also cover the basics of risk allocation to further clarify why the introduction of a (well-designed) long-term hedging mechanism would be backed by sound economic and regulatory principles. Second, we detail our proposed solution, a centralized purchase via an auction of long-term hedges that we term "stability options," to protect (tranches of) end users from the bill impacts during periods of sustained high prices.

5.1 Missing market for long-term hedging instruments and basics of risk allocation

It is not possible to foresee whether this unprecedented scenario of a period of sustained high prices could repeat itself and with which frequency. Most risks (e.g., weather or geo-political risk) cannot be removed, but only transferred. A key feature of an efficient market design is that opportunities exist to transfer risk from more risk-averse participants to less risk-averse parties, who are often also the parties who can better manage these risks.

In the academic literature and in the debate among practitioners, a lot of attention has been devoted to risk from the perspective of investment in generation, see Joskow (2006). The current electricity crisis is a scenario that had not been properly considered by market agents to date, at least not in the EU context. End users keep on evidencing their relentless insufficient participation in the forward markets, but the recent events have also shown that the same is true for a number of retailers (Financial Times, 2021). There is no doubt that the direct impact of the price levels on the short-term financial health of certain tranches of consumers is a major issue that needs to be properly tackled. But this scenario of electricity prices reminds us of a higher-order threat, the potential loss of trust (and patience) of the political class (and the mass media) in the whole market compound. The risk of over-reaction after a price shock of this nature, leading to a major step back, is not irrelevant. It is therefore at least worth considering how to hedge against these events in the future.

In case of perfect information, full economic rationality, and the absence of entry barriers (such as transaction costs), consumers would have entered into hedges themselves not to bear the risk of a period of sustained high prices. These hedges would transfer the risk from consumers to market participants, perhaps generators or financial participants. Consumers would pay a market premium for the elimination of the risk and those parties would, in expectation, earn this market premium but take on the risk. All of the parties in this case are better off. The consumers pay less in a market premium than the expected negative consequences of the risk and the market premium is greater than the expected cost of the risk for those that take on the risk. However, in practice, it is largely demonstrated that many consumers do not perceive this need and significant barriers to long-term hedging products (> 2y) exist. In fact, as can be seen from Figure 3, the volumes and contracts negotiated in the EEX German Power Future, with more than 20 years of existence and by far the most liquid in the EU, are insignificant beyond two years forward.[25] This is even more acute in the case of the French Power Futures.

[25] Newbery (1989) described this issue as a "missing market" problem.

eex — Products and Units

EEX GERMAN POWER FUTURE

2022-01-21 Day Weekend Week Month Quarter Year

Baseload

Name	Last Price	Last Volume	Settlement Price	Volume Exchange	Volume Trade Registration	Open Interest
Cal-23	124.00	8,760	122.63	2,592,960	2,540,400	45,897
Cal-24	92.30	8,784	92.13	597,312	1,168,272	11,410
Cal-25	87.95	17,520	87.00	70,080	271,560	2,505
Cal-26	-	-	84.38	-	35,040	198
Cal-27	-	-	83.09	-	-	96
Cal-28	-	-	81.87	-	-	30
Cal-29	-	-	81.40	-	-	-
Cal-30	-	-	80.59	-	-	-
Cal-31	-	-	79.73	-	-	-

EEX FRENCH POWER FUTURES

2022-01-21 Day Weekend Week Month Quarter Year

Baseload

Name	Last Price	Last Volume	Settlement Price	Volume Exchange	Volume Trade Registration	Open Interest
Cal-23	131.35	8,760	131.34	8,760	122,640	5,908
Cal-24	-	-	95.54	-	-	599
Cal-25	-	-	91.43	-	-	92
Cal-26	-	-	-	-	-	-
Cal-27	-	-	86.08	-	-	1
Cal-28	-	-	-	-	-	-

Figure 3: Lack of long-term liquidity in EU electricity futures markets. Screenshot taken on 01/21/'22 (EEX, 2022).[26]

As electricity is considered an essential good, a period of unanticipated high prices can lead to significant unwelcomed political unrest. Risk averse governments cannot directly hedge themselves for that risk, unless they have a stake in the electricity generation companies and redistribute their inframarginal rents. However, doing so would in some countries imply a (forced) divestment of privately-owned companies and, even in case that path would be pursued, the direct redistribution of these rents to electricity consumers would be a violation of State Aid rules.

The only reasonable way to hedge that risk, at least in today's context, is to introduce a hedge on behalf of the consumers that are deemed in need of bill protection. In that sense, the introduction of such hedge can be welfare enhancing. The risk is transferred from risk averse consumers (and indirectly the risk averse government) to less risk averse market parties (at least from unexpectedly high prices). In turn, this transferred risk would create an incentive for those market parties to hedge themselves by investing in generation assets (e.g., renewables) and/or the purchase of long-term gas contracts. In the current context, the need for generators to hedge themselves against very high gas prices, at least in the middle to longer term, is limited as they can directly pass-through the costs of high gas prices via high electricity prices. In that sense the introduction of a hedge on behalf of the consumers that are deemed in need of protection could "ignite" a chain of long-term hedging contracts, leading to a more efficiently functioning power system. A very similar dynamic, in the context of investment in reliable power supply, is formalized by Mays et al. (2022).

5.2 The design and procurement process of stability options

We propose a regulatory-driven centralized auction in which a central entity buys long-duration Asian call options from generators on behalf of (a subset of) consumers decided by the regulator. The aim of these options, that we call stability options, is to function as a sort of "automatic stabilizer" mechanism by transferring the gains of generators during periods of sustained high energy prices to

[26] The Open Interest refers to the total of all derivatives contracts which have been opened (i.e., not yet settled) at a given point in time. The Open Interest published by EEX considers all opened positions regardless if a position has been closed with a counter trade. The Open Interest provided is not netted.

"protected" consumers. These consumers pay a fee for this "insurance," but avoid "bill shocks" from one month, season, or even year to another.

An Asian option is a derivative with a payoff at maturity that depends on an average of the underlying on a set of predetermined monitoring dates or fixings. A stability option is an Asian option with monthly fixings. In the box below we further introduce the Asian option concept.

Box 3: Energy Asian Options

> Asian options, also called Average Price Options are widely traded derivatives in the energy market because they capture the distinctive features of commodities (CME Group, 2020). The payoff of an Asian option depends on the average of all prices over a specific period, as opposed to vanilla European or American options, where the payoff is determined at a single expiration date. Energy end users are commonly exposed to monthly average prices over time, so Asian options fit very well with their risk profile.
>
> The average price is a geometric or arithmetic average of the price of the underlying asset at discrete intervals, which are also specified in the options contract. As with standard options, if the average price is below the strike price, the loss is limited to the premium paid for the call options.
>
> The most basic are the fixed strike (also known as an average rate) Asian call option. The payoff of this option C(T) can be expressed as max(A(0,T) - K,0), where A denotes the average price for the period [0, T], and K is the strike price.
>
> Asian options tend to be less expensive—sold at lower premiums—than comparable standard puts or calls (in principle the averaging smooths down price spikes and dampens the volatility, see illustration in Box 4). Additionally, in markets where there is the potential for price manipulation, an Asian option offers a good hedge, as these options' payoffs are less sensitive to extreme market fluctuations especially toward the option expiration (i.e., it is more difficult to manipulate the average value of the underlier over an extended period of time).

In particular, a stability option gives the right to the central entity to buy a certain monthly volume of electricity (possibly according to a standard hourly profile) at a predefined average price (i.e., strike price), for an extended period (e.g., 5 or 10 years). In return for granting this right, generators demand an option premium. The central entity sets the strike price and decides about the total volume of options contracted. In the simplest format of the auction for stability options, generators bid the price of the option premium (in €) they want to receive and a maximum quantity of electricity that they can offer (in MWh). The costs of the option premium can be allocated as a levy in the electricity bill, typically spread over all "protected" end users. The pay-outs of the exercised option serve as bill reductions for the end users "protected" by the stability options. Table 1 provides a summary of the proposed design of stability options. In Box 4, we illustrate how the stability options would perform under scenarios of high prices of different natures.

Table 1: Summary of the proposed "stability options"

General characteristics	
Product	Financial call option
Buyer	Central entity on behalf of (a subset of) consumers
Seller	Any generator (existing or new) —technology agnostic but physical and/or financial backup required (e.g., gas contract)
Cost allocation option premium	Via a levy in the electricity bill (similar to how the cost of an RES auction is managed), spread over the consumers under protection
Pay-out exercised options	Monthly electricity bill reduction for the end users "covered" by the stability options = max $[0, \sum_{h\in Month}(DA\_price_h - Strike\_price) * Contracted\_volume_h]$ [27]
Key design parameters set by the regulator and illustrative examples of the parameter settings	
Strike price	Depends on country: e.g., average price of 100 €/MWh
Settlement frequency	Monthly
Duration contract	5 to 10 years
Time lag between auction and delivery	2 or more years
Quantity contracted (MWh)	Consumption of vulnerable consumers or coverage of the consumption of all residential consumers with the option to step out at the start
Demand profile	Flat profile or estimated aggregated load profile

Box 4: Illustrative example of the workings of the stability option

The objective of the hedge provided by the stability options is not to avoid price spikes, but to prevent that sustained high prices could threaten the financial health of certain categories of end users. We discuss the differences between price spikes and sustained high prices in Annex D. The workings of stability options can be illustrated with the following example.

Figure 4 below shows the hourly prices in the Spanish day-ahead market in 2020 and 2021. Two different abnormal price scenarios are highlighted in different colors. 1) In cyan, January 2021: In the second week of that month, a persistent blizzard affected half of the country. The capital city had its highest 24-hour snowfall in 50 years, with over 50cm (20in). Extremely low temperatures remained in subsequent days, leading to high prices in the electricity spot market. 2) In red, December 2021.

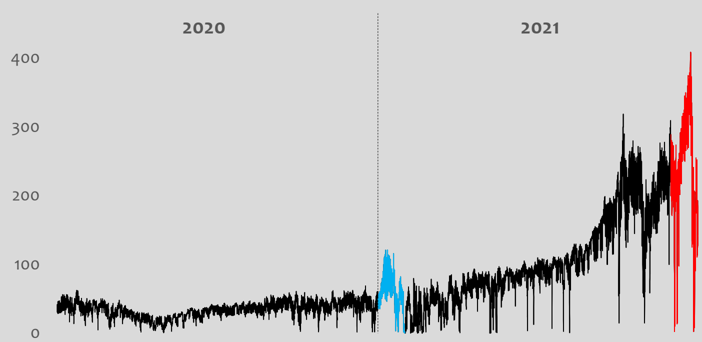

Figure 4: Day-ahead hourly market prices in Spain in 2020 and 2021.

The two graphs in Figure 5 below provide larger detail of the prices resulting in these two months.

[27] With a flat demand profile, the pay-out (when non-negative) equals the difference between the average-day price and the strike price multiplied by the total volume contracted.

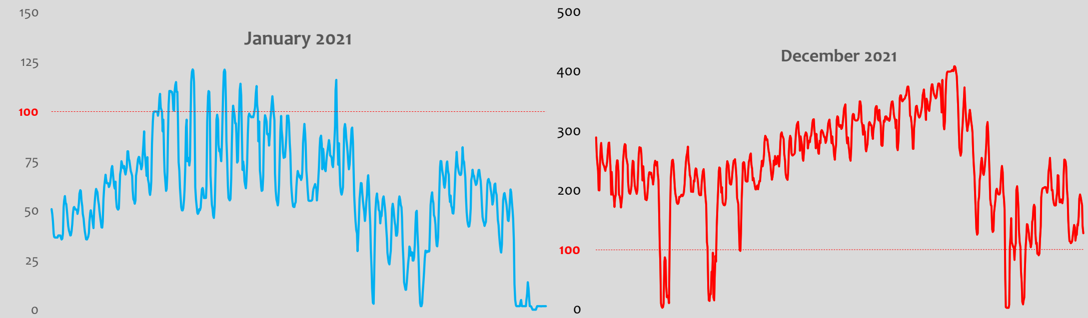

Figure 5: Day-ahead hourly market prices in Spain in January 2021 (left) and December 2021 (right).

If the regulatory decision would have been to hedge for instance vulnerable customers with a stability option at a strike price of e.g., 100€/MWh and a flat load profile, the impact on both cases would have been radically different. In January, despite the fact that prices were above 100€/MWh 51 times in that month, the average was 60€/MWh. Therefore, the stability option would have been out of the money, and it would not have been exercised.[28] Conversely, the average price in December was 239€/MWh, and the electricity bills of vulnerable customers would have been beyond the acceptable range. The option would be exercised, resulting in a pay-out of 139€/MWh to compensate for the high electricity costs of the protected consumers. However, these same customers were still incentivized to consume more when prices are low and *vice versa*.

Importantly, there are two key differences with our proposal, "stability options," compared with the previously discussed measures that also aim to push long-term liquidity, i.e., mandatory auctions for long-term contracts or negotiated long-term contracts. First, the awarded long-term contracts shall result from a fully open and largely competitive process. Second, the long-term contracts shall respect the key functioning of the current short-term market mechanisms running in the EU, i.e., maximizing as much as possible the exposure of counterparties to short- and long-term market signals.[29]

In the following, we first explain in more detail the reason for settling stability options on a monthly period. After, we focus on how to maximize competition in the contracting process; and lastly, we discuss in more detail the scope of stability options. We describe the main principles behind our proposal, but a very detailed discussion of the concrete implementation goes beyond this note.

5.2.1 The settlement frequency and strike price level of stability options

Two key design parameters of the auctioned off call option are the settlement frequency and the level of the strike price. Importantly, these parameters strongly interact as illustrated in Table 2. A stability option has a relatively low strike price and the settlement is done monthly. The level of the strike price can be interpreted as the maximum average electricity price is deemed sustainable over the given settlement period, e.g., an average electricity price of 100 €/MWh over a month. Obviously the lower

[28] If 1000€/MWh prices would have been recorded in ten hours of that month of January, the monthly average price would have gotten up to 73€/MWh, still largely below the strike price of the option, again, leaving short-term signals active.
[29] While we do not go deeper into these issues in this note, it cannot be denied that the introduction of regulatory-driven long-term contracts leads again to the question of the role of retailing (retailers cannot offer such long-term contracts due to volume risk) and requires a significant revision of current State Aid rules. However, within the wider context of electricity liberalization, that sort of regulatory intervention is not new. As we describe in Annex C, at this stage, after the years of experience gathered, the fact is that, more than ever, a good mix of regulation and markets is better than no market at all (quote from Kahn, 1988).

the strike price, the higher the option premium and *vice versa*. By setting the settlement frequency equal to a month, and not, for example, an hour, consumers are still incentivized to respond to sudden price spikes (as illustrated in Box 4), unlocking valuable demand response and, as such, potentially leading to higher-than-necessary (peak) generation investment costs —see e.g., Borenstein (2005).[30] In Annex D, we discuss the differences between short-term price volatility, i.e., price spikes, and "long-term" volatility, i.e., sustained high prices. With regards to the former, reliability options have been introduced, as for in Ireland and Italy. Reliability options are typically related to the mitigation of adequacy concerns.[31] The different objectives of reliability options leads to different design choices: an hourly settlement and a relatively high strike price.[32] An hourly settled relatively high strike price protects consumers from sudden scarcity prices (the strike price acts as a price cap), while avoiding the distortion of short-term signals (at least for prices lower than strike price). However, by having a high hourly settled strike price, consumers are not shielded from bill impacts in periods of sustained high prices, for example a long period of prices at levels slightly lower than the strike price.

Table 2: Trade-offs and opportunities for the design parameters of the auctioned off call options and the impact on the cost of the option premium.

	High strike price (e.g., 1000 €/MWh)	Low strike price (e.g., 100 €/MWh)
High frequency settlement (e.g., hourly)	*Reliability options in Ireland and Italy*: protection from scarcity prices, limited distortion of short-term signal for consumers	Protection from sustained high prices, distortion of short-term signal for consumers
	Ambiguous impact on cost option premium	High option premium
Low frequency settlement (e.g., monthly)	No protection from scarcity price or sustained high prices, no distortion of short-term price signals	*Stability options*: protection from sustained high prices, limited distortion of short-term signal for consumers
	Very low option premium as option is (almost) never exercised	Ambiguous impact on cost option premium

5.2.2 Guaranteeing competitiveness of the contracting process

To guarantee the competitiveness of the contracting process, the auction shall be open for all generation technologies, both existing and to-be-built power plants. With respect to the latter, by having stability options of a relatively long duration of 5-10 years (i.e., a "bundle" of 60 or 120 monthly settled options), stability options protect the beneficiaries of the option pay-out from unpredictable periods of sustained high prices and somehow address the missing market for forward markets issue as discussed in Section 5.1. One might think about the benefits of setting up a secondary market for stability options, but we do not dig deeper into this possibility in this note.

[30] It could also be argued that a financial forward contract (some sort of CfD) would also hedge end users in the long run without necessarily minimizing their incentive to respond to short-term signals. This is partially true, but we consider that an option would be a less intrusive solution, as the monthly electricity bill would remain unaltered whenever the average price is below the strike, while the forward contract would actually have an impact as it would be settled monthly.

[31] Reliability options were first sketched by Prof. Pérez-Arriaga (1999). The mechanism was formally developed in deep detail by Vázquez et al. (2003). For more details about the Italian and Irish reliability options see Bhagwat and Meeus (2019).

[32] Another key difference between stability and reliability options is that reliability options are typically bought on behalf of all end users by the regulator, i.e., adequacy is, at least today in most power systems, considered a public good (for a discussion, see Oren (2009)). In contrast, stability options are not bought on behalf of all end users, but only on behalf of end users deemed in need of protection (or wanting such protection as discussed later in this subsection).

To allow to-be-built power plants to compete at equal footing with existing power plants, it is important to give participants the time to build the new power plant after selling the option. This can be done by, for example, having a time lag of two or more years between the sale of the options and the start of the option contract.[33] To guarantee that the generators have a natural hedge, they are required to prove that they are able to honor the option contract. In that regard, having only sufficient generation capacity (in MW) is not enough. Also, proof of being able to deliver the energy is needed (e.g., a long-term gas contract for a CCGT or historical production time series for RES). The exact implementation of these requirements, and possible penalty schemes, need to find a balance between minimizing financial risk for the option buyer and minimum entry barriers for the option sellers.

5.2.3 The scope of stability options

The regulator must decide about the quantity of volume of the stability options it will procure according to a certain shape of the demand profile. This decision shall be based on which end users are deemed to (or want to) be protected from sustained high prices.

To limit regulatory interference in the market, we recommend minimizing the number of end users on whose behalf the regulated entity buys stability options. For example, the quantity of stability options to be bought can be based on an estimation of the volume of electricity consumed by end users that are deemed in need of protection. These protected end users might not only include "standard" vulnerable consumers, i.e., consumers facing energy poverty in normal price scenarios, but also a large share of residential and/or even commercial consumers that would suffer significantly from periods of sustained high prices.

The cost of the stability option premiums should be allocated among the protected customers via the regulated charge in the electricity bill. The potential savings that could result from those periods in which the option could be "in the money" (i.e., when the average monthly market price happens to be above the strike) should be discounted from the regulated charge.

Regarding the latter group of consumers, we do advise making it possible for consumers to opt-out (and as such would be exempt from paying the levy). Consumers not opting-out before the auction would under any circumstance keep the corresponding charge in the regulated component of their bills (as well as the potential savings when the option is exercised). This charge should be therefore set once for each connection point and it should be implemented as fixed. If eventually any protected consumers want to disconnect from the network before the finalization of the duration of the option contract, they should pay an exit fee.[34] End users that are not by default covered by the stability options (e.g., industrial consumers) shall have the right to opt-in and participate in the auction, with the same rights and future obligations.

[33] The need for such a time lag implies, at least when considering the need to maximize competition, that stability options cannot be directly implemented. In that regard, if considered needed, we suggest to bridge the gap period by allowing for a budgetary or tariff deficit.

[34] Inspiration can be found by looking at the power charge indifference adjustment (PCIA), which is an "exit fee" charged by the Californian's investor-owned utilities to community choice aggregation and other departing load customers to compensate for electricity generation built or contracted in the past at prices that are now above-market (CPUC, 2022).

In terms of demand profile, a flat demand profile of the stability options makes the auction design easier, but might lead to a partial hedge. A more sophisticated demand profile (e.g., following a typical load curve) would provide a more complete hedge, but might complicate the auction design.

6. Closing summary

Since fall 2021, Europe's electricity prices have reached sustained, unprecedented, and largely unexpected levels. These high prices have prompted all national governments to introduce temporary measures to mitigate electricity bill impacts. Some governments argue that temporary measures are not sufficient and call for wider market reforms. The main points of our note can be summarized as three questions and answers.

1/ What was exactly said by the governments calling for a market reform and what has been done at national level?

The central message of the governments calling for a market reform is that the price paid for electricity by end users shall be more closely linked to the average cost of generation. These same governments claim that this objective can be reached with minimal intervention in the current market design, although they demand the amendment of crucial articles in the EU Directive. The basic fundamentals of microeconomics show that in markets of any kind, with no exception of the EU's internal electricity market, it seems challenging, if not impossible, to devise a way to reform regulations to achieve the declared objective of linking short-term market prices to average production costs.

With regards to national measures, besides temporary measures that are compliant with the EC's toolbox (and the existing market design), we have identified two approaches implemented or proposed in different Member States that go beyond the EC's toolbox and that can be linked to the aforementioned objective: taxation/capture of (alleged) windfall profits (Spain, Romania, and Italy) and mandated bilateral contracts (Bulgaria, France, Portugal, Spain, and Italy).

2/ Is it a good idea to expand any of the two measures that can be linked to this call for market reform or any other related measures that might be considered?

We do not recommend pursuing any of the implemented measures that go beyond the EC's toolbox. Besides being incompatible with the existing regulations governing EU electricity markets, these measures have significant negative static and dynamic implications, making the energy transition unnecessarily more costly for end users. These negative implications might not necessarily be evidenced in the short-term, but unavoidably will be in the long run. Beyond these two concrete types of measures, we have identified two other possible approaches to limit (short-term) price increases that are being explored by some policy makers: volume-restricted RES auctions and negotiated long-term contracts. For the same reasons, largely discussed above, we unrecommend these two measures.

3/ What should we do?

We formulate first-best solutions to this energy crisis, which are completely in line with the recommendations of the EC's toolbox. In the short run, energy poverty measures and reductions in the electricity via reduced levies, VAT, or energy taxes shall be considered. In the middle to longer run, the focus should be on further improving the existing market design and reducing the various barriers for new entrants, rather than discouraging new entry via the introduction of windfall profit taxes, mandatory auctions, or other related measures that are under consideration.

But since the economic and socio-political situation is not the same in all Member States, we recognize that some Member States might not be able to repeat the first-best responses to an electricity price crisis at an unpredictable frequency. In this context, and when considering the endemic lack of liquidity in electricity forward markets of contracts of sufficient length to adequately protect end users, we propose a regulatory-driven centralized auction in which a central entity buys lagged long-duration call options from generators on behalf of (a subset of) end users. We term this financial product "stability options." The objective of stability options is to prevent that sustained high prices could threat the financial health of certain categories of end users, while not distorting short- and long-term price signals. We describe the basic design parameters of stability options, explain how the awarded long-term contracts shall be procured via a fully open and largely competitive process and discuss their potential scope. We support future research to analyze in detail the concrete implementation of the proposed stability options and their interaction with other regulatory interventions, retail markets, and current State Aid rules.

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ANNEX A: RECAP OF THE CALLS FOR A WIDER MARKET REFORM

On September 20, 2021, the Spanish economy and energy ministers, Ms. Nadia Calviño and Ms. Teresa Ribera, addressed a letter to the EU Commission expressing their concern for the "unprecedented rise in energy prices" and announcing the implementation of a "set of national emergency measures" (Calviño and Ribera, 2021). Their "Non-paper on energy and electricity markets" briefly hinted at a number of ideas—among others, the "need to reform the wholesale electricity market" since "with today's market design, consumers are not participating in the benefits provided by a cheaper renewable generation mix" as "fossil-fuel plants still set the price."

In the non-paper, Calviño and Ribera claimed that the measures developed in the Spanish Royal Decree 17/2021 (published on September 15) were "within the limits of the European legislative framework and the EU internal energy market" and that "other countries have adopted measures that are less orthodox, and the Commission has maintained a prudent approach." Among other measures (such as reducing taxes and levies from the electricity rates), the decision was to implement a "temporary reduction (until March 31, 2022) of the excess gains that non-CO_2 emitting power plants are obtaining in the wholesale market thanks to the repercussion in the final wholesale price of the cost of gas … The methodology is similar to that used to limit windfall profits from higher CO_2 prices."

On September 30, Mr. Le Maire, the French minister of the economy, finance, and the recovery; and Ms. Pompili, minister of the ecological transition of French government; called in their letter to the President of the Eurogroup for a review of the European gas and electricity markets (Le Maire and Pompili, 2021). They argued that the "disconnection between electricity prices and actual production costs is particularly hard to understand in France." Among other high-level initiatives, they suggested that in the mid-term, structural measures could be explored. In particular, regarding electricity, they invited "the European Commission to conduct an in-depth analysis of the functioning of the European electricity markets and of the measures which could help stabilize market prices, limit volatility for consumers, and provide the right incentive to decarbonize the economy through the use of electricity." They announced measures "to alleviate the impact on the poorest households," but "as all households are facing the current increase in energy prices, wider measures should not be ruled out."

On October 5, Calviño and Le Maire joined by the ministers of finance of the Czech Republic, Greece, and Romania published a common statement in which, among other suggestions, they argued in favor of reforming "the wholesale electricity market… to better establish a link between the price paid by the consumers, and the average production cost of electricity in national production mixes" (Calviño et al., 2021).

On October 13, the European Commission's (2021b) communication "Tackling rising energy prices: A toolbox for action and support," suggested a set of measures, in line with the existing EU rules, to mitigate the impact—from direct income support to tax reductions and state aid. In the same communication, the European Commission formally tasked the European Union Agency for the Cooperation of Energy Regulators (ACER) to carry out an assessment of the current wholesale electricity market design by April 2022 and to provide a preliminary assessment by mid-November 2021. On that same day, ACER (2021a) published a note titled "High energy prices," advancing a brief analysis of the key drivers behind Europe's energy price increase.

On October 25, the Austrian, German, Danish, Estonian, Finnish, Irish, Luxembourgish, Latvian, and Dutch Governments (2021a) published a joint statement on "energy prices in the EU," countering the statements from the Spanish, French, Czech, Greek, and Romanian ministers. The main argument raised was that the design of EU energy markets or climate policy are not causing the current price spike, and that "interfering in the design of internal energy markets" would not be "a remedy to mitigate the current rising energy prices linked to fossil-fuel markets." Thus, they expressed their opposition to "any measure that conflicts with the internal gas and electricity market, for instance an ad hoc reform of the wholesale electricity market." And argued that the price hike could be "best addressed through temporary and targeted national actions by Member States, where appropriate, to protect vulnerable consumers and businesses," under the expectation that "these measures should be easily adjustable in the spring, when the situation is expected to revert to average levels."

On October 25, prior to the meeting of EU energy ministers in Luxembourg, the Spanish government (2021) elaborated a "Non-paper on electricity, gas, and ETS markets," in which one proposal was to explore "decoupling electricity market prices." It was stated that the "marginal price affects electricity futures signals and has a high impact on inflation reducing the effectiveness of hedging mechanism" and that "in these extraordinary circumstances, instead of the pure marginal price signal (contaminated by the spikes in gas prices), the electricity price would be obtained as an average price with reference as well to the cost of 'inframarginal' clean technologies (particularly renewables). The electricity price would be directly linked to the national production mixes, while at the same time protecting consumers from excessive volatilities and allowing them to participate in the benefits provided by a cheaper generation mix." The Secretary of State for Energy of Spain, Sara Aagesen, in her declaration to the press before the meeting said that their proposal was "to set electricity prices separately, on the one hand the marginal market prices, and on the other hand the infra-marginal prices, passing on to consumers the proportional part of both prices" (Peralta, 2021).

After that meeting on October 26, Kadri Simson, the EU Commissioner for Energy, declared that the Commission's "immediate priority is to protect our people and businesses from the impact of the exceptionally high prices" and that "the current market model provides a stable framework that delivers more renewables, enhances cross-border integration, and generally, ensures cheaper energy for all consumers" and that it "remains the best to deliver clean, secure, and affordable electricity across the EU" (European Commission, 2021c).

On November 8, Le Maire clarified in an interview with *Agence France-Presse* (AFP) the French proposal (Teller Report, 2021; Horobin, 2021). This interview was given just before the presentation of the (non-public) "Non-paper from France on energy prices." Le Maire explained that a first proposal is to introduce an "automatic stabilizer" mechanism to transfer the gains of high energy prices from producers to suppliers and customers. Further, he also stated that his country supports the idea to have long-term contracts reflecting the costs of low-carbon energies for businesses and called for assurances for households on the solidity of suppliers. Finally, Le Maire said there was some misunderstanding about what France wants: Their government's intention is not to push for any change to the wholesale market and their proposals are focused on structural issues with a long-term view rather than targeting short-term difficulties.

On November 15, ACER (2021b) submitted its preliminary assessment of Europe's high energy prices and the current wholesale electricity market design to the European Commission. In the assessment, ACER vividly defends the marginal pricing method as the instrumental tool to provide market agents with the right incentives to pursue efficiency in their decision-making, and argues that "alternative market design approaches (e.g., price caps or technology dependent average prices) may risk jeopardizing some of the benefits from EU energy market integration." ACER also describes potential issues with the current market design that will be further investigated in their report due in April 2022. An example of a highlighted issue is whether the current market design accommodates the investment signals needed for incentivizing generation and demand-responsive investment at scale or whether additional measures are needed such as enhanced hedging instruments, more liquid-forward markets, contract-for-difference, and/or increased facilitation of long-term solutions for underpinning sufficient revenue certainty in electricity generation.

On December 1, one day ahead of an Energy Council meeting with all EU energy ministers in Brussels, in which ACER's preliminary assessment was discussed, the "Non-paper on energy and electricity & gas markets" [35] from the French, Greek, Italian, Romanian, and Spanish governments (2021) was made public. The non-paper aimed "at contributing to the necessary debate on the functioning of electricity and gas markets by urging the quick implementation within the Energy Union of ready-to-use proposals." Besides other proposals aimed at enforcing consumer protection and "to address the observed gas market failures," they propose "to amend article 5 of the Electricity Directive in order to allow Member States to enforce regulatory mechanisms, designed at EU level, ensuring that final consumers pay electricity prices that reflect the costs of the generation mix used to serve their consumption." They alleged that these mechanisms would be "based on financial transfers between producers and consumers, [and] would have no effect on the functioning of the wholesale market." "Alternatively or simultaneously," they also "propose to amend article 9 of the Electricity Directive …to allow Member States to enforce services of general economic interest designed to ensure to final consumers an access to a zero emissions and competitive electricity supply that reflects underlying generation costs." Additionally, they ask to "dedicate regulatory efforts, at the European level, to facilitate the development of long-term electricity contracts based on zero emissions energies covering…a contracting period of five to ten years."

On the same day, the Austrian, German, Danish, Estonian, Finnish, Irish, Luxembourgish, Latvian, and Dutch Governments (2021b) published a second joint statement in which they repeat their support of the Commission's stance, saying the current energy price spike must be addressed "within the current European framework for climate and energy." These governments added that they "cannot support any measure that would represent a departure from the competitive principles of our electricity and gas market design."

On December 2, during the Energy Council meeting, Kadri Simson echoed ACER's preliminary assessment, recalling the "risks that alternative pricing mechanisms could pose to cost-efficient decarbonization, cross-border exchanges, and security of supply" (European Commission, 2021d).

The very same day we had to send this version of our document to the MITEI editor for publication, we got to know about a web article report issued on February 18 by Kyra Taylor (2022), in which she leaked a draft communication from the European Commission (2022). In it, two of the annexes develop what in our view can be considered as at least remarkable (if not *jaw-dropping*). These guidelines are

[35] Even though the title of the non-paper mentions "November 2021," the first publication of the paper that we could find was via tweet by "*España en la UE*" on December 1 (https://twitter.com/UeEspana/status/1466135051352092674).

certainly not much aligned with the ones promoted in the toolbox the EC published in October. In a nutshell:

- Annex 1 "Guidance on Application of Article 5 of the Electricity Directive during current situation," raises "reasons to intervene in price setting in response to current energy market situation." It is argued that "Regulated prices should be cost-reflective," but then it is stated that "It is however important that even if regulated prices might be below what is needed to cover wholesale market costs during one specific short term period, they must be cost-reflective taking into account a duly justified longer period."
- It is stated that "To finance support measures in this current crisis, Member States may want to capture a part of this additional infra-marginal rent by specific fiscal measures. However, such a measure would need to be carefully designed to avoid unnecessary market distortions." Annex 3 "Guidance on the application of intra-marginal *(sic)* profit fiscal measures" focuses on discussing how these distortions could supposedly be avoided.

ANNEX B: RENT TRANSFERS AND WELFARE LOSSES OF WINDFALL PROFIT TAXES AND UNCOMPETITIVE MANDATED AUCTIONS

We develop in this annex a simple illustration of the basic economic principles that evidence the argument we raise in Section 3.1.1. The graph below in Figure 6 shows the clearing of an electricity market in which the supply function is built up by different technologies. As we will later show, the variable cost of one of them, depicted in grey, depends on the market price of gas and sets the marginal price. In the demand function, we differentiate two clusters of customers (in red and blue). The latter, in blue, will be the customer group that the mechanism aims to protect/subsidize.

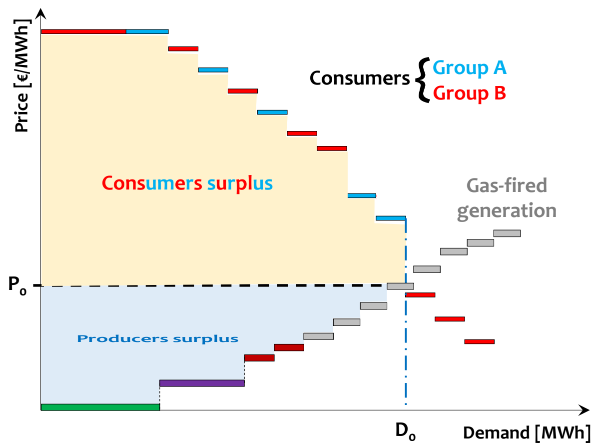

Figure 6: Marginal pricing clearing.

The use of marginal pricing, also referred to as "pay-as-cleared", in the day-ahead auction for electricity, is well grounded in economic theory (Schweppe et al., 1988).[36] Under marginal pricing and the assumption of perfect competition, generators are incentivized to reveal their operating costs when bidding in the day-ahead auction. As such, the market clearing results in the optimal dispatch, which is equivalent to the dispatch under a central planner minimizing operating costs. Paying out the marginal price to all generators implies that generators that are not "at the margin" receive inframarginal rents (producer surplus, as illustrated in the graph above). These inframarginal rents are required for the recovery of investment costs.

It can be shown that without administrative interventions, marginal pricing also leads to the recovery of the optimal investment decisions, see e.g., Hogan (2005). As it is the case in any other market[37], if the operating costs of the marginal sold unit (in the EU, currently being electricity generated by natural gas plants) rises, prices rise, and supply is reduced (and *vice versa*). When market prices are low, as they have been for a significant number of months in the past, cost recovery is challenged. Conversely, price rises increase the inframarginal rents of the plants with relatively stable low operating costs, e.g., nuclear or renewables (see Figure 7 below). Increased inframarginal rents incentivise the entry of new capacity with low operating costs (e.g., among others, more RES).

[36] Professor Ross Baldick (2009) of the University of Texas at Austin also wrote a brilliant explanation of the very basics of a single clearing price.

[37] See, for instance, Bove (2022) discussing the increase in prices of used cars in early 2022.

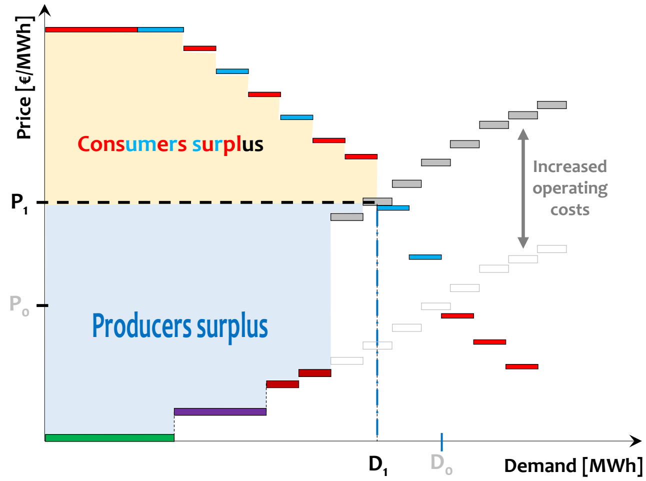

Figure 7: Impact of increased operating costs of the marginal unit on the clearing price and welfare under perfect competition.

Whether a particular policy intervention will increase efficiency in European electricity markets depends on what is causing the observed increases in wholesale prices. A second reason why prices may be increasing is through a combination of increases in natural gas prices and market power. Market power is the situation where firms can unilaterally affect the wholesale prices. This incentivizes them to submit bids that are above their marginal cost (see e.g., Borenstein et al. (2009)). Notwithstanding ACER (2021) reporting that there is currently no obvious indication or evidence of systematic manipulative behavior or insider trading likely to affect the current high-energy price situation, the introduction of windfall profit taxes (as some sort of income or price cap) or mandatory bilateral contracts are typical tools to mitigate market power. In the case of presence of market power, the implementation of these energy releases can improve the market functioning. However, the introduction of such measures in the absence of market power unavoidably leads to welfare losses.

With regards to windfall profit taxes, in case the windfall profit tax is settled hourly and based on a certain % of profits of non-marginal plants, no economic dispatch distortions should be expected. What does happen is a direct transfer of producer to consumer surplus. One extreme implementation of a windfall profit tax can be the requirement for all generators to return all excess profit when the hourly price exceeds a certain level. In that case, the windfall profit tax works as a price cap, implying that a generator has no incentive to produce electricity when its marginal cost exceeds the price cap[38]. Such intervention is illustrated in Figure 8 below. It can be easily seen that less demand is served compared to the ideal dispatch and a welfare loss is incurred. The magnitude of this welfare loss is a function of the implementation of the exact windfall profit tax and demand and supply conditions.

[38] This can lead to inefficiencies, for instance, for the case of storage plants, such as hydro reservoirs, since it turns into an incentive for them to keep the hydro resources for the future under the expectation that the tax could be later removed.

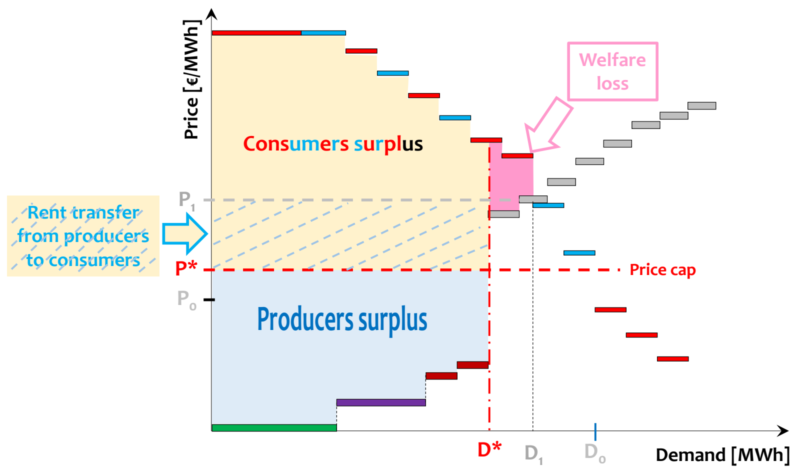

Figure 8: Impact of a windfall profit tax implemented as a price cap.

The direct consequences of the implementation of mandated bilateral contracts with a limited number of allowed buyers are more severe. The released energy in the mandated auctions is "removed from" the market that is accessible for all participants. As such, distortions will be introduced, of which the magnitude will depend, on the one hand, on the utility to consume and, either on the monopsony power of the exclusive buyers or the "behind-the-scenes" auction reserve price defined by the regulator (to limit the artificially created monopsony power); and, on the other hand, on the volume and marginal cost of supply offered via the mandated auctions.

Figure 9 below shows a stylized example illustrating the introduced distortions. On the left side, the mandated auction for the exclusive buyers (Group B) is illustrated. Customers belonging to Group B acquire more electricity and at a lower price than what they could get in the open market (illustrated above in Figure 7). Consequently, there is a rent transfer between generators and customers of Group B. But this is not the only consequence of the measure. As illustrated in the right side of the graph in Figure 9, less (cheap) supply is available in the open market and generation that would not have been called upon in the ideal dispatch is cleared. As a result, the final dispatch differs from the optimized dispatch and welfare losses are incurred. Importantly, in addition, the segment of end users that are excluded from the mandated auctions (Group A) also lose, since they have to pay a higher price.

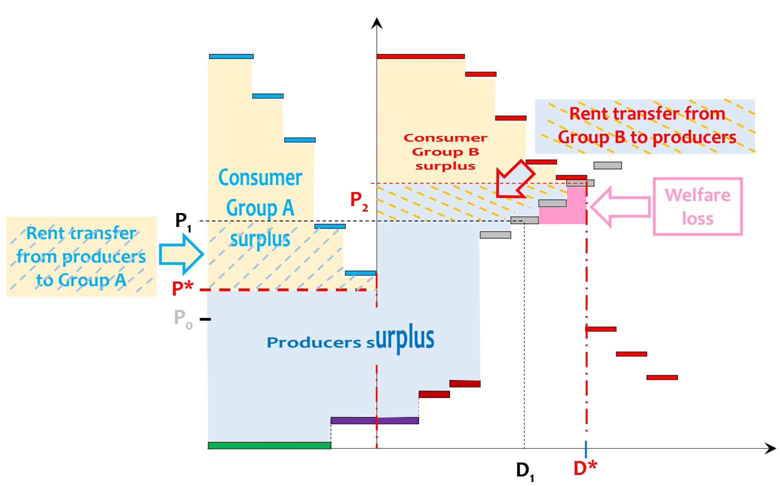

Figure 9: Rent transfers and welfare losses resulting from with mandated auctions with limited buyers.

ANNEX C: THE WIDER PICTURE: ELECTRICITY MARKETS, DECARBONIZATION, AND REGULATION

The recent situation has unfolded a scenario that had not been even considered in Europe: an unexpected and sustained period of very high prices. This crisis has raised significant criticism that has even got to the extreme of putting into question the fundamentals of the liberalization of the power sector. There are plenty of examples in the course of the history of economic regulation displaying how the lack of resiliency of market mechanisms against unanticipated events led to large retreats.

Alfred Kahn (1988), in his masterpiece "The economics of regulation," pointed in the right direction by stating: "Continued deregulation is the proper way to go, to the extent feasible… The central institutional issue of public utility regulation remains finding the best possible mix of inevitably imperfect regulation and inevitably imperfect competition."[39] The weight of regulation in electricity markets is particularly and increasingly significant. After more than two decades of experience, electricity market function has kept improving, but this development has not been uniform along all dimensions.[40] The electricity sector is increasingly a central piece of a much higher order target—the decarbonization of the whole economy. Increased uncertainties have led policy makers to consider it necessary to increase the level of command and control to guide the "greening" and expansion of the power system in the long term. Box 5 contains a couple of examples of this trend.

Box 5: Examples of trends in the regulation of the power sector (extracted from Batlle et al., 2021)

Policy makers have decided that different rules are needed to pursue a higher order decarbonization objective. Take for instance the case in the U.S.: trans-state short-term energy markets complemented with i) capacity markets (which treat various technologies differently, as the methodologies to allocate capacity credits respond to diverse criteria), ii) renewable portfolio standards at the state level (fixing different quotas for various technologies and time terms), iii) federal production and investment tax credits, iv) net metering and net billing state policies (rewarding distributed generation in diverging ways), v) energy storage mandates (in force in seven states as of June 2020), vi) regulated programs to support nuclear investments (e.g., the Clean Energy Standard implemented in New York State), vii) different out-of-market demand response programs. In the European continent, things are not very different. For instance, in Great Britain (GB), i) a capacity market was implemented (but later suspended in 2019 following the decision of the General Court of the EU), ii) renewables are supported through feed-in tariffs, a Contracts for Difference scheme, and a tax regulation mechanism, iii) at the time of this writing, carbon price is made up of the EU emissions trading system price and the Carbon Price Support rate (this latter price set by the British government, and largely uncertain after GB's exit from the EU), iv) a Regulated Asset Base (RAB) model for nuclear, currently open and under discussion.

The initial expectation, when the electricity sector was deregulated, was that political interference was not going to be a factor. This expectation cannot be held anymore. Some argue that the reason why markets do not fully work is precisely due to the excessive intervention from the political/regulatory side. The question is not if this is the reason or not, since it should not be expected that the electricity market could ever be free of the close political oversight. So, at this stage, after the years of experience gathered, the fact is that, more than ever, it is better to try to make regulation and

[39] George W. Bush, in an interview for CNN during the 2008 crisis, put forward a somehow aligned political sentence: "I've abandoned free-market principles to save the free-market system."

[40] In some jurisdictions, the deliberate choice was made not to restructure the power system, e.g., the Mid-West and South-East of the U.S. For a recent discussion of performance of traditional vertically integrated power systems versus restructured liberalised systems (as in the ISO-regions in the U.S. and the entire EU), see Schmalensee (2021).

competition less imperfect, since as Alfred Kahn stated, a good mix of regulation and markets is better than no market at all.

ANNEX D: SHORT-TERM VERSUS "LONG-TERM" VOLATILITY: DIFFERENT ISSUES REQUIRE DIFFERENT SOLUTIONS

The prices occurring in the EU during the energy crisis that started around September 2021 should not be confused with the traditional so-called scarcity prices. In capacity-constrained power systems, as it is the case in the majority of Member States in the EU (also in the U.S. ISO markets), traditional scarcity prices have been understood as sudden price peaks at times of tight supply conditions—see e.g., Hogan (2014). Such price spikes typically occur only in a number of hours within some days and at infrequent intervals.[41] In Figure 10, we show examples from scarcity prices in the EU and the U.S.

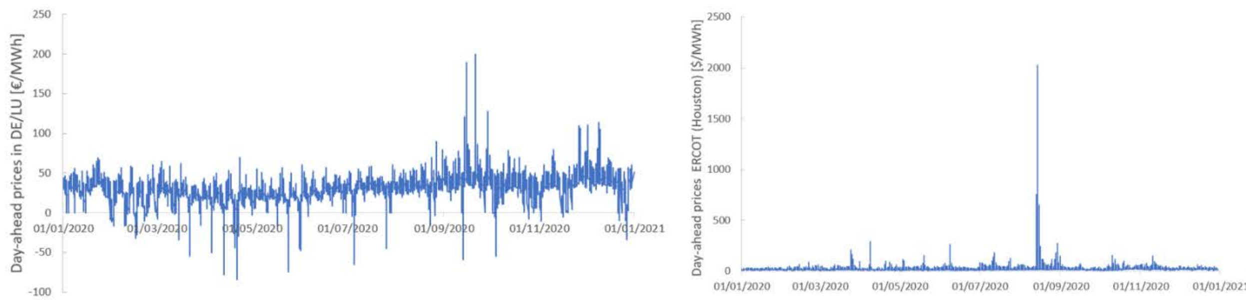

Figure 10: Day-ahead prices series for 2020 from Germany/Luxembourg (two minor price spikes in late September) and the Houston-hub in the ERCOT system (very high price spikes in August).

These prices create "short-term" volatility, i.e., the price of electricity can multiply from one hour to another, even with a factor 10^3 for some U.S. systems. This short-term volatility is deemed undesirable for end users as they can create high costs, but these high costs can to a certain extent by mitigated by the fact that these prices are infrequent and that bill impacts can be reduced by shifting or temporarily reducing load. Allowing the short-term market mechanism to reveal scarcity prices is a key tool to improve reliability in the short run (ideally unlocking short-term demand response) and stimulate investment on the longer run. However, having to rely on scarcity prices for investments, while being confronted with the missing market for long-term hedging instruments, has in the past lead to concerns about adequacy, often addressed by capacity remuneration mechanisms.

In contrast to scarcity prices, the prices seen during the EU energy price crisis have been sustained high prices (almost 24/7) which reflect the high procurement costs of gas power plants (and to a more limited extent CO_2 certificates) setting the marginal price. These sustained high prices can be seen as creating "long-term" volatility, i.e., creating significant fluctuations when looking at the electricity prices averaged over a month, a season, or even a year. The problem of sustained high prices is rather new in the EU, but not in other jurisdictions. An example is the Colombian power system, which is highly dependent on hydroelectricity. Annual dry seasons and the droughts brought by the *El Niño-Southern Oscillation* creates every few years high electricity prices for long periods, e.g., months. In that sense, the Colombian power system is at certain moments energy-constrained but not capacity-constrained—the problem that leads to the previously discussed scarcity prices. In Figure 11, we show the time series of the Colombian day-ahead market between 01/01/1996 and 01/12/2019, and we zoom into three periods of sustained high prices. Each zoomed in price series is the length of a year.

[41] The scarcity prices during the brown outs in Texas are an exception in this regard. More information about the specific circumstances in that case can be found in the report by Wood et al. (2021).

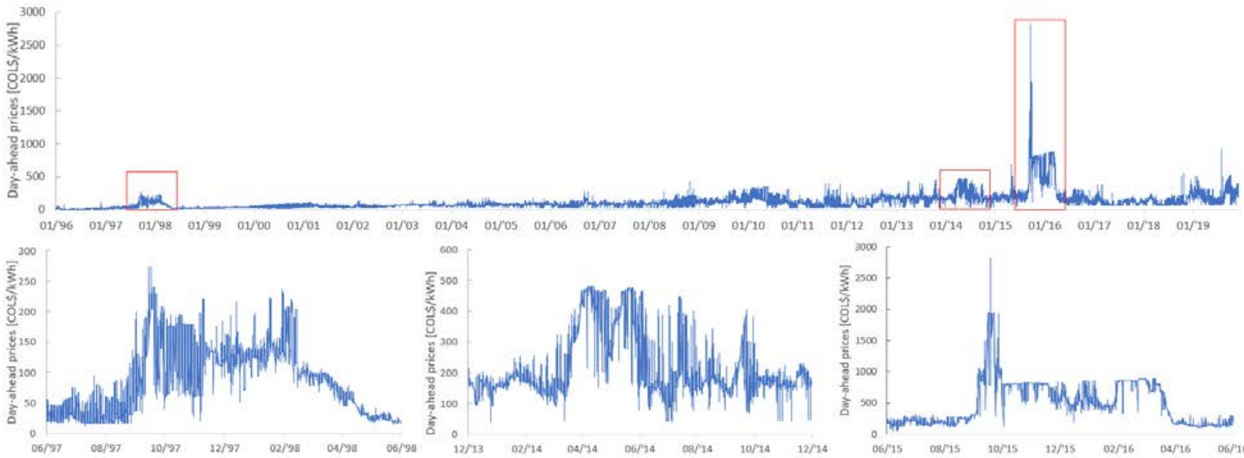

Figure 11: Colombian day-ahead market prices in COL$/kWh between 01/01/1996 and 01/12/2019 with three zoomed-in 12-month periods of sustained high prices (and some price spikes around September 2015). At the exchange rate of January 2022, 150 €/MWh equals about 670 COL$/kWh.

Even though every context is different, it can be argued that the price series during energy-constrained periods in the Colombian system better resemble the current situation in the EU than the scarcity prices do. In Colombia, reliability options have been introduced since 2004 (the first of its kind). It was the sustained high prices in the first shown period (01/06/1997-01/06/1998) that prompted the Colombian government to introduce this mechanism. The introduction of reliability options has not led to the disappearance of periods of sustained high prices, but this is also not its purpose. The purpose of the Colombian reliability options is that consumers (or certain consumer categories) are not fully exposed to these periods of sustained high prices. In that sense, the reliability options as implemented in Colombia come closer to our proposed stability options, with the important difference of a monthly settlement to avoid short-term price distortions. In Table 2, the Colombian implementation can be situated in the right top corner of Table 2 (Section 5.2.1).

Later, reliability options were proposed and/or implemented in other systems around the world (Batlle, 2007), such as in Ireland and Italy. These power systems are capacity-constrained and not-energy constrained. As such, the main difference with the implementation of reliability options as introduced in Colombia was the objective, i.e., addressing adequacy concerns and avoiding price spikes for consumers. Similar to the Colombian case, the settlement is hourly, but typically the strike price is set significantly higher to represent scarcity—at least in theory, as discussed by Pototschnig (2021) and Vázquez et al. (2003). More precisely, in the Colombian implementation, the strike price is set equal to the (indexed) estimated variable costs of a fuel oil power plant. In the Italian case, the strike price is set equal to the estimated variable cost of the marginal technology which is the technology with the lowest annual fixed costs. The strike price is indexed to the gas price and CO_2 prices. In the Irish implementation, the strike price was set equal to 500€/MWh in the first auction, which was the estimated variable costs of demand response.