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Marginal pricing and the energy crisis: Where should we go?

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Like other industries, the energy sector is driven by a mix of long-term expectations and short-term shocks. Limitations of oil resources shaped long term expectations in the seventies until they were superseded by concerns on the climatic consequences of the use of fossil resources. The belief that technology will solve everything and that there is nothing to worry about it is another type of expectation that cycles with population weariness on these issues. Short-term shocks can come from various origins and bear on different horizons: the embargos on oil of the seventies and more recently the disruption of the gas market that accompanied the war in Ukraine are of geopolitical origin and rather instantaneous. But shocks can also happen in responses to policies that turn out to be difficult or just outrageously costly to implement in the short term and this may take more time to mature. Current events on the EV market suggest that this might have been the case with the 2035 ban on the sale of new fossil fuel cars adopted in February 2023. It has also been argued that shocks might increase in frequency and intensity together with surging costs to deal with them (Pisany Ferry et al. 2024). Their recognition in the reasoning may thus be important: whatever the nature of expectations and shocks, their mix create a very uncertain environment that complicates investment in new capacities especially if costly and uncertain R&D is also involved.

This situation is now well recognized. It applies to the electricity system which, so far, has been unable to create a long-term market for linking spot and long-term forward prices to help investment. This issue, among several others, emerged during the 2022-2023 energy crisis when the disruption of the Russian gas supply market led to a wave of amazing comments suddenly questioning the organization of the electricity market that had been in the making for more than 20 years. These calmed down in two years with the adding of new

policies that might themselves imply new short-term shocks (such as the ban on the sale of new thermal vehicles from 2035 already alluded to) and a new legislation with a small

revision of the current market organization combined with an emphasis on PPAs and CFDs as solutions for the long term.

This paper focusses on an important element of the 2022-2023 debate. Our discussion is of a methodologic nature but strongly rooted in considerations that came to the surface at the time. It is also computationally implementable. As noted, the absence of a long-term market of electricity was one of the points of the discussion that led to the new legislation of the electricity market. Finon and Beeker 2023 probably made the most concise and striking declaration on that shortcoming when stating that the spot price does not contain any long-term signal. We start from this comment and explores it through basic principles established in electricity economics in the sixties by Boiteux 1960 and later extended as a general economic result. The statement is well known: short- and long-term marginal costs should be equal when capacities are "adapted"; the statement is obviously relevant for a sector such as the power system which so extensively relies on the notion of marginal cost pricing.[1] The comparison of Boiteux's result with the reality of 2022 is striking. As stated by Finon and Beeker, there is indeed no element of long term marginal cost in the current market design; in contrast the notion of short term marginal cost that was enshrined in the restructured market before the crisis and remains central in the new legislation. The notion of adapted capacities is of particular importance in the discussion: capacities, even if never really fully adapted in the real world, suddenly became completely unadapted to the fuel economics that followed the disruption of Russian gas supplies. Therefore, this paper offers an analysis and extension of Boiteux's classical result when capacities are no longer adapted to the external economic conditions

The analysis is based on the following observations. The idea of basing the power system on the notion of short marginal cost was retained in the revision of the market design. We also take short run marginal cost pricing as our central assumption. We note that the current evolution of the day-to-day design of the market suggests that the current computation of prices could be modified to accommodate new members to the European power system.[2] We thus also allow ourselves some modifications of the existing computation provided they do not change the complexity of the overall system. Taking note that that the spot price should include a long run aspect, we embed that dimension in the spot price without changing its short-term incentives. This is the main contribution of the paper. We do so while imposing the following consistency condition: supposing that the market was to return to a less volatile environment that enables capacities to be (reasonably) adapted to short term conditions, it would then be natural to expect that the long-term signal should satisfy the equality between short- and long-term marginal costs foreseen by Boiteux. We show that this condition is

[1] We use "notion" because the real implementation is not a true marginal cost, but this is inconsequential for the paper.
[2] The notion "convex hull" pricing is often mentioned in this case.

indeed satisfied and emphasize that this is not just a technical exercise: this equality would in any case need to be satisfied in a more general version of our mode to reflect a textbook financial market description where the forward price is equal to the expectation of the spot price in some probability measure. The paper develops these ideas in a formal way and illustrates them on a small example constructed on French data.

The following remarks maybe important when looking at the practical side of the problem. The proposed adaptation of the underpinning model of the spot price does not require more computational effort than in the current system. It implies the same degree of centralization (or decentralization) as the existing one and the same market agents in their current role. While the paper focuses on a simple version of the problem, the underpinning technology is in no way limited to those simplifying assumptions. These extensions are left for future work.

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