Liberalization of the Electricity Market in Ukraine in 2019 - Lessons Learned

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***Abstract*—The liberalization of the electricity market in Ukraine in July 2019 led to unexpected behavior of the market. The initial market design and its changes in December 2019, March, April, May and June 2020 are discussed. The effects on day-ahead market prices, imbalance prices and activated balancing reserves are evaluated with data from July 2019 until April 2020. The data illustrates temporary malfunctions. Changing the imbalance pricing scheme reduced misplaced incentives. In future, more transparency could lead to further improvements. The regulation should allow to quickly adopt and give immediate feedback to the market participants. In addition, allowing higher prices for balancing reserves would give stronger incentives to participate in balancing markets.**

***Index Terms*—Ukraine Electricity Market, Power Balancing, Liberalization**

I. Introduction

The government of Ukraine adopted the law "On Electricity Market" in April 2017 [1]. This law paved the way for the introduction of a liberal electricity market in July 2019. Historically, Ukraine had focused on power exchange with Russia and Belarus. The liberal electricity market is the first step towards coupling with other European markets. The purpose of the liberal market is to ensure transparent and competitive pricing. This shall optimize the energy balance and improve economic, energy, and environmental security. Competitive mechanisms for market participants shall encourage the industry to modernization [2].

The liberalization aims for more competition and more efficiency, but it goes along with more complex mechanisms and legislation. Market participants are organized in Balance Responsible Parties (BRPs). The day-ahead market (DAM) is their main tool for creating schedules and dispatching power generation and load. BRPs shall track their real-time power generation and consumption and stick to the schedule. In addition, BRPs can offer upward and downward reserves at balancing markets. These reserves are activated in case of any imbalance between generation and load in real-time. The costs for the balancing process are allocated to the BRPs with schedule deviations via an imbalance pricing mechanism.

This growing number of market opportunities creates complex interrelations. The design of electricity spot markets, balancing markets and the imbalance pricing mechanism can include misplaced incentives for BRPs. The interaction of these market opportunities is crucial for system stability. Correct incentives lead to efficient electricity markets and a balanced power system. Misplaced incentives can lead to an imbalance between generation and load, as it was seen in Germany in June 2019 [3]. This work aims to research which lessons can be learned from the liberalization of the electricity market in Ukraine since July 2019.

Section II outlines the analysis method. Section III describes the initial market design in Ukraine in July 2019 and relevant changes over time. Section IV presents the applied data and the effects of market design changes. In section V, the findings are discussed and put into context. Section VI concludes main findings of this paper and presents an outlook.

II. Methodology

The method covers a review of the market design, followed by a data analysis. This study aims to identify the key market design parameter for a cost-efficient power system. The initial market design in July 2019 is compared to the market design changes in November 2019, March, April, May and June 2020. Data of DAM prices, the imbalance prices, prices for balancing reserves and the amount of activated balancing power is used to analyze the effects of the market design changes. The intra-day market is not considered. Data over a ten-month period from July 2019 until the end of April 2020 is applied. Data of the integrated power system of Ukraine is evaluated. The zone of Burshtyn, which is in synchronous operation with central Europe, is not considered.

III. Electricity market of Ukraine

The law "On Electricity Market" of April 2017 was adopted several times to change the market design [1]. This section describes the changes with regard to the DAM, power balancing markets and imbalance pricing.

A. Initial market design in July 2019

Prices at the DAM are limited since the first implementation. Different price caps apply during the night, from 23:00 until

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08:00, and during the day, from 8:00 until 23:00. Prices at the power balancing market and the imbalance price for schedule deviations are regulated, too. The price caps are set to be maximum 115% of DAM price cap and minimum 85% of DAM price cap. BRPs with power plants are obligated to offer all available flexibility at power balancing markets with prices in this range. Single imbalance pricing applied in the first place, which was changed later on. The imbalance price is the weighted average price of upwards and downwards balancing energy. The imbalance price is maximum 115% of DAM price cap in case of an positive imbalance (upward reserves dominated) and minimum 85% of DAM price cap in case of negative imbalance (downward reserves dominated). Table I shows the price caps in Ukrainian hryvnia (UAH) per MWh, as implemented in July 2019. The clearing process takes more than a month. This means BRPs pay or receive the imbalance price 4-6 weeks after the considered time period. In contrast, the DAM price has to be paid or is received in advance.

TABLE I
PRICE CAPS FOR DAY-AHEAD MARKET, BALANCING MARKET AND SINGLE IMBALANCE PRICING FROM JULY TO NOVEMBER 2019

	Day hours	**Night hours**
Day-ahead market (max)	2048.23 $\frac{\text{UAH}}{\text{MWh}}$	959.12 $\frac{\text{UAH}}{\text{MWh}}$
Upward reserves (max)	2355.46 $\frac{\text{UAH}}{\text{MWh}}$	1102.98 $\frac{\text{UAH}}{\text{MWh}}$
Downward reserves (min)	1740.99 $\frac{\text{UAH}}{\text{MWh}}$	815.25 $\frac{\text{UAH}}{\text{MWh}}$
Imbalance price (max)	2355.46 $\frac{\text{UAH}}{\text{MWh}}$	1102.98 $\frac{\text{UAH}}{\text{MWh}}$
Imbalance price (min)	1740.99 $\frac{\text{UAH}}{\text{MWh}}$	815.25 $\frac{\text{UAH}}{\text{MWh}}$

B. Changes in December 2019

The government of Ukraine changed the legislation framework with regard to the price caps. The new pricing mechanism came into effect by the 1 of December 2019. The actual DAM price is considered and not the DAM price cap. That means the fixed price range at the power balancing market was changed to a dynamic range. The maximum price for upward reserves is limited to 115% of DAM price and bids for downward reserves have a minimum of 85% of DAM price. The maximum single imbalance price is set to 115% of the DAM price in case of a positive imbalance (upward reserves dominated) and the minimum imbalance price is at least 70% of DAM price in case of negative imbalance (downward reserves dominated). Table II shows the new dynamic price caps.

TABLE II
PRICE CAPS FOR BALANCING RESERVES AND SINGLE IMBALANCE PRICING FROM DECEMBER 2019 TO FEBRUARY 2020

	Day hours	**Night hours**
Upward reserves (max)	DA Price + 15%	DA Price + 15%
Downward reserves (min)	DA Price - 30%	DA Price - 30%
Imbalance price (max)	DA Price + 15%	DA Price + 15%
Imbalance price (min)	DA Price - 30%	DA Price - 30%

C. Changes in March 2020

The government of Ukraine changed the legislation framework with effects on DAM, power balancing markets and imbalance pricing. The new mechanisms came into effect by the 1 of March 2020.

1) Day and night hours: In accordance to new changes of the Market rules for day-ahead market and intra-day market the 8th hour was moved from off-peak hours to peak hours. As a result, the highest price between 7.00 and 8.00 at the DAM increased from 959.12 $\frac{\text{UAH}}{\text{MWh}}$ to 2048.23 $\frac{\text{UAH}}{\text{MWh}}$.

2) Power balancing market: The power balancing market price was set back to be maximum 115% of DAM price cap for upward reserves. The minimum power balancing market price was set to be 55% of the actual DAM price for downward reserves. Table II shows the new price caps.

TABLE III
PRICE LIMITS FOR POWER BALANCING MARKETS FROM MARCH 2020 TO APRIL/MAY 2020

	Day hours	**Night hours**
Upward reserves (max)	2355.46 $\frac{\text{UAH}}{\text{MWh}}$	1102.98 $\frac{\text{UAH}}{\text{MWh}}$
Downward reserves (min)	DA Price - 45%	DA Price - 45%

3) Dual imbalance pricing: The imbalance pricing scheme changed from single pricing to dual pricing. The clearing result for each BRP is now calculated according to Fig. 1. The formula results in different prices for positive schedule deviations (more generation or less consumption than scheduled) and negative schedule deviations (less generation or more consumption than scheduled).

D. Changes in April/May/June 2020

Since 8. of April the maximum price for upward reserves was set to be 105% (not 115%) of DAM price cap. Since 27. of May the minimum price for downward reserves is 65% (not 55%) of the DAM price. Since the 10. of June the minimum price for downward reserves was changed again to be 80% (not 65%) of the DAM price. Table IV shows the new price caps.

TABLE IV
PRICE CAPS FOR POWER BALANCING MARKETS SINCE 08. OF APRIL (MAX) AND BETWEEN 27 OF MAY TO 9 OF JUNE (MIN)

	Day hours	**Night hours**
Upward reserves (max) since 08.04.	2150.64 $\frac{\text{UAH}}{\text{MWh}}$	1007.08 $\frac{\text{UAH}}{\text{MWh}}$
Downward reserves (min) since 27.05.	DA Price - 35%	DA Price - 35%
Downward reserves (min) since 10.06.	DA Price - 20%	DA Price - 20%

E. Summery of market changes

Fig. 2 illustrates all the described changes of the market design at hand.

$$CR_{b,t} = \begin{cases} SD_{b.t} * min(DA_t, IP_t) * (1 - K^{im}) & \text{if } SD_{b,t} > 0 \\ SD_{b.t} * max(DA_t, IP_t) * (1 + K^{im}) & \text{if } SD_{b,t} < 0 \\ 0 & \text{if } SD_{b,t} = 0 \end{cases}$$

With

$CR_{b,t}$ - clearing result (debit, if positive or credit, if negative) of BRP b in time period t

$SD_{b,t}$ - schedule deviation of BRP b in time period t

DA_t - Day-ahead market price in period t

K^{im} - coefficient of imbalance price

IP_t - imbalance price in time period t

Fig. 1. Dual imbalance pricing: calculation since 1 of March 2020

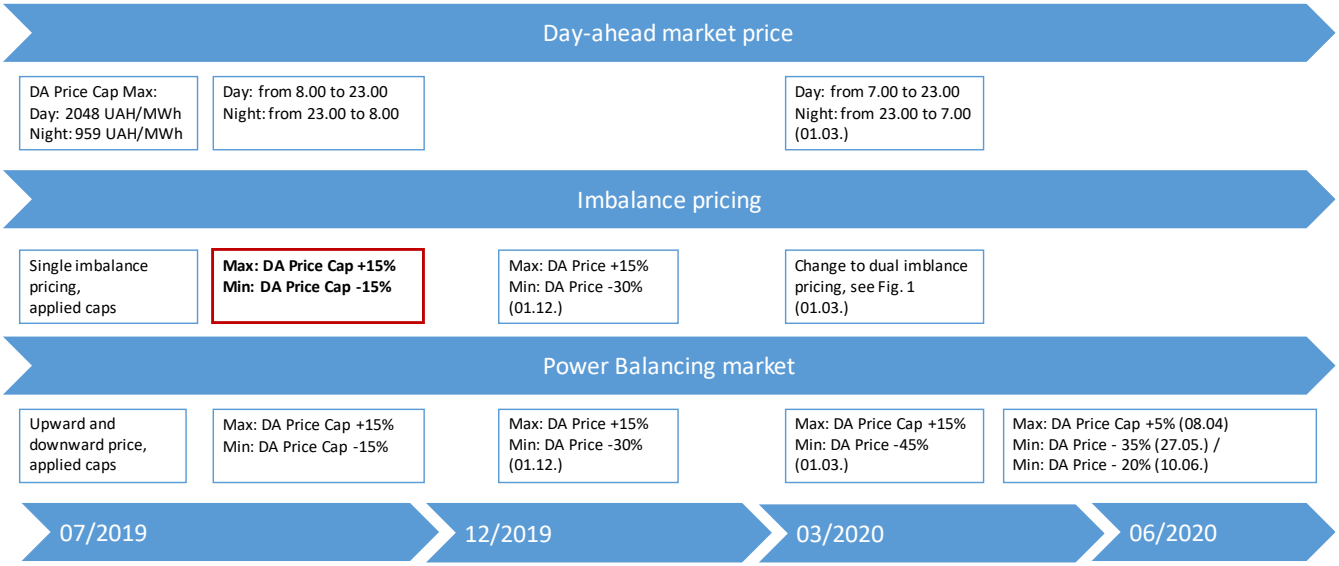

Fig. 2. Market changes over time in Ukraine

IV. Data Analysis

The applied data include DAM prices, the imbalance prices, prices for balancing reserves and the amount of activated balancing power in Ukraine from July 2019 until April 2020. The data is available in 1 hour resolution [10].

Fig. 3 illustrates the mean activated upward and downward reserves per month. The mean activated downward reserves peaked and were 10 times higher than activated upward reserves in November 2019.

Fig. 4 illustrates the costs and revenues for the activation of reserves. Again, November is remarkable. BRPs offering downward reserves actually lost money, because the price for downward reserves was higher than the DAM price.

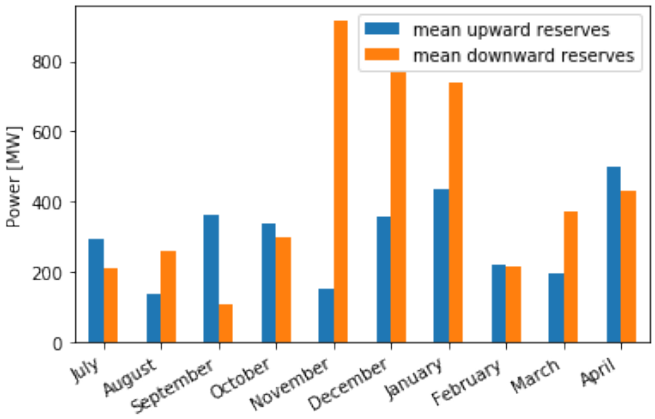

Fig. 3. Mean of activated reserves - July 2019 to April 2020

A. Effects of design change in December 2019

November had 500 hours (of 720 hours) where the imbalance price was higher than the DAM price. BRPs could maximize revenues by not selling energy at the DAM but rather creating an upward imbalance. The data indicates, that this financial incentive led to unwanted behavior. Energy was fed into the grid which was not scheduled and, thus, led to the activation of downward reserves.

The government of Ukraine changed the legislation framework and the approach of how to calculate the price caps of the balancing market and the imbalance price by the 1 of December. Fig. 5 illustrates the imbalance price and the DAM price from 27.11.2019 until 03.12.2019. Fig. 6 illustrates

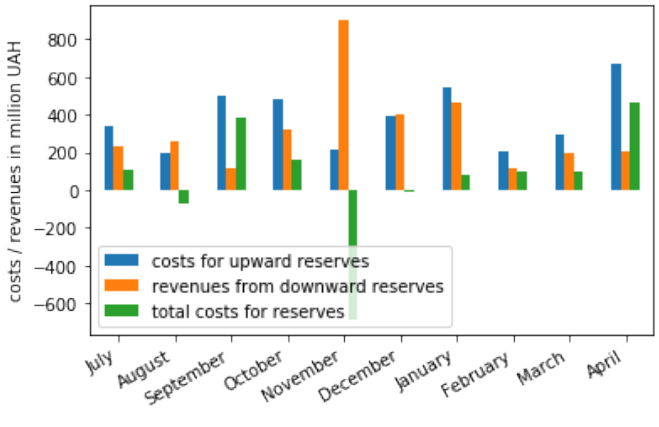

Fig. 4. Costs / revenues for activated reserves per month - July 2019 to April 2020

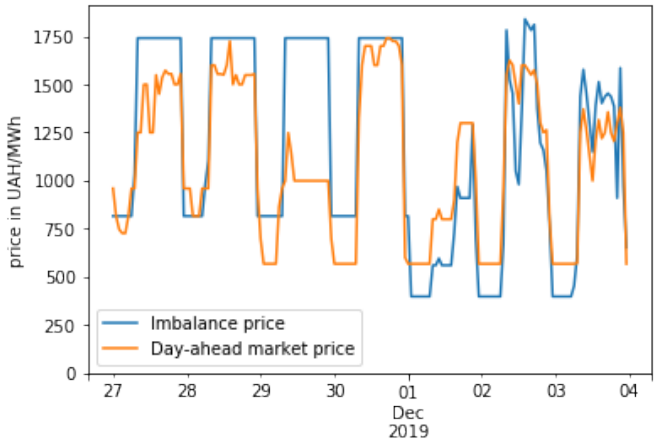

Fig. 5. Imbalance price and DAM price from 27.11.19 to 03.12.19

the prices for upward and downward reserves per hour from 27.11.2019 until 03.12.2019. Due to the market design change, the imbalance price and the price for downward balancing reserves can reach values under 1741 $\frac{\text{UAH}}{\text{MWh}}$. Fig. 7 illustrates the mean of activated upward and downward reserves per hour from 27.11.2019 until 03.12.2019. In December 2019 and January 2020, the system was in a more balanced situation. Nevertheless, the activation of downward reserves was still higher than the activation of upward reserves, as shown in Fig. 3. Fig. 8 illustrates the hourly distribution of activated downward reserves in December 2019 and January 2020, which peaked especially in night hours during these two months. The government stated to investigate the manipulation of DAM and balancing markets in February 2020. This statement reduced the activation of reserves very effectively.

B. Effects of design change in March 2020

As shown in Fig. 3 and Fig. 4, the differences between February and March are less extreme. The new market design allows higher prices for balancing reserves. The immediate effects are a shift back to higher prices for reserves, which can

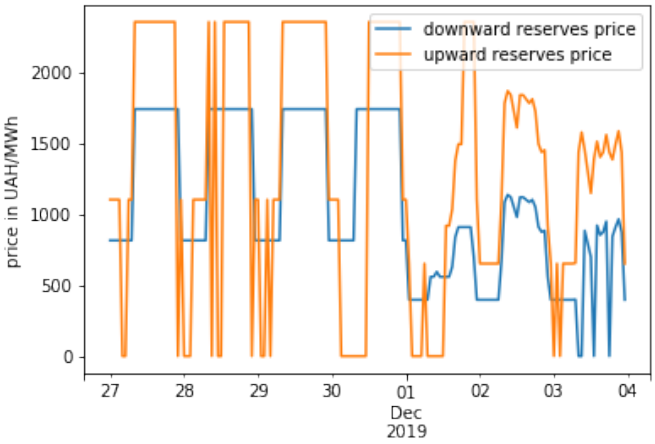

Fig. 6. Price for reserves from 27.11.19 to 03.12.19

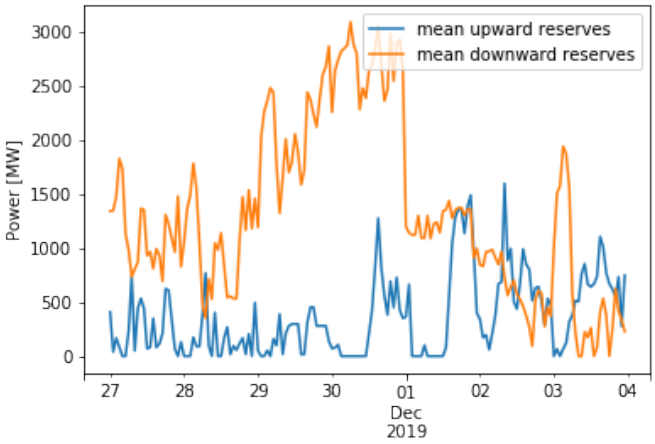

Fig. 7. Activated reserves from 27.11.19 to 03.12.19

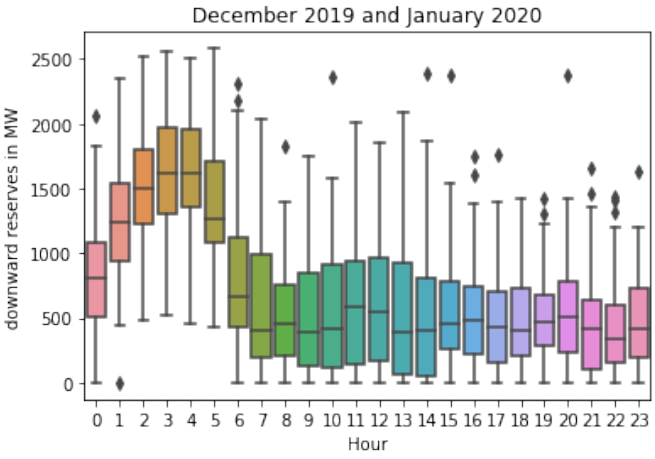

Fig. 8. Hourly distribution of downward reserves in December 2019 and January 2020

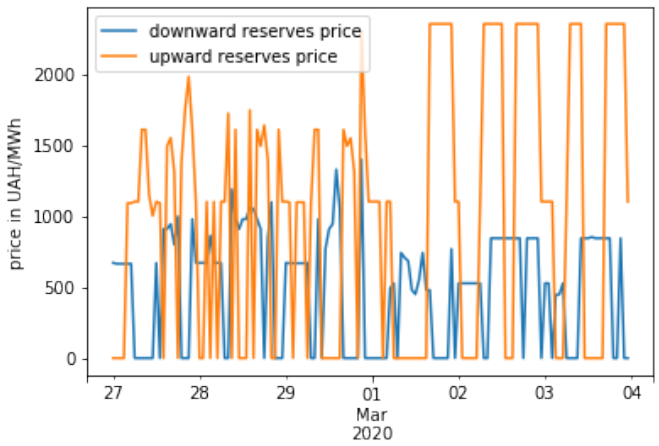

Fig. 9. Price for reserves from 27.02.20 to 04.03.20

be seen in Fig. 9. The activation of reserves increased in March and in April. Dual imbalance pricing leads to penalties for all schedule deviations, also for those who reduce the required balancing reserves.

C. Effects of design change in April, May and June 2020

The potential income from balancing reserves are reduced, in contrast to the market design changes in March 2020. The available data does not allow to evaluate the effects of design changes in April, May and June 2020.

V. Discussion

The different time periods are short and statistical evidence cannot be provided. Nevertheless, the data indicates that misplaced incentives of the initial market design led to situations of physical energy scarcity. In November 2019, the amount of activated downward reserves peaked. The misplaced incentive was a combination of low DAM prices and fixed imbalance prices, which exceeded the DAM price in 500 out of 720 hours. The market design change of how to calculate the imbalance price caps by 1 December 2019 did eliminate the minimum imbalance price. The new approach avoids misplaced incentives in case of low DAM prices. The governmental statement of starting an investigation on market manipulation in February 2020 came along with the most balanced month. Changing to dual imbalance pricing in March 2020 did not improve the situation further.

A. Lessons learned in other countries

The market liberalization in other countries is put into context. This leads to an outlook of how the market design in Ukraine might develop in the nearby future. The shift from regulated electricity monopolists towards liberal energy markets takes place in European countries since 1996. Reason of the "unbundling" was the Directive 96/92/EC of the European Parliament and of the Council of 19 December 1996 [4].

Gencer et. al. (2020) describe the liberalization in England and Wales, Germany, Belgium, Denmark and Switzerland. According to the analysis, energy markets evolve in three steps. The initial "Monopoly" is replaced by "Wholesale Competition": industry and generators start trading at spot markets. Afterwards, "Retail competition" allows all consumers to choose their energy supplier at free markets. The final stage of "Reregulation" adopts rules "to intervene to induce or prevent certain behaviours by market participants". Gencer et. al. (2020) conclude that (i) many regulatory frameworks lagging behind innovation in the market, (ii) the behavioral factors are as important as economics and (iii) agile market frameworks should give a long time perspective, but also pay attention to feedback of stakeholders. [5]

B. Harmonization of markets

Ukraine aims to develop energy markets in convergence with EU guidelines, as stated in Article 338 (d) of the Association Agreement [6]. The EU electricity balancing guideline (EBGL) gives guidance for the process of harmonization in Europe [8]. As of today, European energy markets are diverse and details of common rules are still under consultation [7].

According to Article 53, the imbalance settlement period shall be 15 minutes. Ukraine applies 1 hour. The imbalance pricing scheme shall be single pricing, as stated in Article 52 (2). Ukraine applies dual pricing since March 2020. Clearing of power balancing markets shall be marginal, defined in Article 30 (1). Ukraine applies marginal clearing. [8] [1]

C. Integration of power systems

Besides the market harmonization, Ukraine aims for synchronous operation of its two zones. In addition to the zone of Burshtyn, also the integrated power system of Ukraine shall operate within the Central European zone. As a first step, Ukraine plans to run the integrated power system of Ukraine in island mode in 2022. The grid operator and balancing service provider are preparing for this test period. [9] Ukraine could benefit from its position between Russia and central Europe. Enabling power balancing between different zones becomes more important with increasing amounts of renewable energy generation.

VI. Conclusion and Outlook

The liberalization of the electricity market in Ukraine illustrated how misplaced incentives lead to unwanted market reactions. Initially, creating positive schedule deviations was more attractive than selling energy at the DAM leading to high amounts of activated downward reserves in November 2019. Changing price caps and governmental statements did stop this speculation of BRPs leading to minimum amount of activated reserves in February 2020. Dual imbalance pricing was introduced in March 2020, but no further improvements could be seen. Lessons learned in other countries can help to evaluate behavioral factors. In the future, regulation should allow to change the pricing schemes again, if the market behavior makes it necessary. The elimination of price caps in balancing markets could lead to an increase of competition and innovation. Changes of legislation should be made transparent and with fast implementation to avoid temporary speculations.

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