MEMO

EVALUATION OF THE BALANCING MODEL

1. Introduction

In accordance with the Danish Utility Regulators (DUR´s) approval of the change in the balancing method from December 6th 2021, Energinet is asked to prepare an evaluation of the balancing model based on the first five months of operation (October 1st 2022 to March 1st 2023). The original evaluation deadline was June 2023, but has since been postponed due to IT issues that has inhibited Energinet from effectively assessing data quality, pushing the deadline to April 15th 2024.

To supplement the evaluation of the new balancing model, Energinet has consulted market participants based on their experience with the new balancing model during the first five months (from October 1st 2022 to March 1st 2023). Energinet received a total of three consultation submissions, whereof two of these represent the opinion of a broad part of the shipper community and mainly represent shippers towards the end-consumer markets in Denmark and Sweden[1].

Most of the feedback provided by market participants on the initial months of implementing the new gas balancing model revolved around issues on overall functionality of the supporting IT-system, data quality, and communication. Specifically, the feedback addressed data inaccuracies in consumption data (DMS and NDMS), allocation of CAP volumes, and calculation of ASB, IASB, Yellow Zone trades, and NPP values. Further, feedback addressed issues of lack of balancing prices, smoothing data, matching, and nomination data. Combined, these issues led to uncertainty and lack of transparency, thereby adversely affecting shippers' ability to balance. This evaluation addresses the key issues highlighted by market participants. Consequently, the evaluation presents an overview of data support and quality of data (DMS) based on geographical area, an evaluation of the smoothing concept, balancing incentives, market liquidity and flexibility.

Lastly, this evaluation will also be used to form future discussions in Energinet concerning the overall functionality of the model and the potential for enhancements through adjustments in the model.

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[1] The consultation feedback submissions will be added as appendices, when the final evaluation report is forwarded to the Danish Utility Regulator by 15th of April 2024

1.1 Executive summary

This report evaluates the overall performance of the new gas balancing model with regards to the data quality, smoothing concept, balancing incentives, market liquidity, and flexibility. Firstly, Energinet acknowledges and generally agrees with the feedback provided by market participants that the functioning of the new gas balancing model during the implementing phase in Q4 2022 was impeded by poor data quality, poor IT-system performance, and poor communication, which adversely affected the shippers' ability to balance their portfolios during this period. Consequently, Energinet decided to extraordinarily neutralize days affected by these issues. In January 2023 Energinet had, however, addressed and solved the majority of the remaining critical IT-issues related to the overall poor functioning of the balancing model. It is therefore Energinet's overall impression that the balancing model has functioned as intended since the beginning of January 2023. Nevertheless, Energinet acknowledges that the frequency of significant data issues that has occurred since January 2023, is affecting the reliability of the data applied in the model. These isolated instances have, as intended in the methodology, been compensated to shippers through the No Punishment Principle (NPP), which aims to safeguard the market shippers in the Joint Exit Zone (JEZ) against poor data quality. Further, it was outlined that most of the data issues were related to independent configurational errors, for which controls have since been implemented and is thus not an overall characterization of the general level of data quality. Thus, when examining the overall level of data quality, the analysis shows that the data quality has improved. Energinet will, however, continue to work on further improving the robustness of the IT-system by adding additional control mechanisms, improving the usage and quality of fallback data, and by discussing and learning from previous issues. Followingly, Energinet evaluated on the smoothing concept, which is functioning as intended, aiding the balancing of the shippers during the day. The incentives within the balancing model were also assessed, with the conclusion that the incentive structure has to a large extend functioned as intended. However, Energinet will continuously monitor market behavior against the incentive structure to identify any improper response to imbalances and followingly adapt if required. Finally, Energinet evaluated on flexibility provided in the new model, where Energinet based on the learnings from the first full year of operation has introduced a new dynamic green band that will ensure that the flexibility can be adapted to overall system use.

2. Evaluation of data support for the balancing model

This section covers the following four points from DUR's balancing method approval:

- *"Erfaringer med regionalisering, herunder kriterierne for definitionen af regioner, antallet af regioner, samt en analyse af den godkendte datametodes implementering i de forskellige regioner,"*
- *"Erfaringer med dataunderstøttelsen fra distributionsselskaberne, herunder kvaliteten af data, og datametodens tidsvinduer for indhentning af data,"*
- *"Erfaring med de anvendte metoder og modeller til brug for estimation af aftaget i JEZ,"*
- *"Vurdering af behovet, fordel, mulighederne og omkostninger ved forbedring af datakvaliteten, hyppighed og frister for tilrådighedsstillelse af data. En analyse af fordelingen af omkostninger og fordele for de involverede kategorier af berørte parter inkl. Netbrugere,"*

2.1 Evaluation of the defined regions and the implementation of the data method in each region

When the balancing method application was forwarded and later approved by DUR, it was still not decided if Denmark should be split up in regions different from what it has been historically. However, after the approval, it was decided to operate with the same regions as in the past, as there were no obvious reasons to change the previous regions:

1. Northern Jutland and Northern Zealand, including the Copenhagen area (previously known as the HMN area).
2. Southern Jutland and rest of Zealand.
3. Funen.

Apart from the Danish region, Sweden is also considered as its own region in terms of data quality analysis.

The regions are further separated in six distributions zones for which the data and data quality is analyzed. The six distribution areas in the Joint Exit Zone are:

- Distribution area 1: Southern Jutland
- Distribution area 2: Western Zealand
- Distribution area 4: Northern Zealand, including the Copenhagen area
- Distribution area 5: Northen Jutland
- Distribution area 6: Funen
- Distribution area 7: Sweden

While the regions and distribution zone remained the same, the new time-based regime did require redevelopment in the computational model, data flows, and the protocols for data transmission to Energinet from both Evida and Nordion. Both data suppliers experienced several challenges in the first months after the go-live on October 1, 2022. Especially the short deadline for retrieving, validating, and calculating, as well as ensuring that Energinet received the consumption data within half an hour, required optimization and fine-tuning of the system and were largely at fault for the imprecise data in the beginning period of the balancing model. Consequently, the timeframe for retrieval of data where extended, which lead to improvements in data quality.

The Swedish distribution zone 7 consists of five separate DSOs, apart from the TSO. When then implementation of the new balancing model started there were still several DSOs that had not yet implemented hourly meter readings for DMS-customers. Information about the new

demands for hourly meter readings were presented to the DSOs early in the project. The general view is that most meters were ready for hourly meter readings by 01.10.2022, although not all. In dialogue with DSOs it is stated that the biggest difficulties in changing the meters were related to issues with suppliers and longer lead times than anticipated from placing orders on meters and delivery.

Lastly, Energinet and its data suppliers evaluates that with the current number of hourly metered consumption points, it is possible to perform hourly calculation with all remotely read data, but it could become a challenge if the number significantly increases.

2.2 Evaluation of the data support from distribution companies, including the quality of data and the time intervals of the data retrieval method

With the implementation of Energinet's new balancing model, within-day obligations were introduced for Danish and Swedish shippers. This new element increased the complexity of data flow between Energinet and the primary data suppliers Evida and Nordion. To address this challenge, a strengthened partnership was established to ensure the fulfillment of the new and comprehensive data requirements as well as the provision of data that meets satisfactory quality standards.

However, when evaluating the period Energinet acknowledges that the data quality and the setup in general and especially during the initial three months have not met expected standards, adversely affecting the ability of shippers to appropriately manage their portfolios in the Joint Exit Zone. Consequently, Energinet has actively engaged in dialogues with market participants and, as a result, made the decision to extraordinarily neutralize the imbalance payments incurred by shippers in Q4 2022 and 2023 on days affected by technical errors and subpar data quality.

Moreover, Energinet emphasizes that there have been several reasons for poor data quality, which has made it more challenging to identify and address the issues. In particular, the data exchange between Energinet and its primary data providers, Evida and Nordion, has been prone to data errors, adversely affecting the data quality of non-valid data. Therefore, Energinet decided to strengthen the already close collaboration with Evida and Nordion in November 2022, which involved regularly held work meetings aimed at promptly and effectively resolving the data issues identified by market participants. This enhanced collaboration streamlined the process and resulted in a faster resolution of data errors.

### 2.2.1 Data analysis of DMS data from January 1st 2023 to November 1st 2023

As part of the new balancing model, Energinet, together with Evida and Nordion, developed a new data model used for allocating imbalance volumes and fees. The new data model collects as much DMS (Daily Metered sites) data as possible every hour between the timestamps for XX:00 and XX:20 and computes estimates for the remaining meters that have not been collected. The purpose of collecting DMS data every hour is:
1. To calculate and allocate the specific causers of imbalance when trading in the Yellow Zone, and
2. To increase the frequency of data delivery to the market (from 5 to 24 times during the gas day), enabling the market participants to better balance their portfolios.

Based on input from market participants and discussions with Evida and Nordion, a certain threshold for the DMS data quality was set by Energinet. The threshold serves as a target for the DMS data's accuracy during the gas day, comparing it with the valid DMS allocations. Based

on the accumulated model and its effect on data quality during the gas day, a threshold level of ten percent during the first hour of the gas day was decided, decreasing to eight percent during the second hour, six percent during the third hour, four percent during the fourth hour, and ending at three percent for the remaining hours of the gas day. Figure 1 below illustrates the agreed threshold for DMS data.

Figure 1: Daily data quality threshold for DMS data
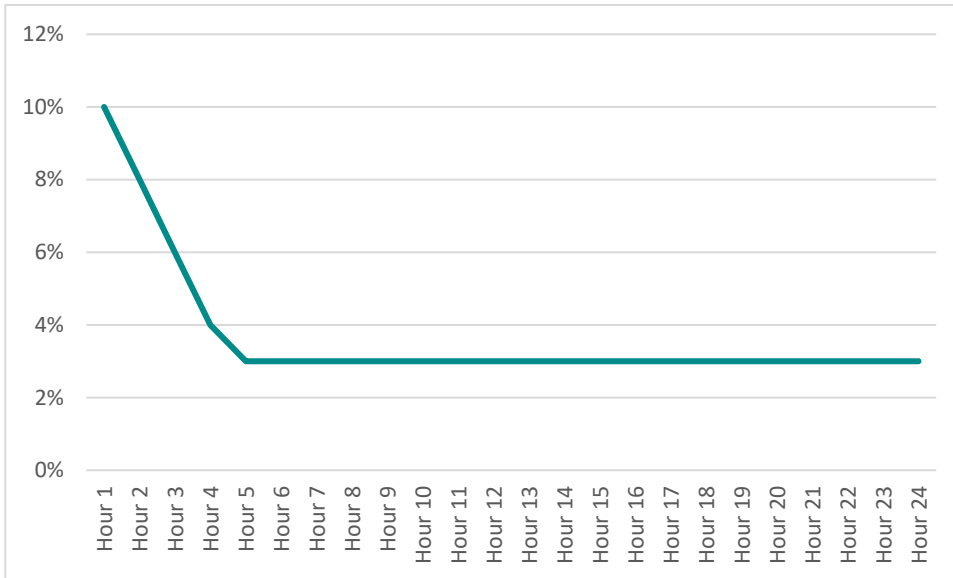
Thus, the foundation for the data analysis focuses on the daily metered data (DMS), chosen for analysis due to its quality requirements from Energinet's data suppliers. It is also the data type anticipated by shippers to be the most challenging to directly measure or estimate in the new time-based regime. Furthermore, non-daily metered data (NDMS) is derived from the residual gas in remaining in the transmission mission system after subtracting DMS data. Thus, low-quality DMS data will, in most cases, lead to low-quality NDMS data. NDMS data quality will, however, in some instances, also be poor because of Energinet forwarding subpar metering data to Evida.

Box 1: Method of assessing data quality

Data quality assessed for each hour of the gas day and for each DSO area by calculating the deviation between non-valid data and valid data according to the following formula:

- $Data\ quality_{tD} = \dfrac{\left|\sum_{i=1}^{t} Vi - \sum_{i=1}^{t} NVi\right|}{\sum_{i=1}^{t} Vi}$
- NVi = accumulated non-valid allocation in hour x
- Vi = accumulated valid allocation in hour x
- t = hour
- D = distribution area

The data requirements for the DMS quality have been defined as:

Gas hour	Deviation limit
06:00	10%
07:00	8%
08:00	6%
09:00	4%
10:00 − 05:00	3%

Energinet is due to logging errors in the DMS data for Q4 of 2022 unfortunately not able to reliably assess and illustrate the development of DMS data quality for Q4 2022 by applying the appropriate methodology explained in Box 1. Consequently, the data quality for Q4 2022 will be

evaluated using the invoiced and forecasted No Punishment Principle (NPP) volumes for Cash-out as a proxy. The No Punishment Principle is a compensation fee granted to shippers for Cash-out and Yellow Zone trades performed by the BAM on inaccurate data. Thus, the comparison of NPP Cash-out volumes from Q4 2022 and the first two quarters of 2023 provides an overall indication of the data quality during Q4 2022.

Figure 2: Invoiced and forecasted Cash-out NPP volumes as a percentage share of total Cash-out volumes (October 2022 – May 2023)
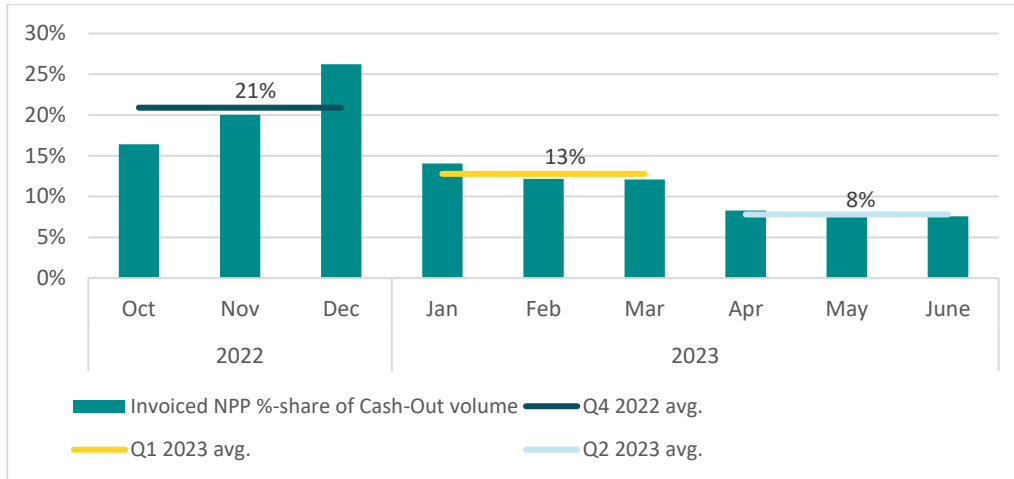

Figure 2 depicts the outcome of the analysis concerning the development in the rewarded NPP Cash-out volumes. It reveals a decline in the share of NPP volumes relative to end of day Cash-out from an average of 21 percent in Q4 2022 to an average of 13 percent Q1 2023 and 8 percent in Q2 2023. The substantial decrease in NPP volumes allocated to shippers from Q4 2022 compared to the initial five months of 2023 emphasizes that the data quality in Q4 2022 did not meet the desired standards, but also that there has been an improvement in data quality. As previously stated, the observed low data quality in Q4 2022 were a result of the balancing model encountering significant challenges in its initial phase due to large inaccuracies in estimating non-valid data. Inaccurate estimation due to zero values and issues pertaining to the process of matching nominations on storage emerged as two of the prominent issues during this period, accounting for majority of the substantial deviations observed. Energinet has since implemented initiatives to solve these issues. To address the inaccurate estimation of zeros, Energinet extended the timeframe in which data suppliers can gather data from the metering stations. This allows Energinet's data suppliers more time to collect data, consequently reducing the need for estimation data and the frequency of zero values. The time window for retrieval of data is, however, now at its maximum length and further configuration of the setup is no longer possible, within the current methodology. To reduce the frequency of matching errors in the storage point, a bug fix related to matching on the storage point was implemented in the balancing system in January 2023. Both initiatives have been contributing factors to the improved data quality observed in 2023.

Analysis of DMS data quality January 2023 – November 2023

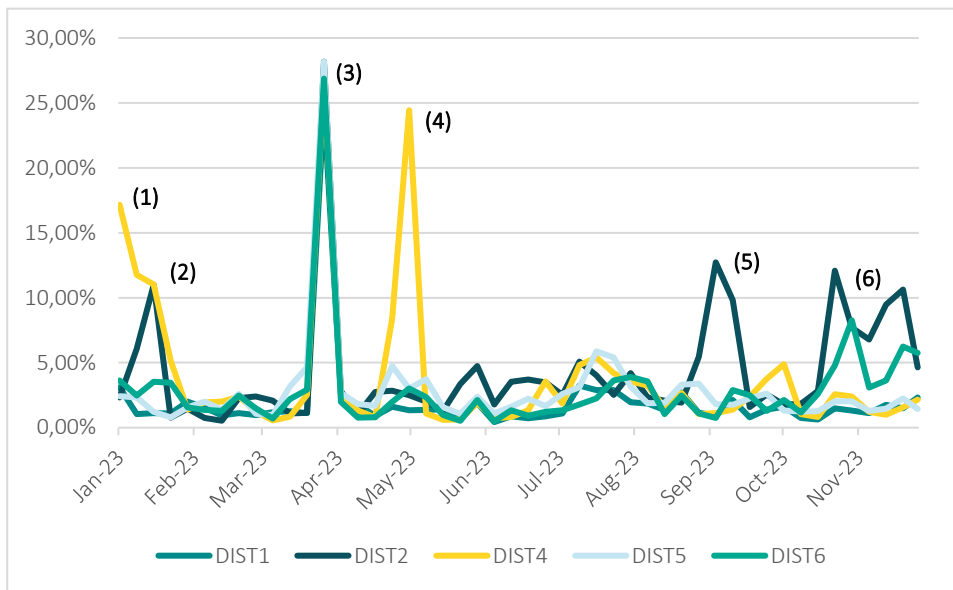*Figure 3: DMS data quality January – November 2023 (Denmark) (average weekly basis)*

Figure 3 illustrates the development of DMS data quality in the five Danish distribution zones in the period January to November 2023. The data quality has been calculated according to the methodology outlined in Box 1. When looking at the data quality from Figure 3, it is evident that the first part of January 2023 was still affected by the poor data quality that characterized Q4 2022. However, the graph also illustrates that the data quality has since improved, except for the six highlighted instances. The cause for each of the six peaks in poor data quality is explained below:

(1) The low data quality in January 2023 in distribution zone 4 was caused by a system delay at Evida in the measurement of data in the period from 01.01.2023 06:00 to 03.01.2023 05:00

(2) The low data quality in distribution zone 2 in the period 15.01.2023 – 21.01.2023, were caused by a new IT release in Evida's data system which impacted performance and ultimately resulted in a higher frequency of estimated values being transmitted to Energinet. Evida has since implemented an additional control in the release procedure to prevent such issues from recurring.

(3) Configurations related to the daylight-saving time negatively affected the data exchange between Energinet and Evida in all five Danish distribution zones in the period from 26.03.2023 06:00 to 27.03.2023 11:00. The error was identified, and a control was created. Nor Energinet or Evida has observed this issue since.

(4) One shipper in distribution zone 4 received a large amount of incorrect non-valid data in the period from 28.04.2023 06:00 to 30.04.2023 05:00. The error was due to a database server being overloaded at one of Evida's data service contractors. Consequently, system monitoring was intensified, and neither Evida nor Energinet has detected this issue since.

(5) Due to delays in the data retrieval process at Evida, the non-valid data was plagued by underestimation in the distribution zone 2 for two shippers in the period from 03.09.2023 to 11.09.2023. Evida and its supplier has worked to optimize the process.

(6) Due to delays in the data retrieval process at Evida, the non-valid consumption was plagued by large inaccuracies in the distribution zones 2 and 6 in the period 22.10.2023 to 28.10.2023 and from 19.11.2023 to 25.11.2023. Evida and its supplier has worked to optimize the process.

In addition to the initiatives implemented in connection with the highlighted instances of poor data quality, Evida has generally throughout 2023 worked to reduce the amount of estimations values and increase the direct measured values being forwarded to Energinet. In detail, Evida has sought to optimize the time windows in the data flows between Evida and Energinet to achieve the highest possible data quality before the transmission of data. Additionally, adjustments have been made to the integrations between the systems to reduce the number of errors in the data import/export, and several validation rules have been added to data controls.

Energinet is pleased with the enhanced collaboration with Evida, which has led to more efficient identification and rectification of data discrepancies. However, Energinet recognizes that the highlighted data errors adversely impacted the shippers' ability to balance their portfolios during these periods. As shown in figure 3 these instances do, however, not reflect the overall trend of the data quality, which since 1st of July 2023 has averaged 2.72 percent across all hours in the five Danish distribution zones.

Figure 4: Daily DMS data quality in distribution zone 7 (Sweden) (January – November 2023)
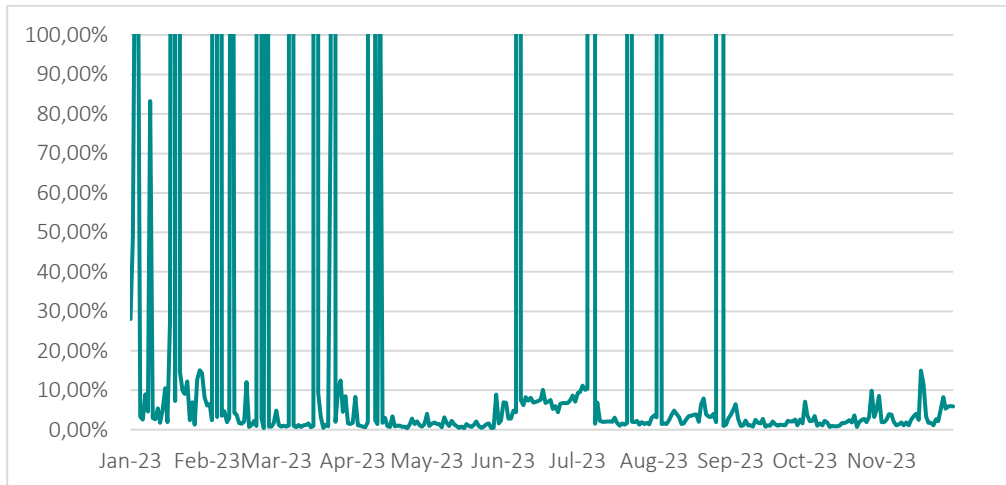

Figure 4 illustrates the DMS data quality for distribution zone 7 (Sweden) from January to November 2023. As shown in the graph, the deviation in DMS data for distribution zone 7 is primarily influenced by significant estimation errors on individual days/hours rather than prolonged periods. The challenges that distribution zone 7 faced stem from certain hours throughout the day being estimated with excessively large values that exceed the expected consumption. In detail, this problem is rooted in that a gas meter in one of the Swedish DSOs starts to transmit large incorrect values as if the gas meter had reached its maximum numerical capacity and restarts (it doesn't mean that the gas meter restarted but that it somehow failed). Unfortunately, this occurred quite frequently for one of the five Swedish DSOs. Another problem that characterized the start of 2023 is that DSOs sometimes did not send any DMS values for several hours. This also had an impact on the DMS data quality, however not as much as the extreme values due to a failing gas meter.

Nordion Energi began to investigate the root causes of the deviations to come up with ideas and initiatives for how the deviations can be reduced. The first step was to frequently monitor the IDM-values to notice if highly deviant values were being exported. The second step was to start a dialogue with Sweden's DSOs with the aim of informing them about the effect the large deviations have on the market as well as how the deviations could be reduced. One of the things that came out of these dialogues was that the DSO that contributed to the large estimation errors shown in figure 4 started to work intensely to reduce them from occurring. Thereby

reducing the amount of large estimation errors. Nordion Energi started to send out daily reports that shows an approximative picture of how well the DSOs DMS value were in relation to the non-valid values. The aim of the daily report was to further make the DSOs aware of their reporting statistics.

The actions taken by Nordion Energi have had a positive effect on the DMS data quality in region 7. However, the problem of receiving highly deviant values still lingers on some occasions. Fortunately, in most instances, these estimation errors are promptly identified, meaning that Energinet did not trade based on these estimations.

The observed decline in DMS data quality during the summer 2023 occurs because DMS values are estimated too high due to higher temperatures. In addition, it requires longer time for DSOs to react to the deviations during the summer as there are fewer people working during that period. Lower DMS data quality around the end November 2023 occurred because the DMS values were estimated too low due to colder temperatures.

Similarly, to the case for the five Danish distribution zones, these spikes in data quality cannot be considered a full characterization of the DMS data quality for distribution zone 7 across the entire period. Positively, the most recent significant data error was observed on August 28th, and since then the data quality in distribution zone 7 has maintained an average level of 2.77 percent across all hours.

Figure 5: Total share of hours pr. month where the data requirements are exceeded (January – November 2023
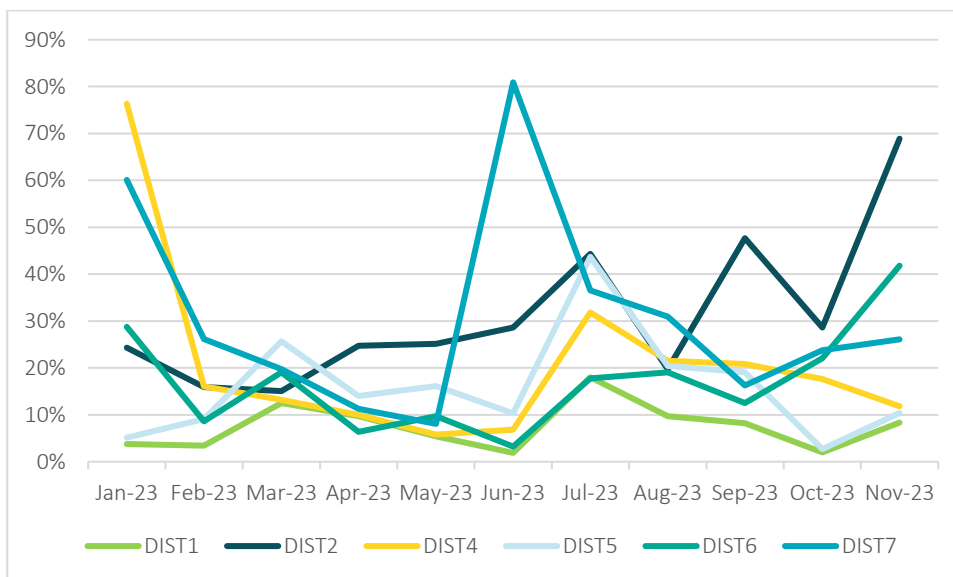

Figure 5 illustrates the total share of hours pr. month for which DMS data requirements are exceeded per distribution zone in the Joint Exit Zone (JEZ). Thus, the graph demonstrates the extent to which the data requirements agreed upon with Energinet's data suppliers are fulfilled. When examining Figure 5, it is evident that the percentage of instances exceeding the deviation threshold correlates with the periods characterized by poor data quality identified in Figure 3. Moreover, the peaks in the total share of hours, which lie outside the required data threshold in the period from June to August 2023, can largely be attributed to the low consumption in these months, which reduces the margin for error in the estimations and thereby increases the likelihood of breaking the thresholds. Moreover, estimating consumption during summer months is more challenging due to the likelihood of atypical consumption patterns

being more prevalent. The increase in threshold exceedance during Q4 2023, is not satisfactory and can be attributed to an overall small decline in data quality rather than a few isolated incidents. The decline in data quality is attributed by one of Energinet's data suppliers' system running slowly, leading to reduced time to gather all the necessary data to make reliable estimations. Energinet has initiated efforts with its data supplier to improve the data quality.

Figure 6: Total share of hours pr. month where the deviation lies within the specified ranges (January– November 2023)
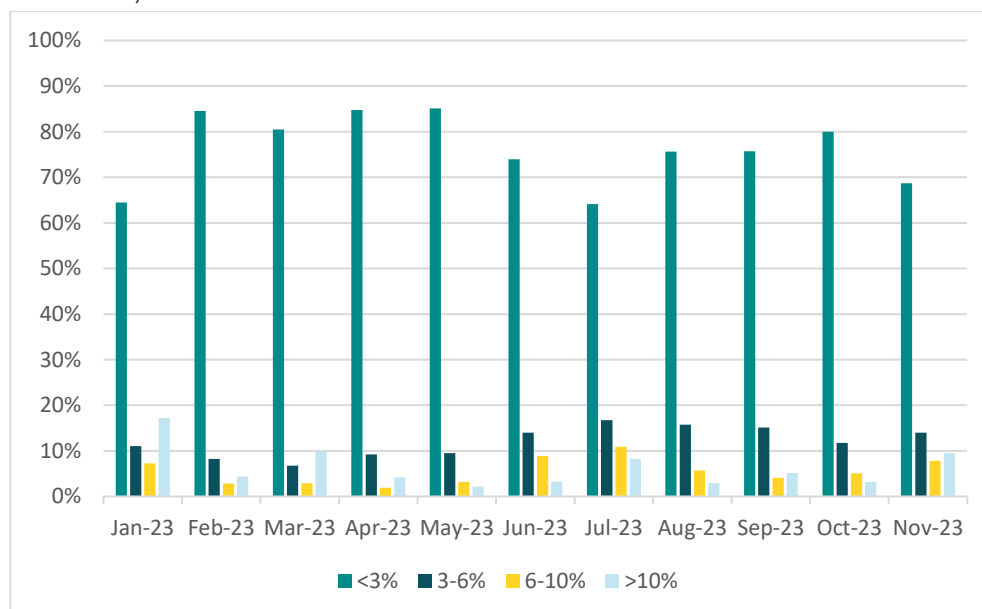
Whereas Figures 3 and 4 illustrate the overall level of data quality and Figure 5 illustrates Energinet's ability to meet its data requirements, Figure 6 illustrates the consistency in the data quality in the period from January to November 2023 in the Joint Exit Zone. More precisely, Figure 6 measures data consistency by splitting the percentage difference between non-valid and valid DMS data per hour into five different ranges. When examining Figure 6, Energinet observes that the variance in data quality between non-valid and valid data remains within the lower threshold of three percent for at least 75 percent of the total hours per month in 8 out of 11 months. Alternatively, it can be stated that eight percent of the total hours from January 2023 to November 2023 had a data deviation, which exceeded ten percent. Notably, in Figure 6, a decrease in hours that lie within the three percent threshold is observed during June, July and August 2023. This decrease is explained by the increased difficulty in estimating DMS data during the summer, in which consumption is significantly reduced and is more exposed to atypical consumption patterns. Furthermore, the spikes in instances registered within the 3-6, 6-10, and >10 percent brackets during June and July 2023 are largely caused by estimation errors (3-6 percent) on individual days (June 7th and 8th, July 6th, 7th, and 22nd), causing data to be skewed. Further, the threshold of three percent applies only for the last 20 hours of the gas day, whereas a larger threshold, up to four to ten percent, is accepted for the first four hours of the gas day. This means that instances registered within the 3-6 and 6-10 percent brackets do not necessarily exceed the threshold for the respective hour, in which they were registered.

In conclusion, Energinet acknowledges that the balancing model suffered from significant data quality issues during the initial three months of operation. However, it is noted that the data quality has since stabilized, except for the six highlighted significant data errors, and maintained a consistent level of overall quality across all hours on 2.72 percent since 1 July 2023 in the Danish distribution zones and 2.77 since 28 August in the Swedish distribution zone.

2.3 Experience with the methods and models used for estimating the off-take in JEZ

The primary tool utilized for forecasting consumption in the JEZ is the NDMS forecast, which is forwarded to the market one day prior to the gas day and subsequently updated five times throughout the gas day. The configuration of the NDMS forecast were, along with other elements, also altered in relation with the commencement of the new balancing model. This ensured the forecast's compatibility with the new regime through introducing within-day obligations.

Energinet has assessed the accuracy and performance of the NDMS forecast based on the total deviation for all distribution areas between the most recent available forecast (dispatched to shippers at 01:40 AM) and the valid data illustrated in Figure 7. As seen in Figure 7, the accuracy of the NDMS forecast largely exhibits the patterns as illustrated for data quality in Figure 5. During the first period of the commencement of the new balancing model, the NDMS forecast exhibited notable deviations from the valid data. The accuracy of the forecast, did however, improve during Q3 2023. Energinet acknowledges that the accuracy of the forecast has not met the desired or expected level of forecasting performance needed for the forecast to be effectively used as an estimation tool. Consequently, Energinet will initiate efforts to enhance the validity and accuracy of the NDMS forecast.

Figure 7: Deviation between NDMS forecast and valid data (October 2022 – November 2023)
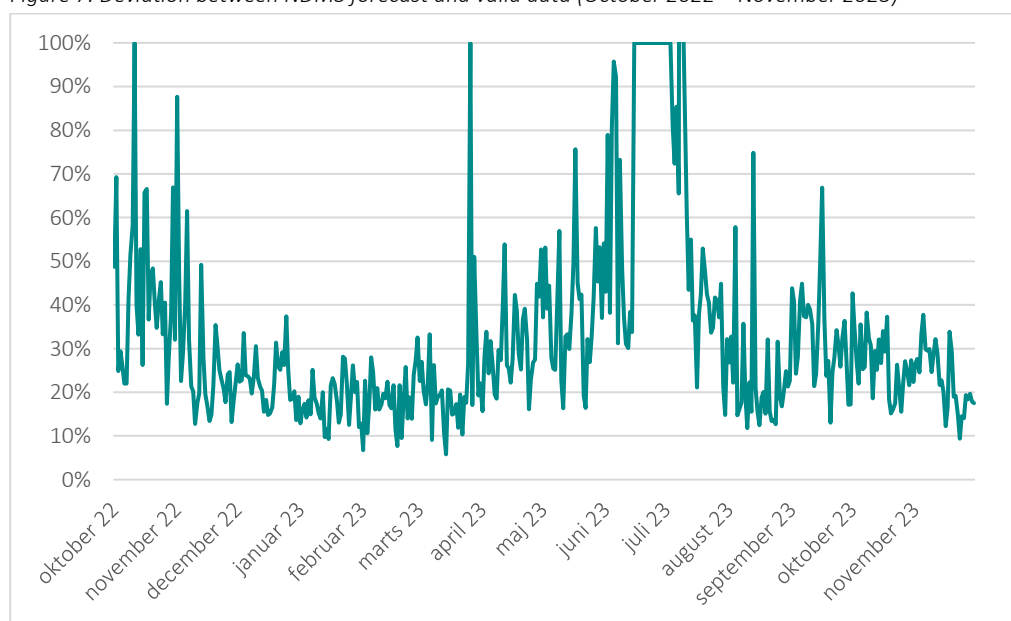
2.4 Assessment of the need for improving data quality, frequency, and deadlines, including an analysis of the distribution of costs vs. benefits and possibilities for the different parties, including network users

Based on the analysis of the DMS data quality for each distribution area in the Joint Exit Zone presented in section 2.2.1, this section assesses the need for improvements in overall data quality and outlines the initiatives aimed to further strengthen data quality. Thus, this evaluation report concludes that poor DMS data quality adversely affected shippers' ability to balance portfolios during the initial implementing phase of the new gas balancing model in Q4 2022. Consequently, Energinet decided to extraordinary neutralize individual days affected by IT issues, going beyond the neutralization in the implement No Punishment Principle. DMS data quality in the Joint Exit Zone has, however gradually improved throughout 2023, causing DMS data quality to consistently lie within the agreed-upon thresholds during the gas day. The data

analysis did, however, identify that the model was exposed to six significant data errors in distribution zones 1-6 and that distribution 7, was heavily exposed to data errors in the period January 2023 to August 2023. Given the fact that no large data errors have been observed in distribution zone 7 since August 2023 and that controls have been put place for distribution 1-7 minimizing the chance for these data issues to occur again, Energinet considers the overall accuracy of DMS data during the period from July 2023 to November 2023 to be of a quality which allows the shippers to balance their portfolios. Energinet will continue to monitor data quality, with the aim to make further improvements.

Based on the feedback submission from market participants and Energinet's analysis of data quality, Energinet has, identified several areas for improvement, which are currently being implemented or considered for implementation:
- Improving the NDMS data quality and forecasting model.
- Improving fallback data when the main data source is unavailable.
- Further increasing the number of control and monitoring mechanisms to detect data issues faster.
- Improving general stability of data systems and data flows both internally and between the relevant entities.

In terms of optimizing the hourly data flow, it is Energinet's opinion that data flows have been optimized as much as possible within the given hour to ensure as much data as possible is collected without compromising the process time.

Moreover, Evida and Nordion are implementing several internal actions aimed at improving the quality of their data submitted to Energinet. These initiatives can be summarized as:
- Closer monitoring of the DMS data quality with the aim of blocking highly deviating DMS values using automated tools and control systems (Nordion + Evida)
- Early warnings to the DSOs delivering large estimation errors. Parts of this procedure will be automated (Nordion).
- Delivering reporting statistics reports based on the first DMS (IDM) values in relation to the within-day data with the aim to spread awareness (Nordion).
- Continued dialogue with the DSOs to better understand their metering problems. As a result, Nordion Energi would be a part of finding long term solutions for the problems the DSOs are facing (Nordion).

Developing and testing some of these future initiatives will incur costs and time. However, it is anticipated that these initiatives will enhance DMS data quality significantly as they address the root cause of the lower data quality issue. For the Swedish region it is important however to remember the importance of DSOs cooperation with the implementation of these future initiatives as the DSOs are the building block when it comes to DMS data quality.

In conclusion, the first part of the evaluation point to gradual improvements in data quality and Energinet will continue to further improve the data quality through the aforementioned actions.

Finally, Energinet notes that the conclusions of this analysis are based on Energinet's perception of data trends, aided by insights from Evida and Nordion. As Energinet is continuously undergoing internal evaluation of the functioning of the new gas balancing model, Energinet encourages feedback for further improvement of the model from market participants in future

dialogue and public consultation. Continuous feedback plays a key role in ensuring short term improvements, as well as long-term advancements of the balancing model.

3. Evaluation of the smoothing concept

This section covers the following three points from DUR's balancing method approval:
- *"Erfaringer med fastsættelsen af S-max med hensyntagen til den generelle systemfleksibilitet,"*
- *"Erfaringer med tildeling af smoothing-volumer på baggrund af netbrugernes indmeldte udjævningsprofiler,"*
- *"Erfaring med anvendelsen af markedsandele som parameter for tildelingen af smoothing-voluminer,"*

It is Energinet's general opinion that the smoothing concept works as intended, including in its calculation of the individual S-max based on market shares, and in forwarding the value to market participants so they can nominate their smoothing profiles. However, Energinet agrees with feedback from market participants that initial IT-issues also affected the smoothing concept in the start phase in days, where the S-max was delayed or not forwarded, and on isolated days, where the calculation was incorrect.

Before the new balancing model's GO-live on October 1st 2022, Energinet decided that the total S-max value should be a fixed value of five GWh per day all year, which was communicated to the market via the Balancing User Group on August 17th 2022[2]. The five GWh were chosen based on the following arguments:
- Starting out with a "conservative low" profile, which could be adjusted later (up or down based on experience).
- Starting with five GWh based on an assessment of historical data to cover the need for smoothing on most gas days during the gas year (see Figure 8 below).
- Unused smoothing is returned and used as flexibility in the green zone so unused smoothing flexibility is not "lost".

Figure 8: Analysis of need for smoothing during the gas year
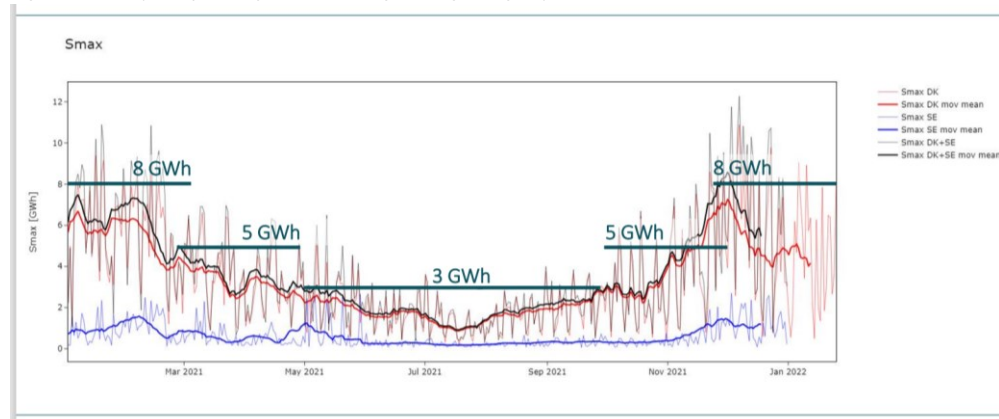
Based on the experience using smoothing from October 1st 2022 until 15th April 2024, Energinet has made the following observations:
- As expected, smoothing is mostly needed during the winter period but is also utilized at a lower level during the spring/summer period.
- As expected, there are shippers who fully utilize their S-max potential during winter, who would potentially utilize a higher level, if possible.
- There are shippers that only partially utilize their S-max potential during winter.

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[2] [Gas balancing model (energinet.dk)](#)

- There are single shippers that do not use the smoothing possibility at all.

For Energinet, the flexibility in the green zone and the flexibility provided via smoothing is considered 1:1. This means that the total flexibility on a given gas day can either be used for smoothing or for the green zone. Currently, five GWh is reserved for smoothing, which means the initial green zone size is 20 GWh where any unused smoothing is added.

One comment from market participants indicates that the S-max does not always cover the needed flexibility for the shipper's overall gas balance. This was expected based on the published analysis. Energinet is happy to receive input from the market on the ratio between the green zone and smoothing values and on opinions on possible adjustments to the ratio.

4. Incentives and liquidity

This section covers the following three points from DUR's balancing method approval:
- *"Erfaringer med markedsaktørernes adfærd ift. incitament strukturen, herunder vurdering af størrelsen af small adjustment,"*
- *" Udviklingen i markedets likviditet som følge af indførelsen af intradag-forpligtelser,"*
- *" Udviklingen i antallet af nødvendige gulzonehandler foretaget af BAM, og dennes erfaringer med intradag-handel,"*

4.1 Market behavior in terms of incentives in the balancing model and assessment of the size of small adjustment

The evaluation of incentives primarily focuses on the period spanning from mid-January to December 2023 as the initial period was marked by limited flexibility during the winter months and compounded by IT and data issues. These challenges question the validity of this first three months of operation and consequently, the conclusions that can be derived from it.

It is Energinet's general impression that incentives of the balancing model encourage shippers to balance their portfolios as intended. Shippers are generally balancing their portfolios to avoid the accumulated system balance to reach the Yellow Zone. The period from mid-January to mid-February 2023 and December 2023 was, however, due to operational considerations such as maintenance and the rearrangement of pipelines in Vestfyn, characterized by a low level of flexibility. Hence, there has been an increase of days during this period where the system has been in the Yellow Zone.

Based on this period, it is Energinet's view that when there is a trade in the Yellow Zone, the imbalance in the current direction is not significantly increased further and is most often reduced. In some cases, the direction of the system imbalance is changed as an effect of the Yellow Zone trade. Therefore, Energinet concludes that:
- In general, the market participants are balancing their portfolios at the best of their ability to avoid the ASB to reach the Yellow Zone.
- When a Yellow Zone trade is completed, it serves as a barrier for the market to further increase the imbalance in the relevant direction.
- In most cases, the imbalance is reduced, and in some cases the direction of the system balance is changed.

The overall conclusion by Energinet is that incentives work as intended during the gas day especially on days with Yellow Zone trading. However, Energinet has a focal point in terms of incentives to balance end-of-day in particular when no Yellow Zone trades are performed (e.g., is size of small adjustment sufficient). This will be assessed in more detail by Energinet in 2024 in order to consider if adjustments are needed.

4.2 Development of liquidity at the Exchange Transfer Facility (ETF)

It is difficult to conclude if the implementation of the hourly obligations in the balancing model had a direct impact on the liquidity at ETF, as many other factors could play a role e.g., the gas prices that were significantly affected by the Russian invasion of Ukraine.

As seen in Figure 9 below, the Within-Day-prices at ETF decrease after October 1st 2022 and then the prices increase from mid-October 2022 to December 2022. From December 2022 the prices decrease again and continue to decrease to a more stable level throughout 2023 and early 2024. The exact same price development is also seen at THE and TTF. Hence, the price development at ETF is not caused by the introduction of the hourly balancing obligations but is a reaction to the general supply/demand situation in Europe.

Figure 9: Development of within-day prices at ETF (Oct 2022 - dec 2023)

The traded quantities at ETF illustrated in figure 10 have slightly increased from October 2022 to January 2023 but to the same level as seen the year before (winter 2021/2022). This increase is, therefore, expected to occur due to the winter season. Conversely, the traded quantities continue to increase in the spring 2023 and a very high increase is seen from May to August 2023. The large increase in liquidity on ETF in June and August 2023 is due to trades made on the Day-ahead market, and thus not trades made on basis of intraday balancing. Moreover, when comparing Energinet's traded volumes for balancing, it becomes evident that the ETF market is predominantly influenced by the actions of other market players rather than Energinet trades.

Figure 10: Development of traded quantities (kWh) at ETF (Oct 2021 – Dec 2023)
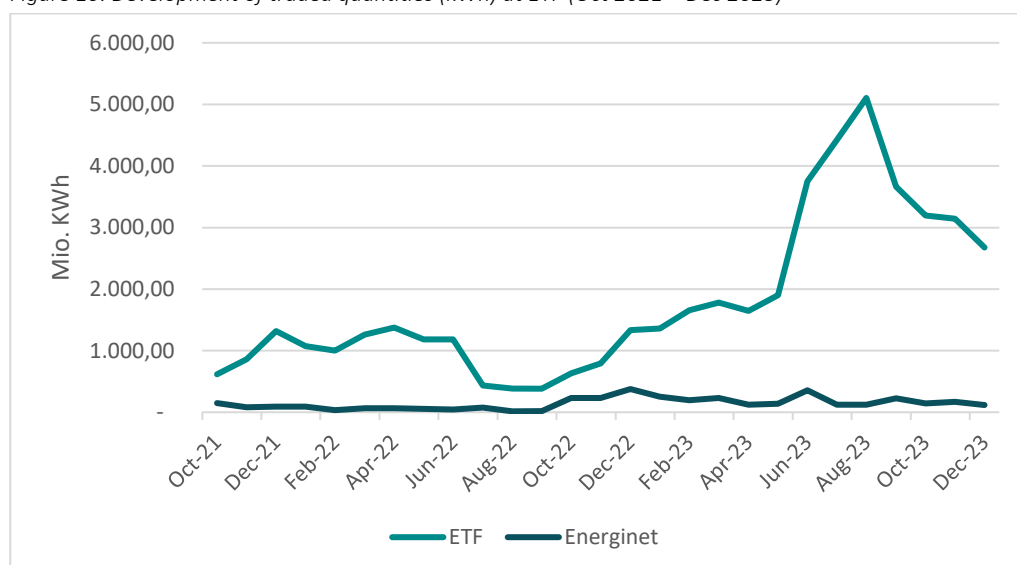
The large increase in traded quantities is most likely due to the Baltic Pipe and not to the implementation of the balancing model with hourly balancing obligations. The introduction of Baltic Pipe has opened to new markets (Poland and Norway), which attracts more market players to the Danish Gas Market using the ETF for trading. Energinet has registered several new participants since the GO-live of Baltic Pipe and six new market participants players have started trading at ETF since the GO-live date.

4.3   Development in Yellow Zone trades and the BAM's experience with intraday trades

The period from October 1st, 2022, until February 14th 2023 was characterized by a low level of flexibility in the green zone due to account for the beforementioned technical issues that plagued this period. Energinet experienced IT and data issues, causing both compromised data towards the shippers and incorrect signals in the balancing overviews (e.g., ASB and IASB). Consequently, it is difficult to conclude to what extent the new balancing model itself had an impact on the Yellow Zone trading development, when looking at the first period. However, since the green zone's expansion from the gas day of the 14th of February and the fix of major IT-issues in the start of 2023, the ASB has been in the Yellow Zone on 32 days in the remaining 10 months of 2023, which is a significant decrease compared to the 62 days with Yellow zone trades in the period from October 2022 to February 14th 2023. The decreased frequency of Yellow Zone days is a combination of the general increased flexibility, less need for flexibility due to season, and improved data quality, which enables shippers to better balance their portfolios.

Figure 11: Development in the number of hours with Yellow Zone trades pr. gas day (October 2022 – December 2023)
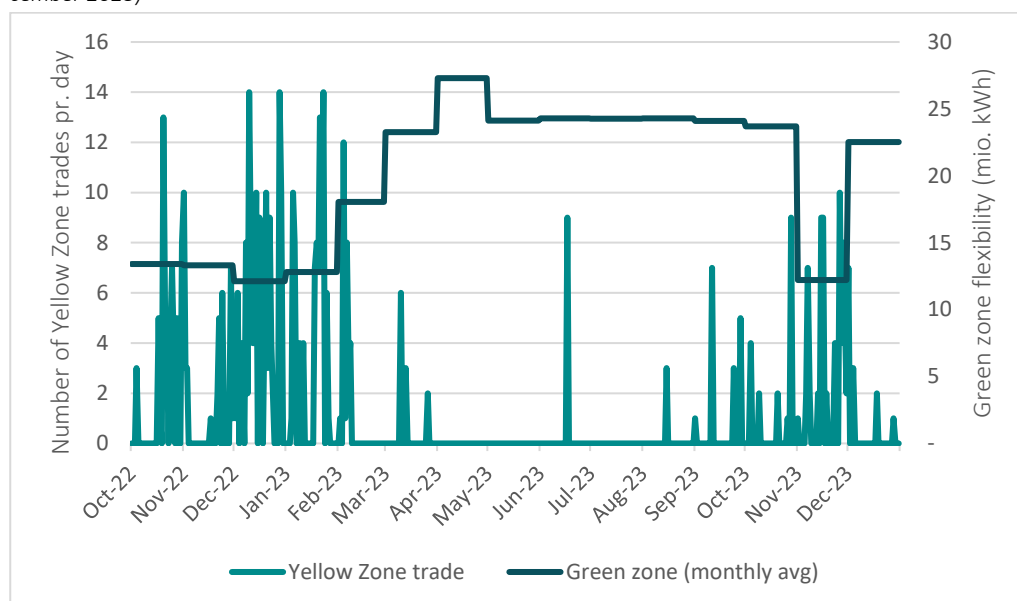

Table 1: Overview of the total hours with Yellow zone trades pr. month (October 2022 – December 2023)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2022										58	38	135
2023	91	29	11	0	0	9	0	0	16	18	67	13

The development of Yellow Zone trades during the period from October 2022 to December 2023 is illustrated in Figure 11. As shown in the figure, the level of flexibility in the green zone was lower during both periods Q4 2022 (IT issues) and Q4 2023 (Project Vestfyn), where the need for flexibility is typically higher. As expected, the lower level of green zone flexibility led to an increased number of hours with Yellow Zone trades. However, Figure 11 illustrates that the level of flexibility was increased from Q2 2023 to Q3 2023, which caused the average daily number of hours with Yellow Zone trades to decrease in the period. This trend is also result of the improvements made in the IT and data operations, providing improved data to shippers and balancing overviews (e.g., ASB and IASB), which has led to a decreased need for balancing actions. Furthermore, based on the learnings from the first review of Q4 2022, the BAM has been able to optimize trading actions considering data issues, which further limits the frequency of balancing actions.

However, the periods of Q4 2022 and 2023 have given Energinet valuable learnings and tenets which have already been implemented:

- The BAM should not trade if there are major data issues and should inform the market of the cancellation.
- In general, the BAM should inform the market of any issues that prevent/delay trading.
- The BAM should always trade the full amount when trading.
- The BAM should be cautious of large price deviations, especially when trading large amounts at night.

One experience that requires further investigation is how to structure the trading at night. Due to the characteristic of the within-day product being a rest-of-day product, it can force the BAM to trade a very large hourly amount at night, when there is only one or a few hours left of the product. Energinet will investigate possible ways of restructuring, e.g., through introducing a maximum hourly amount or by trading day-ahead instead of within-day for those specific

hours as well as other possible measures. However, such possible changes will require approval from the Danish Utility Regulator.

5. Size of the green zone

Following the consultation with market participants on the balancing model, Energinet received feedback submissions pertaining to the size and flexibility of the green zone. During the first 4,5 months of operating the Baltic Pipe, the flexibility available to the market has been at a total of 15 GWh, where up to five GWh is initially reserved for smoothing. The low level of flexibility in the first period is due to two main factors:

1. Operational issues where the Everdrup compressor station has forced Energinet to operate the system at a lower pressure and within a narrower range than expected.
2. Certain IT tools needed for the control center to properly operate the system that were not in place.

In terms of the operational issues pertaining to Everdrup compressor station, Energinet managed to arrange an agreement ensuring an operational solution together with Gaz-System in Poland. As illustrated in figure 11, the solution increased the level of flexibility from around 13 to 23 GWh on February 14th 2023. The issues pertaining to Everdrup compression station have since been solved.

Solving operational issues and ensuring sufficient IT tools will bring the maximum flexibility level up to 40 GWh. This is 25 percent higher than the maximum green zone before January 2022, which was 32 GWh.

Nevertheless, Energinet agrees with the feedback provided by market participants that the initial communication (e.g., at the balancing user group on November 15th 2019) on the expected green zone size was too optimistic. The green zone levels calculated in 2019 were in principle more or less equal to the levels calculated closer towards October 1st 2022. However, it was not accounted for that part of the flexibility is needed for operational reasons, predominantly to handle possible large renominations during the gas day, lead-times in terms of trading, and other operational uncertainties.

Additionally, the communication in 2019 was unfortunately incorrect, as the maximum green zone (32 GWh at the time) was communicated as the average size in the figure illustrated in appendix 2 of Green Power Denmark's consultation letter on March 3rd 2023.

Thus, Energinet acknowledges that the previous communication should have been more precise and should have included a disclaimer as the calculations were made well in advance of the Baltic Pipe's commencement.

However, Energinet would like to highlight further perspectives to the flexibility made available after October 1st 2022:

The full flexibility after October 1st 2022 will in average be larger than the green zone size before October 1st 2022. Since October 1st, 2022, the average green zone has been 20 GWh, reflecting a three GWh increase compared to the flexibility provided between January and September 2022. Thus, despite the green zone being lowered on some days due to technical and operational constraints in five out of the thirteen months from October 2022 to December 2023, the green zone was in average higher in the new model, when comparing to 2022 levels.

The flexibility levels corresponding to the flow in Baltic Pipe are illustrated in Figure 12 below, which was presented at the Stand-up meeting on January 24th 2023.

Figure 12: Slide from Stand-up meeting January 24th 2023, illustrating possible flexibility averages as a function of BP utilization levels
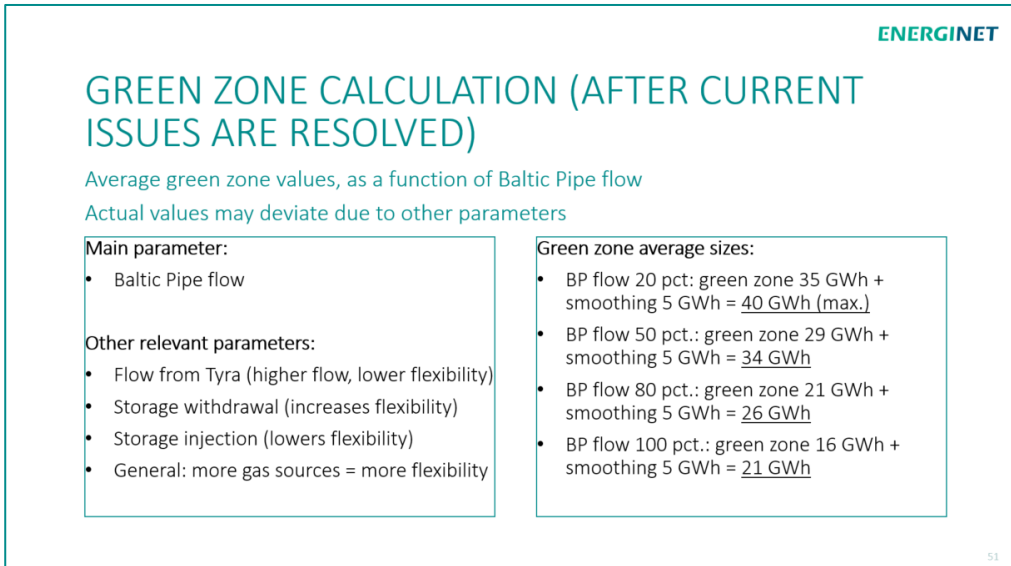
The nature of the new accumulated balancing model indirectly gives more flexibility in the first part of the gas day. In the previous balancing model, the E(SCB) consisted of values for all 24 hours of the gas day. This meant that the E(SCB) could change significantly from one hour to another, as all 24 hours could be renominated. In the new balancing model, the ASB is an accumulation of all previous hours, where only one hour is added at a time. Thus, it is no longer possible to change all remaining hours of the gas day at once, but only one hour at a time. However, the flexibility offered via the green zone is still distributed with same value every hour, as in the previous model. This indirectly means there is greater flexibility in the beginning of the gas day compared to the previous model, which significantly reduces the risk of being in the Yellow Zone in the first part of the gas day. The nature of the accumulated balancing model and the green zone is illustrated in Figure 13 below. The light green color illustrates the extra flexibility that is indirectly part of the model as a function of the accumulated balancing.

Figure 13: Illustration showing that the nature of the fixed green zone value for the full gas day indirectly increases the flexibility in the first part of the gas day.
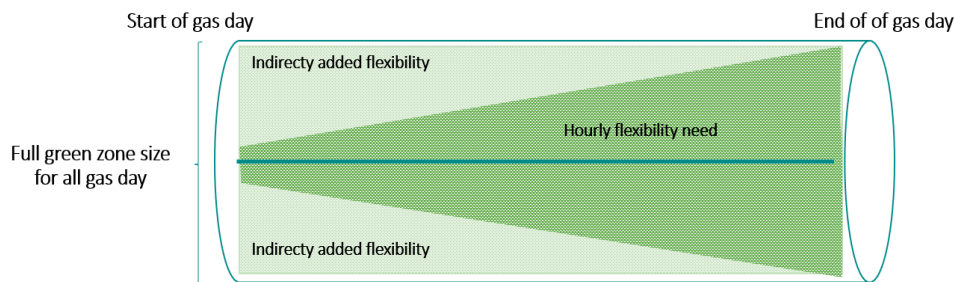
Energinet introduced the Dynamic Green Zone on 1st. February 2024. Drawing from the initial full year of operational experience with the new balancing system, as well as the resolution of IT issues and issues related to the Everdrup compressor station, Energinet has implemented a dynamic calculation of the green zone as intended. In contrast to the fixed green zone, the

dynamic green zone will on a daily basis adapt to the prevailing flow conditions in the Danish transmission system. Figure 14 illustrates the increase in the flexibility provided to the market since the implementation of the dynamic green zone on the 1st of February 2024. Energinet anticipates that the dynamic green zone calculation will provide a higher flexibility to the market in the majority of the flow scenarios compared to the previous fixed band.

Figure 14: Green zone development January 2024 – March 2024
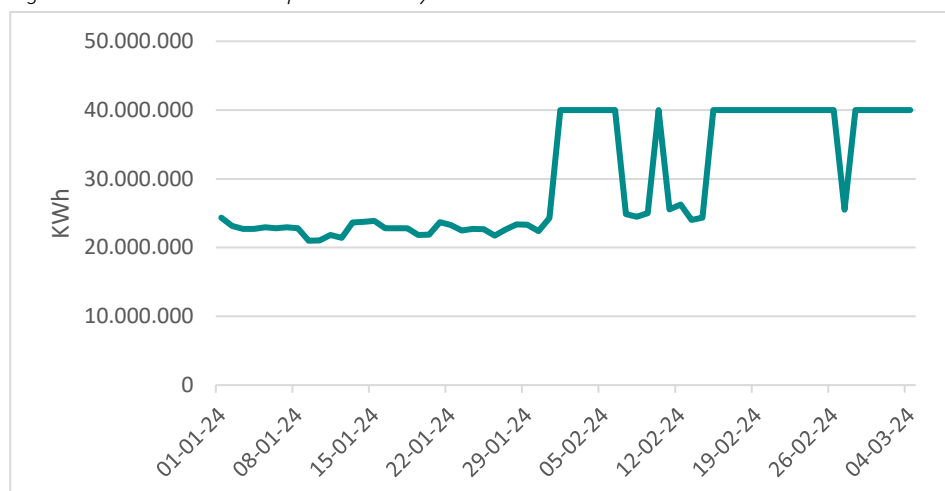
6. Conclusion

This report evaluates elements of the new gas balancing model since its operational start in October 2022 and answers the questions from the Danish Utility Regulator. Consequently, the evaluation has presented an overview of data support and the quality of DMS data based on geographical area, showcasing poor data quality especially during Q4 2022 as well as the improvements made during 2023. Energinet recognizes and acknowledges that data errors especially during the initial three months of operations have adversely impacted shippers' ability to balance their portfolios. Energinet recognizes that especially six unrelated, but substantial data errors during the period exceed the desired level of data quality. However, Energinet finds it positive that focused data monitoring and collaboration with data suppliers has stabilized data quality, maintaining a level of data quality across all hours on 2.72 percent since 1 July 2023 in the Danish distribution zones and 2.77 since 28 August in the Swedish distribution zone. Energinet will use the findings in this evaluation to further enhance the model and has outlined the initiatives aimed to achieve future improvements.

The report has further assessed and evaluated the smoothing concept, showing that smoothing generally functions as intended, despite, now solved, issues pertaining to the calculation of smoothing in the initial phase.

The report has further assessed and evaluated the balancing incentives and market liquidity, since the commencement of the model. Based on the analysis of liquidity and frequency of Yellow Zone trades it is Energinet's impression that the incentives of the balancing model encourage shippers to balance their portfolios as intended. Energinet will, however, continue to monitor the volatility between gas days and the resulting effect on incentives to balance end-of-day as well as the incentive to balance when no Yellow Zone trades are performed. Moreover, Energinet identified that the frequency of hours with Yellow Zone trades has significantly decreased since the start of 2023 as a result of the expansion of the green zone and improvements in IT. Energinet further identified that the new balancing model has increased the

liquidity at ETF due to Baltic Pipe opening the Danish market to new shippers, rather than a result of Energinet's balancing actions. Lastly, the within-day prices at ETF were concluded to exhibit the same price trends as other European exchanges and thus not adversely affected by the new balancing model.

Finally, the report has assessed and evaluated the size of the green zone. Energinet acknowledges that initial communication on the expected size of the green zone to be imprecise. However, the full flexibility after October 2022 will average scenarios be larger than the green zone size before October 1st 2022. Additionally, the nature of the new accumulated balancing model indirectly gives more flexibility in the first part of the day.

Based on this evaluation of the new gas balancing model and possible key issues highlighted by market participants both previously and during the market consultation, Energinet will continue to look how the balancing model may be optimized and adapted going forward to mitigate previous experienced issues and reach the best possible approach to achieve the main objectives of the model. This will also take in account the results of coming assessment of the Joint Balancing Zone. which Energinet expects to submit to the Danish Utility Regulator following a market consultation in May 2024.