

# Performance Review Body Advice on the Union-wide targets for RP4

## Annex II – Impact of Russia's war of aggression on horizontal flight efficiency

March 2024

# TECHNICAL NOTE ON THE IMPACT OF THE WAR IN UKRAINE ON HORIZONTAL FLIGHT EFFICIENCY (HFE) INDICATORS

*A QUANTIFICATION OF THE EFFECTS OF CONFLICT ZONE  
AIRSPACE RESTRICTIONS ON HORIZONTAL FLIGHT EFFICIENCY  
VALUES*

*Technical note prepared by the EUROCONTROL Aviation Intelligence Unit (AIU)*

---

## TABLE OF CONTENTS

<b>1</b>	<b>INTRODUCTION</b> .....	<b>5</b>
<b>2</b>	<b>BACKGROUND</b> .....	<b>5</b>
2.1	HORIZONTAL FLIGHT EFFICIENCY INDICATOR.....	5
2.2	AIRSPACE CLOSURES .....	7
<b>3</b>	<b>DESCRIPTION OF THE METHODOLOGY APPLIED</b> .....	<b>7</b>
3.1	DEFINITION OF IMPACTED AREA .....	8
3.2	DATASET AVAILABLE .....	9
3.3	IDENTIFICATION OF THE IMPACTED FLIGHTS VIA AIRPORT PAIRS .....	10
3.4	IDENTIFICATION OF THE IMPACTED FLIGHTS VIA AREA PAIRS .....	11
3.5	SUMMARY OF STEPS FOR ASSIGNMENT OF UNIMPACTED STATUS TO A FLIGHT .....	13
3.6	CORRECTION APPLIED TO THE INDICATOR. ....	13
<b>4</b>	<b>RESULTS</b> .....	<b>14</b>
4.1	SES AREA 2022 .....	18
4.2	SES AREA 2023 .....	19
4.3	AUSTRIA 2022 .....	20
4.4	AUSTRIA 2023 .....	21
4.5	BELGIUM 2022 .....	22
4.6	BELGIUM 2023 .....	23
4.7	BULGARIA 2022 .....	24
4.8	BULGARIA 2023 .....	25
4.9	CROATIA 2022 .....	26
4.10	CROATIA 2023 .....	27
4.11	CYPRUS 2022 .....	28
4.12	CYPRUS 2023 .....	29
4.13	CZECH REPUBLIC 2022 .....	30
4.14	CZECH REPUBLIC 2023 .....	31
4.15	DENMARK 2022 .....	32
4.16	DENMARK 2023 .....	33
4.17	ESTONIA 2022 .....	34
4.18	ESTONIA 2023 .....	35
4.19	FINLAND 2022 .....	36
4.20	FINLAND 2023 .....	37
4.21	FRANCE 2022 .....	38
4.22	FRANCE 2023 .....	39
4.23	GERMANY 2022 .....	40
4.24	GERMANY 2023 .....	41
4.25	GREECE 2022 .....	42
4.26	GREECE 2023 .....	43
4.27	HUNGARY 2022 .....	44
4.28	HUNGARY 2023 .....	45
4.29	IRELAND 2022 .....	46
4.30	IRELAND 2023 .....	47
4.31	ITALY 2022 .....	48
4.32	ITALY 2023 .....	49
4.33	LATVIA 2022 .....	50
4.34	LATVIA 2023 .....	51
4.35	LITHUANIA 2022 .....	52
4.36	LITHUANIA 2023 .....	53
4.37	MALTA 2022 .....	54
4.38	MALTA 2023 .....	55
4.39	NETHERLANDS 2022 .....	56
4.40	NETHERLANDS 2023 .....	57

---

4.41	NORWAY 2022	58
4.42	NORWAY 2023	59
4.43	POLAND 2022	60
4.44	POLAND 2023	61
4.45	PORTUGAL 2022	62
4.46	PORTUGAL 2023	63
4.47	ROMANIA 2022	64
4.48	ROMANIA 2023	65
4.49	SLOVAKIA 2022	66
4.50	SLOVAKIA 2023	67
4.51	SLOVENIA 2022	68
4.52	SLOVENIA 2023	69
4.53	SPAIN 2022	70
4.54	SPAIN 2023	71
4.55	SWEDEN 2022	72
4.56	SWEDEN 2023	73
4.57	SWITZERLAND 2022	74
4.58	SWITZERLAND 2023	75

## LIST OF FIGURES

Figure 1: Map of impacted airspace	9
Figure 2: Information on dataset available	9
Figure 3: Steps for assignment of unimpacted status to flight	13
Figure 4: Correction applied to the indicator	14
Figure 5: Impact of war on KEA indicator per State, 2022	16
Figure 6: Impact of war on KEA indicator per State, 2023	17

## LIST OF TABLES

Table 1: 3-ways categorisation based on airport pairs with 1% threshold	11
Table 2: 3-ways categorisation based on airport pairs with 5% threshold	11
Table 3: 2-ways categorisation based on airport pairs with 5% threshold	11
Table 5: 3-ways categorisation based on area pairs with 5% threshold	12
Table 4: 2-ways categorisation based on area pairs with 5% threshold	12
Table 6: Quantification of impact of war on indicator value for SES States, year 2022	15
Table 7: Quantification of impact of war on indicator value for SES States, year 2023	15

---

## 1 INTRODUCTION

The invasion of Ukraine which began on February the 24<sup>th</sup> 2022 has led to extensive airspace closure and the need for airlines to reorganise the affected traffic, either cancelling flights or operating longer flights.

As the Horizontal Flight Efficiency (HFE) indicators utilise flight length as the main proxy for efficiency, those increased lengths have led to higher values for the indicators, which in the case of States close to the restricted airspace (in the northern and eastern part of Europe) have been notably higher. Due to the difference of the traffic flows involved, the effects have not been uniform.

Availability of alternative values of the indicator in which the impact of the exceptional circumstances has been considered is useful when there is a need to have comparisons. Such is the case for example when considering time series, which would otherwise be broken in two periods with different baselines. Similarly, those corrected values enable the comparison with targets which were established under assumptions which were valid at the time the targets were established but could not consider such exceptional circumstances.

The purpose of this Technical Note is to define a methodology which can be used to generate those values, provide the details of the approach and the outcome of applying it to the data currently available.

Some HFE indicators are used in the Single European Sky (SES) performance scheme and targets have been set on the Key Environment indicator based on Actual trajectories (KEA). The technical note therefore provides some detail on the specificities of the indicator adopted for performance purposes and the proposed correction.

In this updated version, the final section of the technical note provides the values of the HFE based on the radar trajectories for the period January 2022 – December 2023, monthly and per SES Member State. Values for the entire SES area are also provided.

KEA is based on the HFE indicator calculated on radar data, with an additional provision to limit the impact of unusual, but temporary, circumstances: it is an annual rolling average in which the ten best and ten worst days are excluded from consideration. The evolving values of the KEA indicator (on the last day of each month) are also provided in the final section.

## 2 BACKGROUND

### 2.1 Horizontal Flight Efficiency Indicator

The Horizontal Flight Efficiency Indicator (HFE) uses the length of the trajectory as a proxy for the flight efficiency, so that longer flights are considered more inefficient flights.

It is the entire flight, gate-to-gate, from origin to destination, which is the main interest for performance purposes and for which measurements such as the additional distance are unequivocally defined (in the case of the additional distance is the length of the flight less the distance between the airports). At the core of the indicator is the consideration that while that is true, there is also interest in considering the different geographical areas which are traversed by the flight or split the flight in different phases, and the expectation that the additional distances will be additive. Thus, the goal is to have a measurement such that the sum of the additional distances, no matter how the entire flight is split into parts, is equal to the additional distance from origin to destination.

“Achieved distance” is the technical means to obtain the additivity property described above (i.e., the sum of the values in the different airspaces traversed over the entire flight is the value from the origin to the destination of the flight).

---

The achieved distance considers both location and time, with time providing a natural sequence of the different geographical points. Multiple passages over the same point (at different times) can also be taken into account.

The achieved distance assigns an estimate to the amount of distance that has been covered between any two points. The estimate (i.e., the achieved distance) is the average of

- how closer the flight gets to the destination (measured in terms of the difference of the two great circle distances at the two times), and
- how farther the flight gets from the origin (measured in terms of the difference of the two great circle distances at the two times).

Over the entire flight the two measurements will both correspond to the great circle distance between origin and destination (the distance to destination starts at that value and goes down to zero, while the distance from origin starts at zero and increases to that value).

The calculation ensures that:

- When the two points are the origin and destination, the achieved distance is the great circle distance between origin and destination, i.e., the total distance to be covered by the flight.
- For any other two points the value of the achieved distance:
  - Does not depend on what happens before and after (except for the location of the origin and destination of the flight).
  - Is less than the great circle distance between the two points, so that it provides an estimate of the additional distance due to the misalignment of the entry and exit points with respect to the origin and destination.
  - The sum over all airspaces traversed is equal to the great circle distance between the origin and destination.

This does not depend on how the flight is split into different parts, portions or periods. While the indicator is almost always presented in terms of entry into and out of airspaces, the same would be true for the different phases of the flight or for points taken at regular time intervals.

This is because every intermediate point will be considered once with a positive sign and once with a negative sign (for each of the two values – towards destination and from the origin), while the origin and destination are taken into consideration once with the value of the overall great circle distance, and once as zero.

This is not true for the so called “direct” between the two points. Direct refers to the possibility to join the two points without obstructions or deviations – the equivalent of a straight line in Euclidean geometry. The corresponding length is equal to the great circle distance between the two points on a sphere. In geometrical terms, the more the points considered (i.e., the more the portions considered), the better the approximation of the length of the flight. This is a fact due to the mathematical properties of distances.

As the purpose of the indicator is to calculate additional distances, and the distance “flown” is assumed to be known (and naturally additive), what is missing is an estimation of the distance covered. It is worth noting that, for the additional distances to be always greater than zero and sum up correctly, the achieved distances are allowed to take negative values. This is to cover limit cases such as for example flying in the opposite direction with respect to the one from the origin to the destination, which might be efficient locally but is clearly inefficient for the whole flight, as it implies more distance to be covered later in the flight.

---

In the version of the indicator which has been adopted for regulation purposes the origin and destination of the flight have been artificially “moved” from the airports to the border of the reference area, and the en route phase (which is the one of interest) is considered to begin and end when the flight crosses a cylinder of radius 40 nautical miles centered at the airport(s).

One of the consequences of placing the origin and destination at the borders instead that at the airports is that the overall inefficiency (the one that is not simply the difference between the flown and the direct) has to be spread over a shorter distance.

An additional change is the use of the value of the achieved distance not only to calculate the additional distance but also as the base to calculate the inefficiency in percentage terms (i.e., the percentage reported is the increase with respect to the achieved distance).

The KEA indicator is built upon the HFE indicator and is based on an annual moving window from which the ten best and worst days are removed.

More details on the calculation of horizontal flight efficiency and on the indicators can be found in the dedicated section of the Aviation Intelligence Unit’s website (<https://www.eurocontrol.int/portal/pan-european-air-navigation-services-performance-data-portal>).

## 2.2 Airspace closures

Immediately after the invasion of Ukraine, EASA issued a Conflict Zone Information Bulletin (CZIB) detailing restrictions on the operations of flights in Ukraine, Russia and Belarus (the restrictions on Belarus’ airspace were active since February 2021), whose validity has been extended several times.

The CZIB is available at the page <https://www.easa.europa.eu/en/domains/air-operations/czibs/czib-2022-01r08>.

It lists the following as regions in which operators should not operate:

- All altitudes / flight levels of the following Flight Information Regions: FIR LVIV (UKLV), FIR KYIV (UKBV), UIR KYIV (UKBU), FIR DNIPROPETROVSK (UKDV), FIR SIMFEROPOL (UKFV), FIR ODESA (UKOV).
- All altitudes / flight levels of the airspace within 200NM surrounding the borders with Ukraine in the FIR MOSCOW (UUWV).
- All altitudes / flight levels of the FIR ROSTOV-NA-DONU (URRV).

In addition, operators are urged to exercise caution for the entire FIR MOSCOW (UUWW) and reminded that operations are prohibited in the FIR MINSK (UMMV), due to previous safety directives.

A map of the affected airspace is provided as part of the description of methodology in the following section.

## 3 DESCRIPTION OF THE METHODOLOGY APPLIED

As it is common in the case in counterfactual analysis, the data available cannot directly show what would have been the value of the measurements under different conditions which would have directly or indirectly led to alternative decisions. The analysis must rely therefore on assumptions or simulations. In this case the direct simulation of trajectories is not available, and the analysis relies on information from the past about flight between airport pairs

---

Faced with airspace closures an airline must consider the trade-off between the increased costs due to the need to fly longer trajectories (which might not even be feasible with the type of aircraft originally planned) and the loss of revenue and costs related to the cancellation of the flight.

In the former case the data includes a (possibly very) inefficient flight, while in the latter case the absence of the flight means that the recorded inefficiency is better than the one which would include the flight.

The latter aspect is not considered in this analysis, which does not consider any replacement of the “missing” traffic.

For what concerns the former aspect, the analysis does not exclude completely the affected flights but applies instead for them a correction to the value of the indicator.

The main rationale behind the counterfactual reasoning is the following:

- Airlines base their decisions on the entire flight, whose end points are the airport of departure and arrival. The location of the two airports is a strong predictor of the airspaces which will be traversed.
- For the period before February the 24<sup>th</sup> 2022, flight plans reveal airlines preferences about the areas to be traversed. These preferences are unaffected by the restrictions, which were not active at that time.
- If airlines did not file to use an airspace in the period preceding the invasion, then its subsequent closure should make no difference to them.

The bulk of the analysis consists of defining how to identify the flights impacted by the restrictions based on the information about past behaviour. As it will be shown the information about the airport pairs is not always sufficient, as there will be flights operating on markets and destinations which were not served before (or at least not in the period analysed). Those flights will be treated differently.

### **3.1 Definition of impacted area**

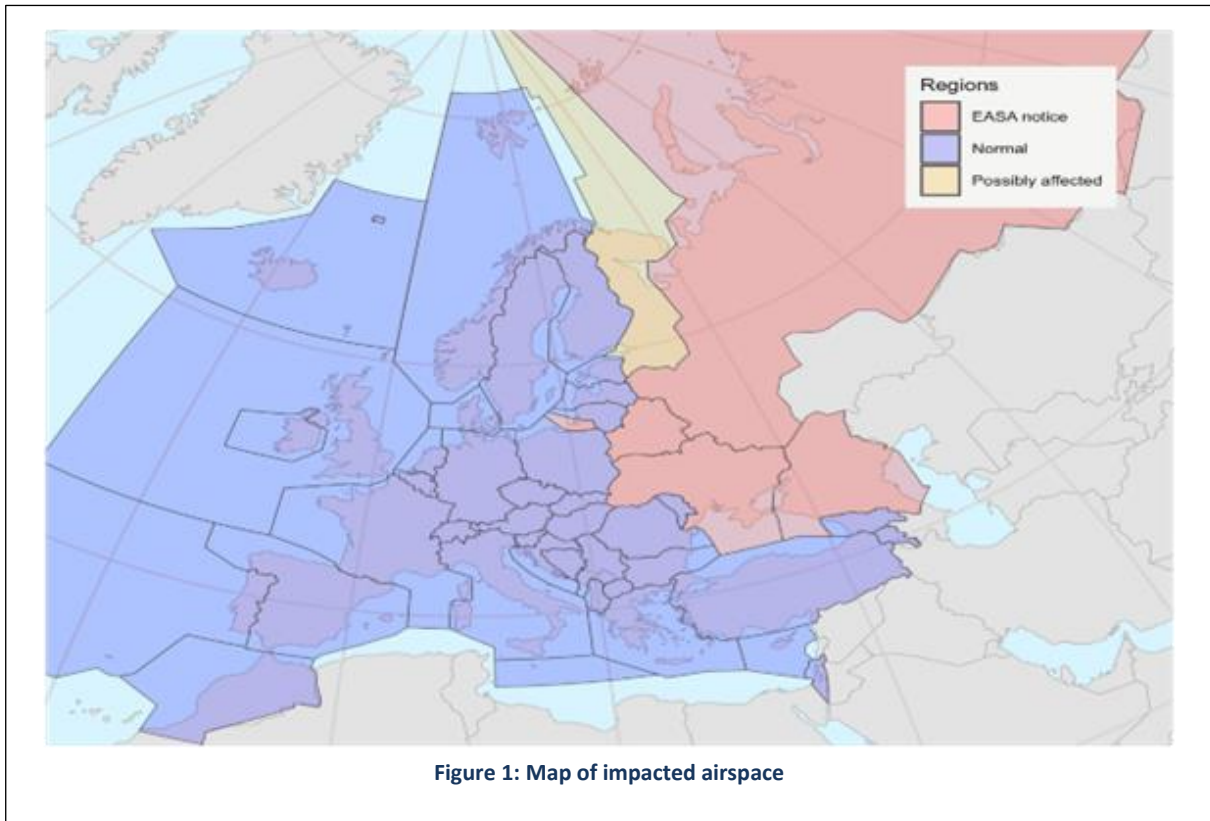
While the restrictions are related to airspace closures in Ukraine, Russia and Belarus, their impact might be wider due to the redefinition of the traffic flows.

The analysis considers a slighter wider area than the one directly mentioned in the EASA’s CZIB by taking in consideration all FIRs with ICAO code beginning with the following letters: UK, UL, UM, UR, UU.

Figure 1 shows in red the areas directly affected by the notice and in yellow the area considered as very probably affected, UL. It is considered as very probably affected as it is an area which is part of the Russian federation and is wedged between the restricted area and the area of interest for the analysis.

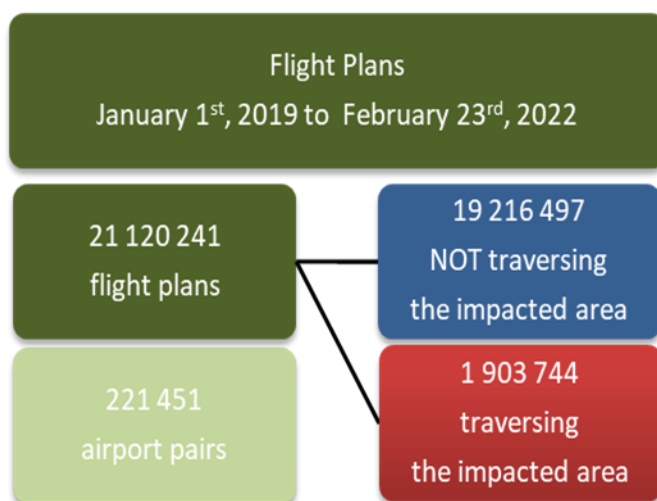


As a preliminary step of the analysis, all flight plans have been categorised based on whether the plan included traversing one or more affected FIR regions (any of the yellow and red areas in the map).



### 3.2 Dataset available

The dataset considered for the identification of the affected flights consists of all flight plans in the pre-invasion period from January the 1<sup>st</sup> 2019 to February the 23<sup>rd</sup> 2022, whose main statistics are summarised in Figure 2.



**Figure 2: Information on dataset available**

It consists of around 21,1 million flight plans, of which around 1,9 million include the traversal of the impacted area (flying into, flying out, flying inside or flying over). The number of airport pairs included is around 221 thousand (an airport pair is one-directional, distinguishing airport of departure and airport of arrival; AAAA-BBBB and BBBB-AAAA therefore are considered to be two different airport pairs).

There is not a one-to-one correspondence between airport pairs and traversal of the impacted area, as for the same airport pair some flight plans might include the traversal, while others

might not include it (flight plans are specific to the flight and there is no predefined route between airport pairs).

---

For the purpose of categorising flights in the post-invasion period, though, the goal is to assign them based on airport pairs.

### 3.3 Identification of the impacted flights via airport pairs

For the categorisation to be based on airport pairs, there is the need to assign airport pairs for those cases in which some of the flights have requested to traverse the impacted area while others have not.

For each airport pair the analysis calculates the number of flights for which the flight plan includes the crossing of the impacted area (traversing flights) and what percentage they make of the total for that airport pair. As a reminder, we are referring to the period before February the 24<sup>th</sup> 2022 in which the area was not restricted. Belarus is an exception as it is an area which has been restricted since 2021, but the dataset includes the years 2019 and 2020 of higher pre-pandemic traffic, while in 2021 the level of traffic was still low because of the pandemic. The percentage gives therefore an estimate of the strength of the preference to go through those airspaces when flying between the two airports.

The application of a threshold either side of the bounds on the percentage of traversing flights allows to define three categories: unaffected, unassigned, affected.

The bounds on percentages are 0% and 100%, so a threshold of 1% implies the use of 1% and 99% as cutoff values, while 5% implies the use of 5% and 95% as cutoff values.

The lower the threshold, the fewer airport pairs (and all flights related) will be unequivocally assigned to the affected or unaffected category.

- When the percentage of traversing flights is below the threshold (e.g., 1%, for an airport pair with 200 flights: 2 or less have flight plans crossing the now restricted airspace), we consider the airport pair as unaffected (all flights between the airport pair would be considered unimpacted post-closure).
- Conversely, when the percentage of traversing flights is above the complementary threshold (e.g.,  $100\% - 1\% = 99\%$ , for an airport pair with 200 flights: 98 or more have flight plans crossing the now restricted airspace) we consider the airport pair as affected (all flights between the airport pair would be considered impacted post-closure).
- When the percentage is between the two values (e.g., between 1% and 99%, for an airport pair with 200 flights: between 3 and 97 have flight plans crossing the now restricted airspace), we consider the airport pair to be “unassigned”, as it might be considered to be in either category.

An alternative approach would be to categorise the airport pair according to the majority rule (a threshold of 50%), but in this exploratory phase of the analysis the goal is to have a better idea of how many of the airport pairs fall in the undecided category.

Table 1 and Table 2 show the outcome of applying the categorisation based on the value of 1% or 5% as threshold. In terms of comparison with the example above with 200 flights, the 5% threshold implies the following categorisation based on the number of flight plans crossing the now restricted area: unaffected if between 0 and 10, unassigned if between 11 and 189, ,

A comparison of the two tables shows that by changing the threshold to 5% a small percentage of airport pairs (and a higher one of flights) move out of the unassigned category and into the other two categories, but without major changes. This means that we are able to increase the percentage of flights which are categorised via the categorisation of relatively fewer airport pairs.

Category (Threshold 1%)	Airport Pairs	Flights	Airport Pairs %	Flights %
Unaffected	194 229	18 553 318	87.7%	87.8%
Unassigned	5 283	1 001 668	2.4%	4.7%
Affected	21 939	1 565 255	9.9%	7.4%
<b>Total</b>	<b>221 451</b>	<b>21 120 241</b>	<b>100.0%</b>	<b>100.0%</b>

Table 1: 3-ways categorisation based on airport pairs with 1% threshold.

The stability in the overall percentages is consistent with the fact that the great majority of airport pairs (which includes airport pairs within Europe and arriving from the South or from the West) is not affected by the airspace restrictions.

Category (Threshold 5%)	Airport Pairs	Flights	Airport Pairs %	Flights %
Unaffected	194 975	18 819 669	88.0%	89.1%
Unassigned	4 351	668 015	2.0%	3.2%
Affected	22 125	1 632 557	10.0%	7.7%
<b>Total</b>	<b>221 451</b>	<b>21 120 241</b>	<b>100.0%</b>	<b>100.0%</b>

Table 2: 3-ways categorisation based on airport pairs with 5% threshold.

To reach an either-or decision concerning the categorization of the airport pair, we take a conservative decision which errs towards considering an airport pair as impacted. We therefore group the unassigned and affected together in the impacted category. Table 3 shows the results after the regrouping.

For an airport pair with 200 flights and the 5% threshold, this means that the airport pair is considered impacted if more than 10 flights have planned through the now restricted airspace. For airport pairs with low traffic (up to 20 flights), a single flight traversing the area is sufficient to declare the airport pair as impacted.

Category (Threshold 5%)	Airport Pairs	Flights	Airport Pairs %	Flights %
Unimpacted	194 975	18 819 669	88.0%	89.1%
Impacted	26 476	2 300 572	12.0%	10.9%
<b>Total</b>	<b>221 451</b>	<b>21 120 241</b>	<b>100.0%</b>	<b>100.0%</b>

Table 3: 2-ways categorisation based on airport pairs with 5% threshold.

### 3.4 Identification of the impacted flights via area pairs

Moving to the analysis of data related to the post-invasion period, it can be verified whether the methodology would be successful in categorising all the flights.

For the period between February the 24<sup>th</sup> 2022 and May the 31<sup>st</sup> 2023, there are 159 632 airport pairs and 11 036 002 flight plans. Of those, 41 145 are new airport pairs (they were not present in the previous dataset), for a total of 101 831 flight plans.

Category (Threshold 5%)	Area Pairs	Flights	Area Pairs %	Flights %
Unaffected	4565	18 651 624	66.7%	88.3%
Unassigned	695	896 050	10.2%	4.2%
Affected	1581	1 572 567	23.1%	7.4%
<b>Total</b>	<b>6841</b>	<b>21 120 241</b>	<b>100.0%</b>	<b>100.0%</b>

Table 4: 3-ways categorisation based on area pairs with 5% threshold.

- the first two letter of the ICAO code) instead of the airport itself.
- Consideration of the unordered pair instead of the ordered pair (i.e., AA-BB is grouped with BB-AA)

The results of applying the modified categorisation on the previous dataset are shown in Table 4 and Table 5, and can be compared with Table 2 and Table 3 of the previous section. The conservative categorisation in this case leans slightly more towards the assignment to impacted than when considering the airport pairs. This is to be expected as the areas defined via the two letter codes could be quite broad and the threshold used is high.

Category (Threshold 5%)	Area Pairs	Flights	Area Pairs %	Flights %
Unimpacted	4 565	18 651 624	6.7%	88.3%
Impacted	2 276	2 468 617	33.3%	11.9%
<b>Total</b>	<b>6 841</b>	<b>21 120 241</b>	<b>100.0%</b>	<b>100.0%</b>

Table 5: 2-ways categorisation based on area pairs with 5% threshold.

For some airport pairs, the categorisation would be different between the two approaches.

While it is only 1% of the flights, it is around a quarter of the city pairs, and it would be preferable to have an additional criterion to assign the category of flights between those city pairs. This would necessarily be based on a coarser grouping.

The categorisation as been made coarse thus:

- Consideration of the airport's ICAO area (based on

### 3.5 Summary of steps for assignment of unimpacted status to a flight

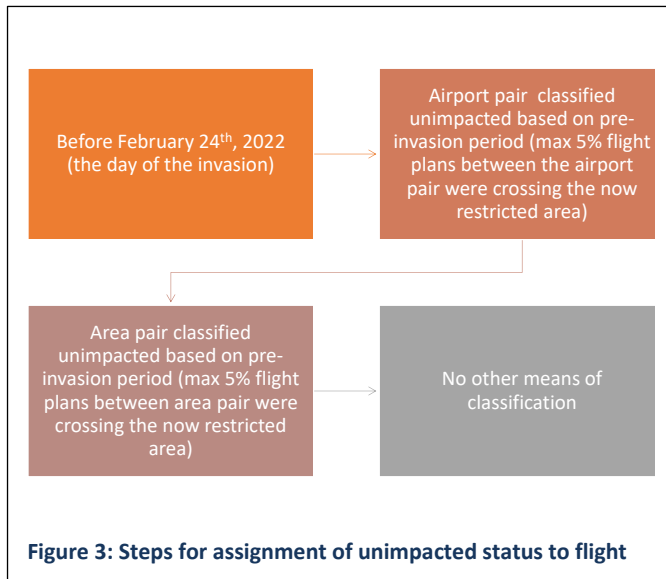


Figure 3: Steps for assignment of unimpacted status to flight

The process of assigning the unimpacted status to flights follows a sequential order illustrated in Figure 3.

Flights before February the 24<sup>th</sup> 2022 are considered all unimpacted because the restrictions were not active.

For flights after that date the assignment is made first on the more detailed information, i.e., the airport pair (which has been assigned unimpacted status if maximum 5% of the flight were filing to cross the now restricted area).

When that information is not available the assignment is made on the basis of the area

pair (using the same threshold).

If the category of the area pair is also unknown, lacking any other information it is assumed that the flight would not be operated if particularly inefficient (the assumption compensates somewhat the small bias towards assuming that the flight has been impacted of the previous two steps). The flight is therefore assigned to the unimpacted category.

### 3.6 Correction applied to the indicator.

The role of the achieved distances in the indicator is to account for the additional distance which is due to the different orientation of the two local points (e.g., entry/exit into and out of an airspace) with respect to the overall flight (e.g., the origin and destination).

The achieved distance is always less than the direct distance between the entry and exit point into an airspace to take in consideration that unless those points are aligned with the origin and destination, they imply an additional length (external to the airspace, so what is considered is the “negative” impact on other airspaces) to join the origin and destination.

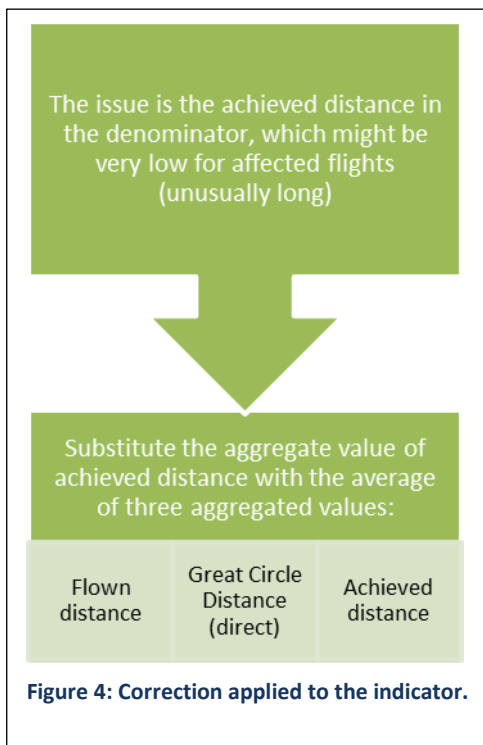


Figure 4: Correction applied to the indicator.

The implicit redistribution of the additional distances is over the whole length of the flight and is slightly heavier near the origin and destination of the flight, which are the two reference points for the calculation of the achieved distances.

As a matter of fact, the achieved distance can even be negative in case the direction of flight is opposite to the direction between origin and destination (the original indicator is geared towards the calculation of the additional distance in kilometers/nautical miles, calculated as the difference between flown and achieved, and the calculation works even when considering circular flights).

As the adopted indicator uses the achieved distance not only for the calculation of the additional distance but also as

the base to consider the percentage, a decrease in the value of the achieved distance is amplified by the use of the achieved distance also in the denominator.

There are two conflicting effects due to the move of the origin and destination at the border of the area instead of the airports, as on the one hand there is a shorter overall distance on which to distribute the additional distance, while on the other hand the part of the flight considered might be better aligned with respect to the modified origin and destination than with respect to the airports.

The correction therefore must be a heuristic one to be applied on the aggregate values. The one proposed is to keep the achieved distance (whose difference from the flown would still provide the correct value of the additional distance between origin and destination), but to limit the influence in the denominator by using an average of the flown, direct, and achieved distances in the denominator (the value of the average will necessarily be higher, and the correction will lead to a lower value of the indicator). This correction is applied only for the impacted flights.

#### 4 RESULTS

The first results presented are the KEA values for the years 2022 and 2023 before and after the proposed correction, and the value of the correction itself.

Table 6 , Table 7, together with Figure 5 and Figure 6, provide a summary per State of those values (plus the value for the entire SES area).

In the two figures the areas are presented in descending order of the corrected KEA values, i.e., the values after the impact of the war on the indicator has been considered. The value in the white font and the length of the green bar correspond to the value after the correction has been applied, the length of the light-coloured bar and the text in black correspond to the correction applied, and the total length correspond to the value of the KEA indicator (i.e., the sum of the two other values). The

uncorrected KEA values can read in the two tables, where the areas are presented in alphabetical order.

The following subsections provide the detail at the monthly level for the entire year 2022 and the entire year 2023, presented in two graphs per year.

The first graph shows the total number of flights considered (blue bar) and the number of flights which have been considered impacted (green bar), together with the share of this value over

Area	Impact of war	Corr. KEA	KEA 2023
Austria	0.18%	1.93%	2.11%
Belgium	0.08%	3.51%	3.59%
Bulgaria	1.28%	2.12%	3.40%
Croatia	0.07%	1.44%	1.51%
Cyprus	0.89%	3.84%	4.73%
Czech Republic	0.35%	2.26%	2.61%
Denmark	0.12%	1.32%	1.44%
Estonia	4.17%	2.38%	6.55%
Finland	1.86%	1.53%	3.39%
France	0.03%	3.30%	3.33%
Germany	0.16%	2.53%	2.69%
Greece	0.13%	2.13%	2.26%
Hungary	0.75%	1.36%	2.11%
Ireland	0.02%	1.42%	1.44%
Italy	0.05%	3.04%	3.09%
Latvia	5.14%	2.83%	7.97%
Lithuania	8.62%	4.52%	13.14%
Malta	0.05%	1.53%	1.58%
Netherlands	0.11%	2.83%	2.94%
Norway	0.14%	1.15%	1.29%
Poland	2.40%	2.18%	4.58%
Portugal	0.01%	1.49%	1.50%
Romania	1.90%	1.71%	3.61%
Slovakia	1.95%	2.10%	4.05%
Slovenia	0.10%	1.63%	1.73%
Spain	0.02%	3.24%	3.26%
Sweden	0.56%	1.19%	1.75%
Switzerland	0.07%	4.36%	4.43%
<b>SES Area</b>	<b>0.28%</b>	<b>2.71%</b>	<b>2.99%</b>

Table 7: Quantification of impact of war on indicator value for SES States, year 2023

Area	Impact of war	Corr. KEA	KEA 2022
Austria	0.16%	1.93%	2.09%
Belgium	0.07%	3.46%	3.53%
Bulgaria	1.19%	2.09%	3.28%
Croatia	0.06%	1.43%	1.49%
Cyprus	0.57%	3.64%	4.21%
Czech Republic	0.32%	2.23%	2.55%
Denmark	0.10%	1.13%	1.23%
Estonia	3.26%	2.20%	5.46%
Finland	1.73%	1.55%	3.28%
France	0.03%	3.25%	3.28%
Germany	0.14%	2.62%	2.76%
Greece	0.13%	2.20%	2.33%
Hungary	0.76%	1.41%	2.17%
Ireland	0.03%	1.09%	1.12%
Italy	0.04%	2.94%	2.98%
Latvia	3.73%	2.53%	6.26%
Lithuania	7.56%	4.65%	12.21%
Malta	0.05%	1.85%	1.90%
Netherlands	0.10%	2.94%	3.04%
Norway	0.08%	1.24%	1.32%
Poland	2.30%	2.49%	4.79%
Portugal	0.00%	1.52%	1.52%
Romania	1.63%	1.73%	3.36%
Slovakia	1.78%	2.26%	4.04%
Slovenia	0.09%	1.63%	1.72%
Spain	0.02%	3.30%	3.32%
Sweden	0.52%	1.18%	1.70%
Switzerland	0.05%	4.46%	4.51%
<b>SES Area</b>	<b>0.24%</b>	<b>2.72%</b>	<b>2.96%</b>

Table 6: Quantification of impact of war on indicator value for SES States, year 2022

the total number of flights (light-blue line, right vertical axis).

The second graph shows the value of the monthly HFE, both with the current indicator (blue bars) and the corrected one (red bars).

It also shows the value of KEA on the last day of the month, again both with the current indicator (green diamonds) and the corrected one (red diamonds). The numerical values are provided in the tables at the bottom of the graphs.



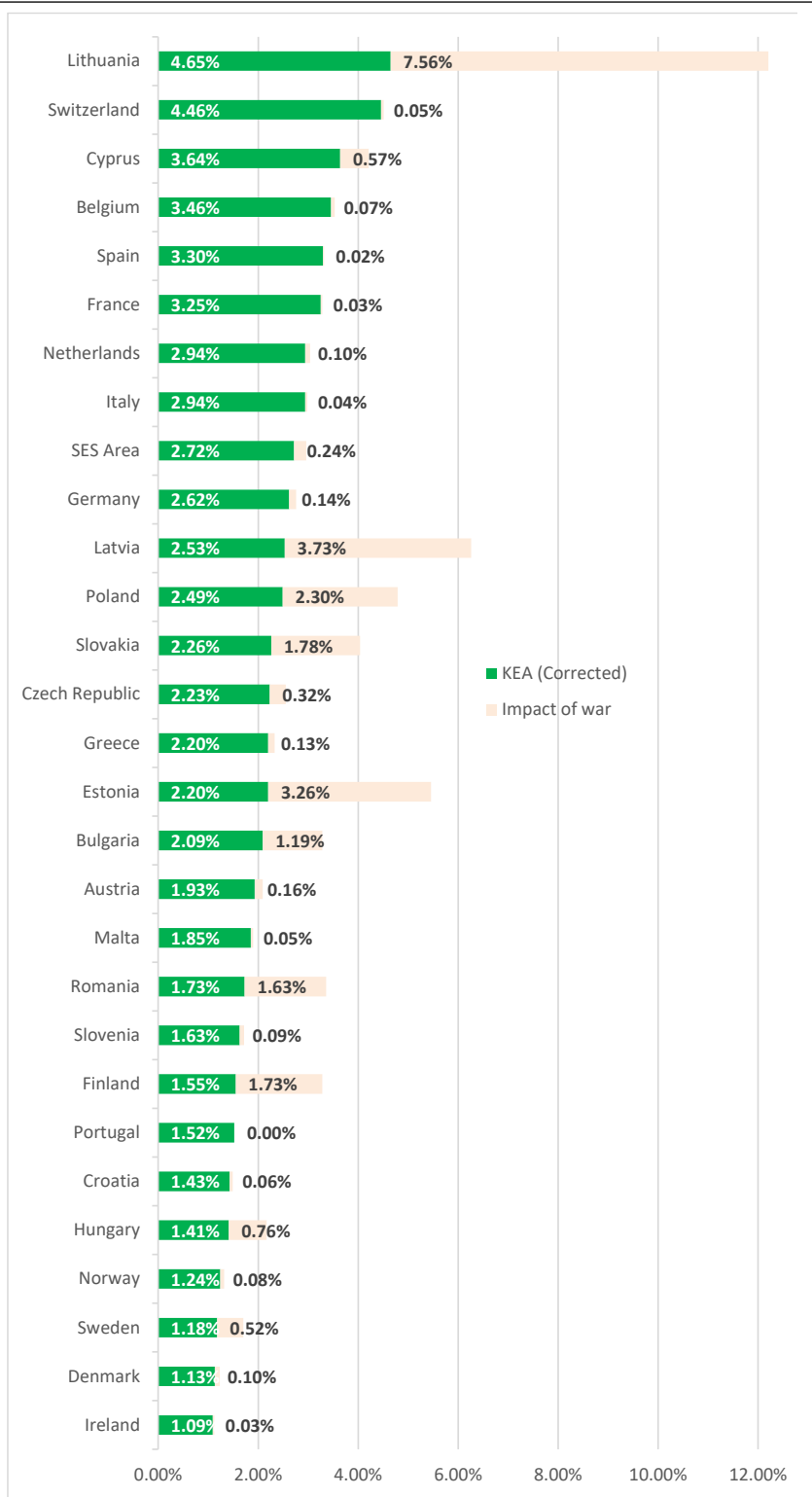


Figure 5: Impact of war on KEA indicator per State, 2022

The value in the white font and the length of the green bar correspond to the value after the correction has been applied, the length of the light-coloured bar and the text in black correspond to the correction applied, and the total length correspond to the value of the KEA indicator (i.e., the sum of the two other values). Detailed values available in the corresponding table.



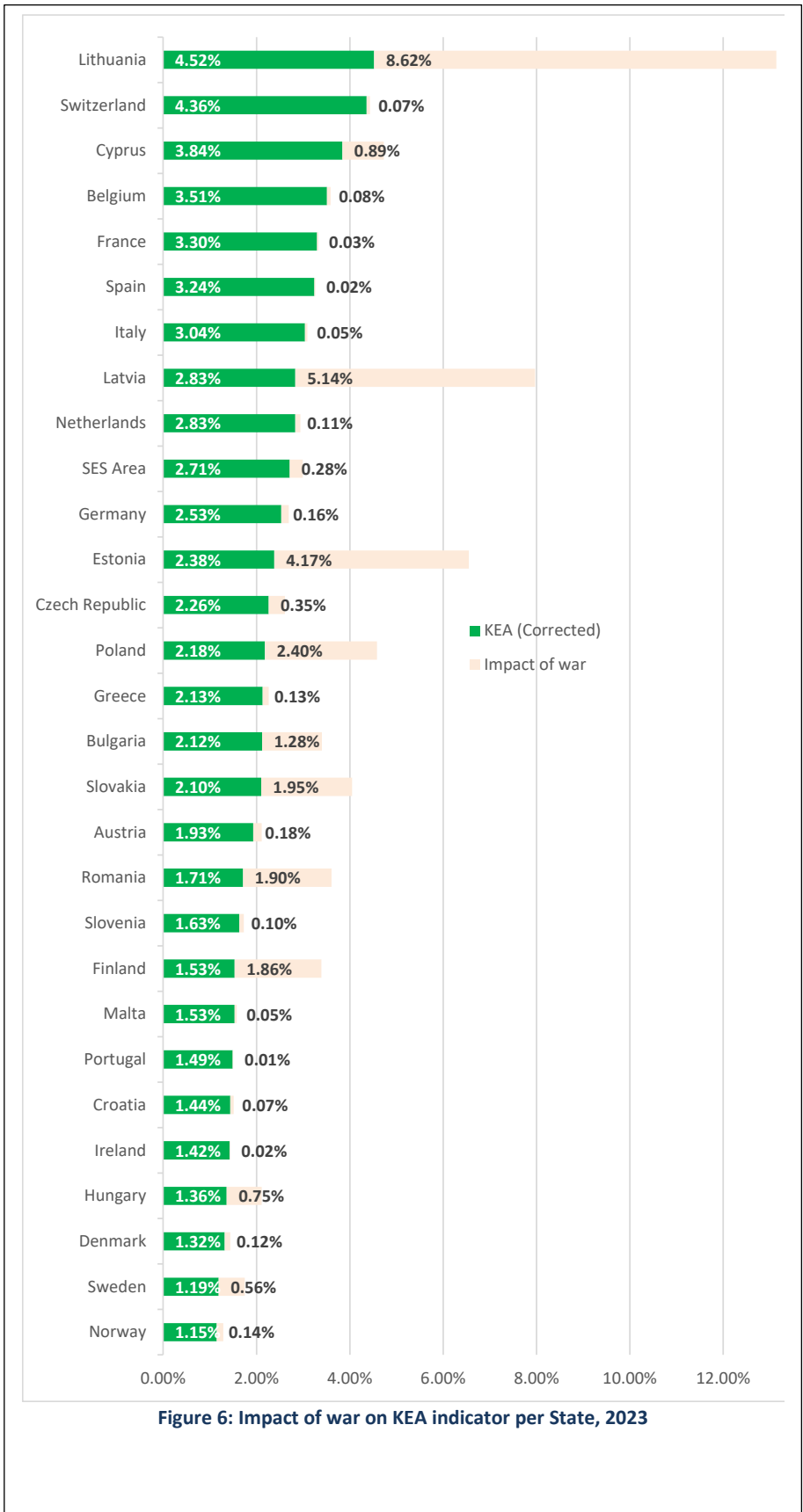
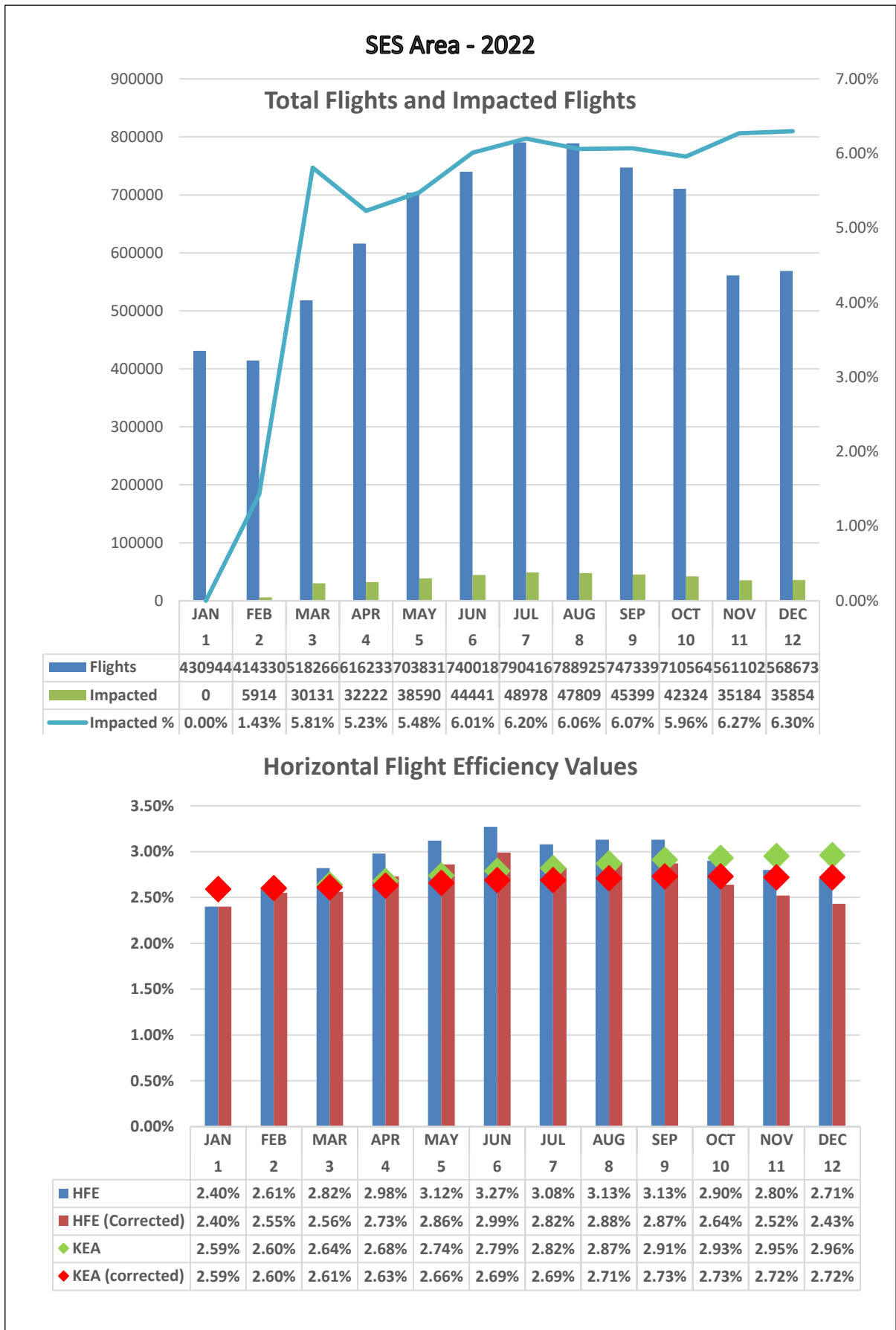
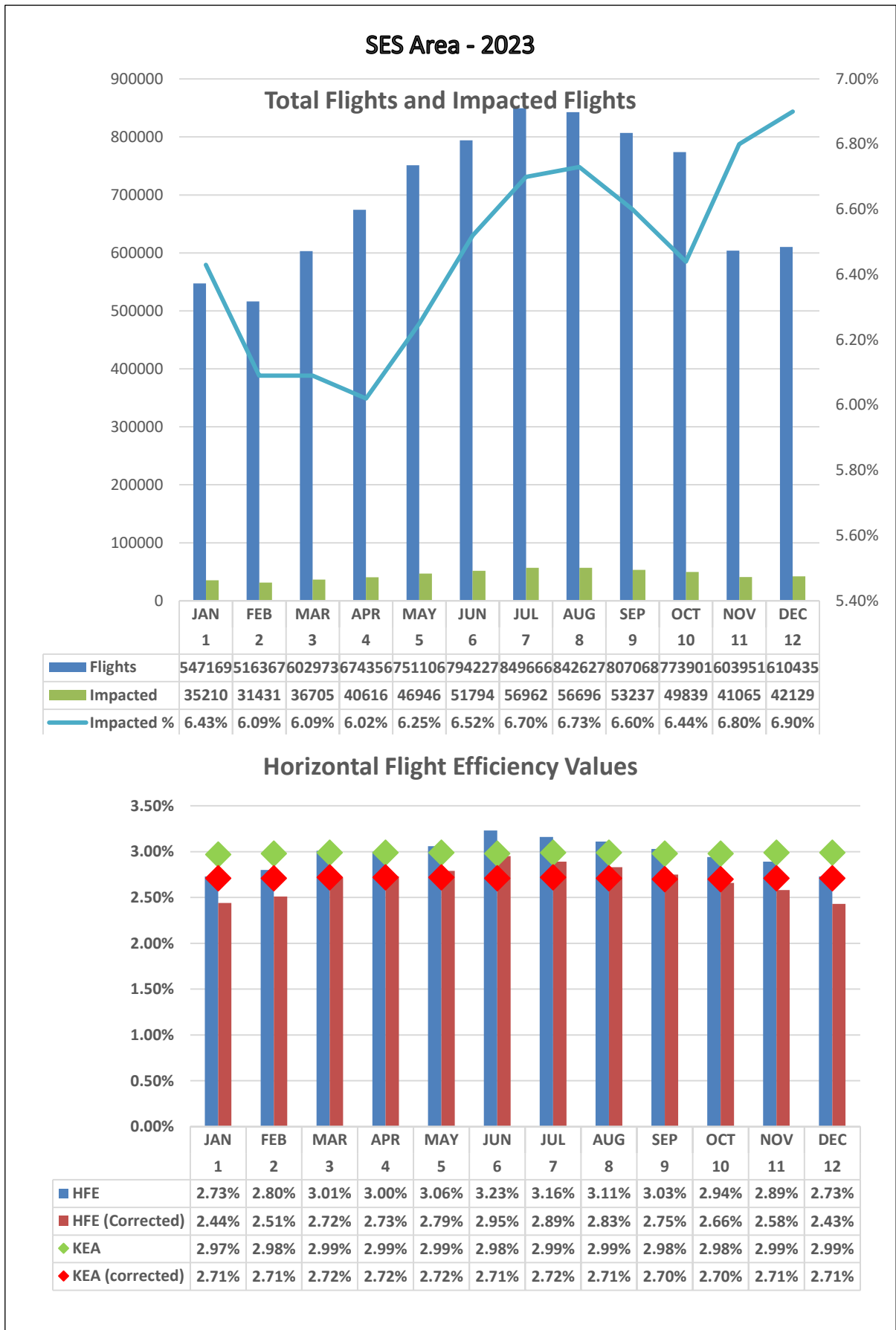


Figure 6: Impact of war on KEA indicator per State, 2023

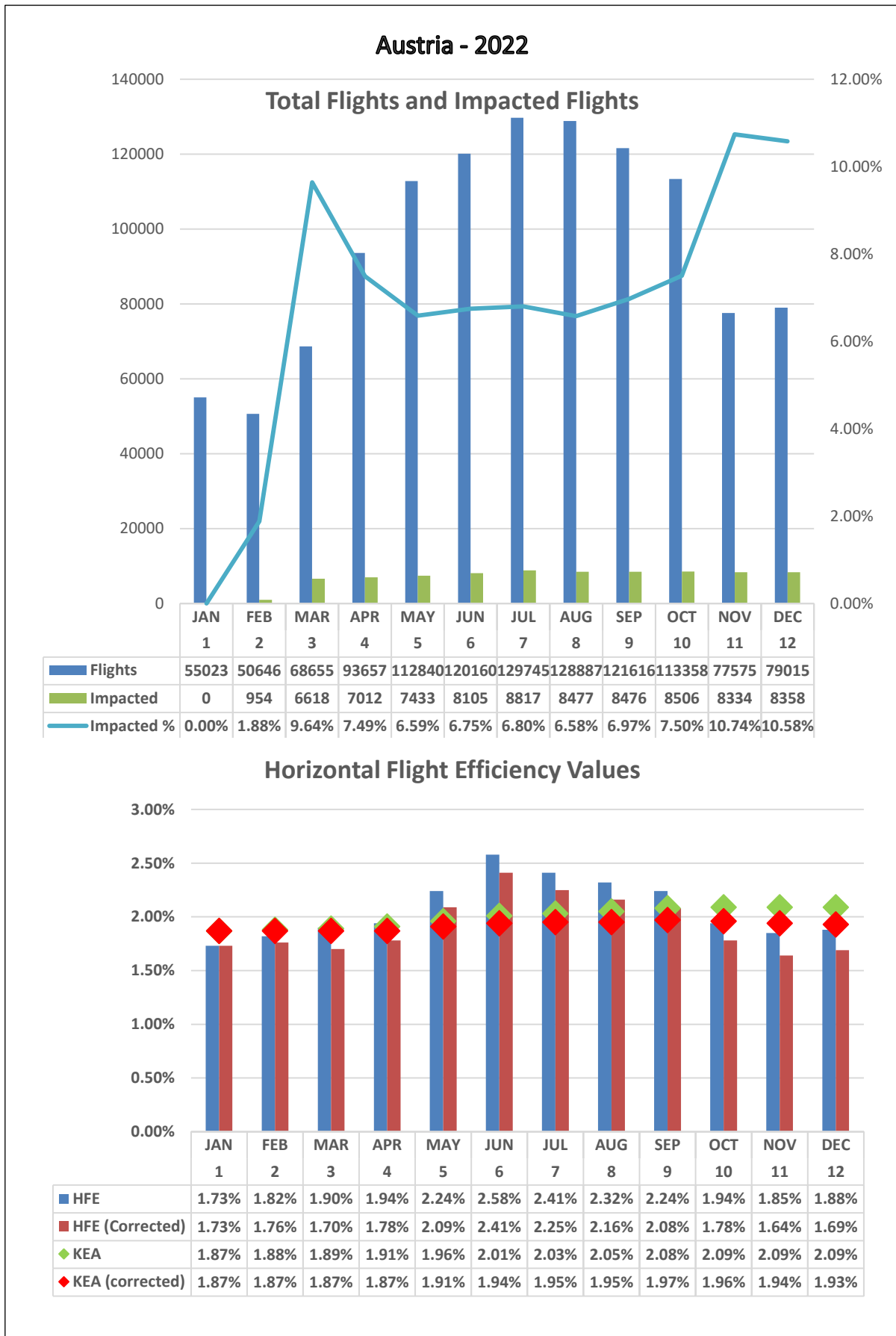
4.1 SES Area 2022



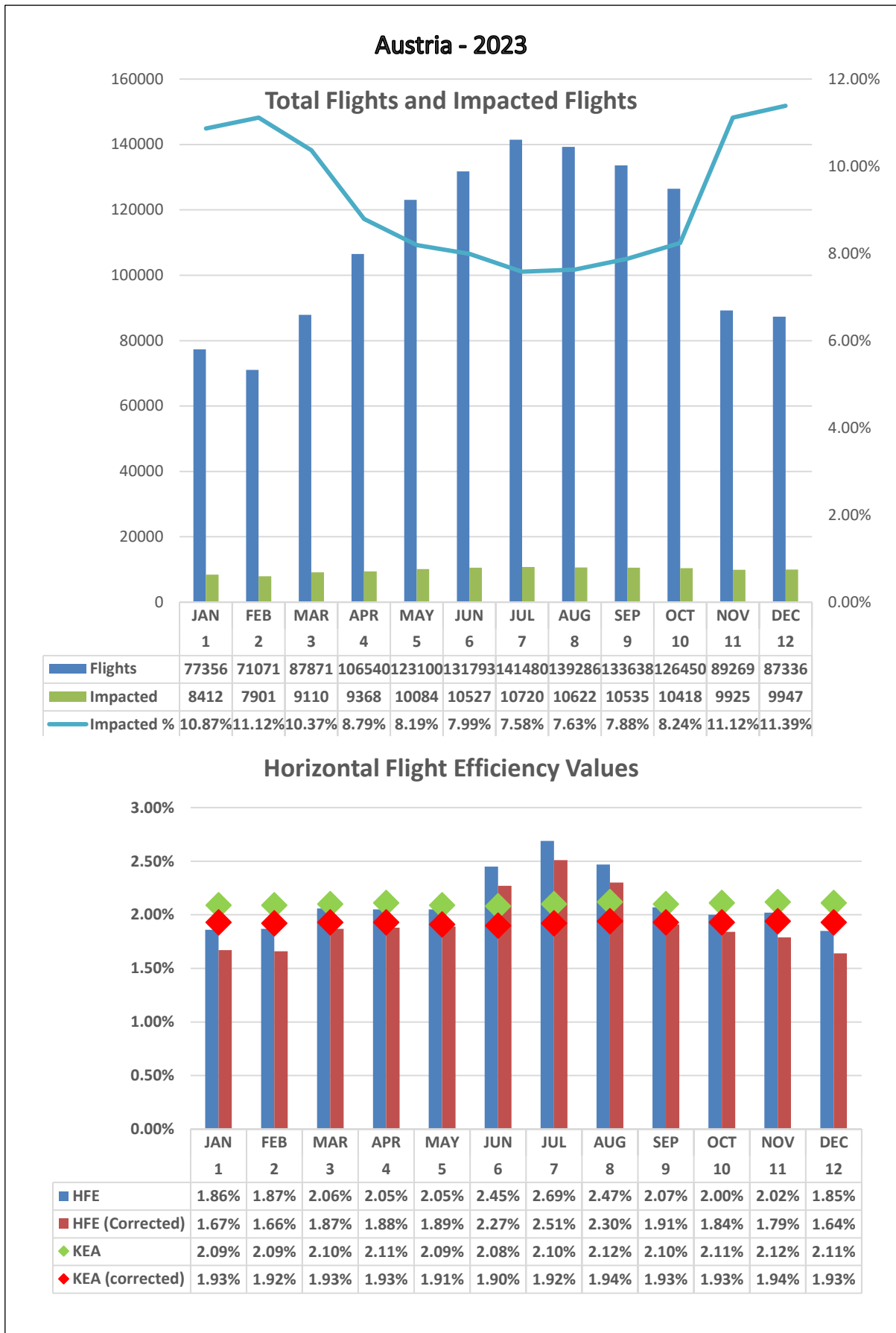
4.2 SES Area 2023



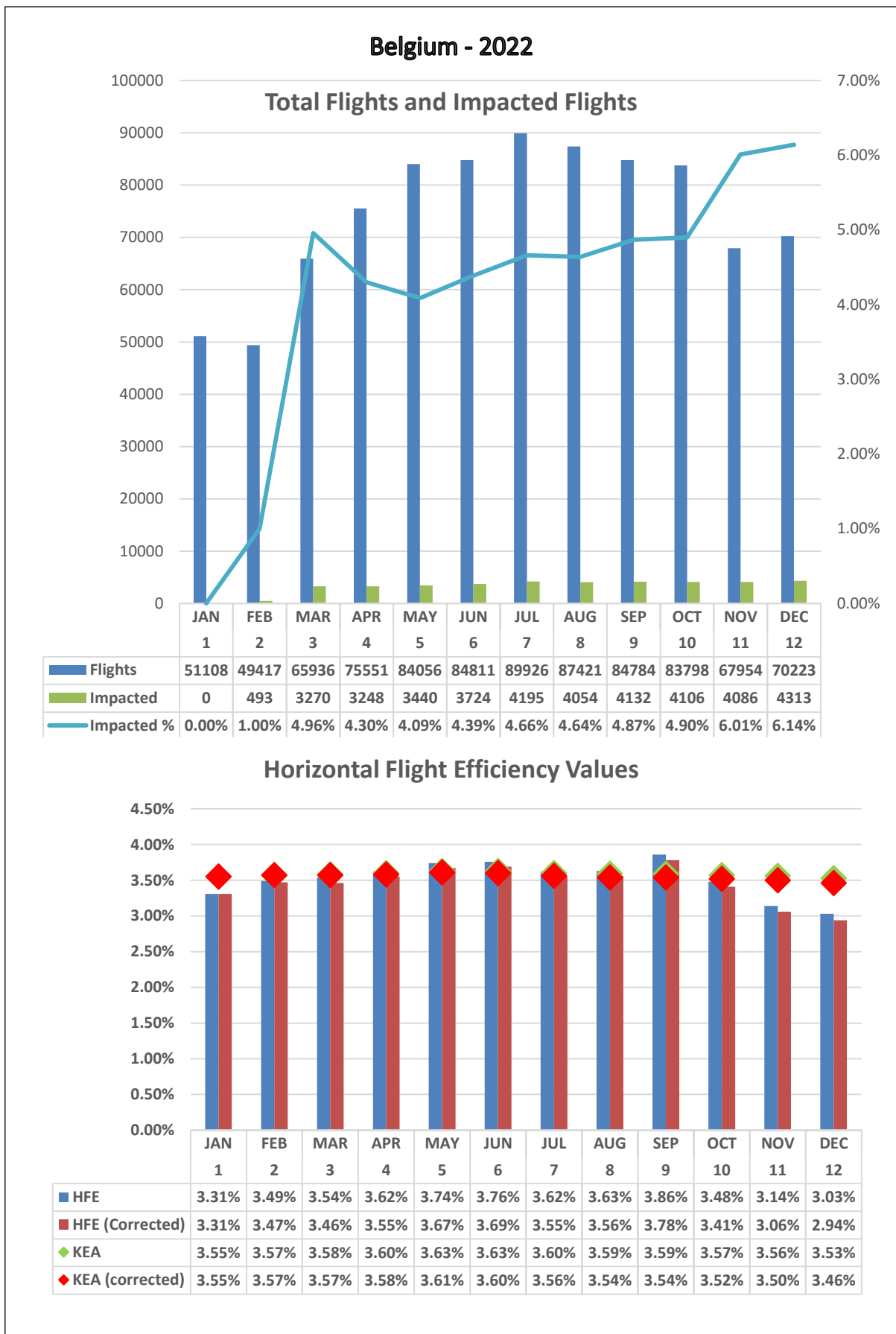
### 4.3 Austria 2022



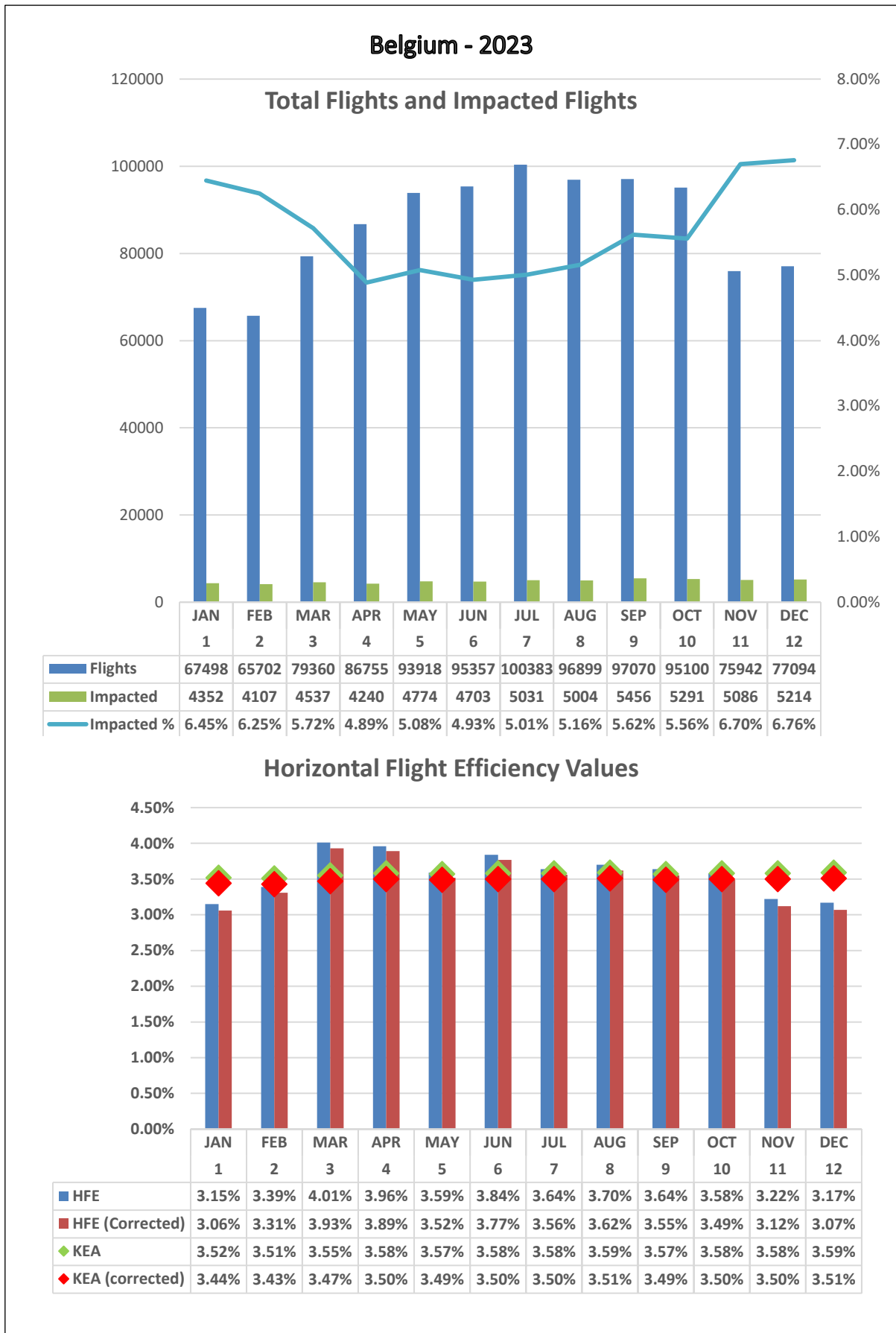
#### 4.4 Austria 2023



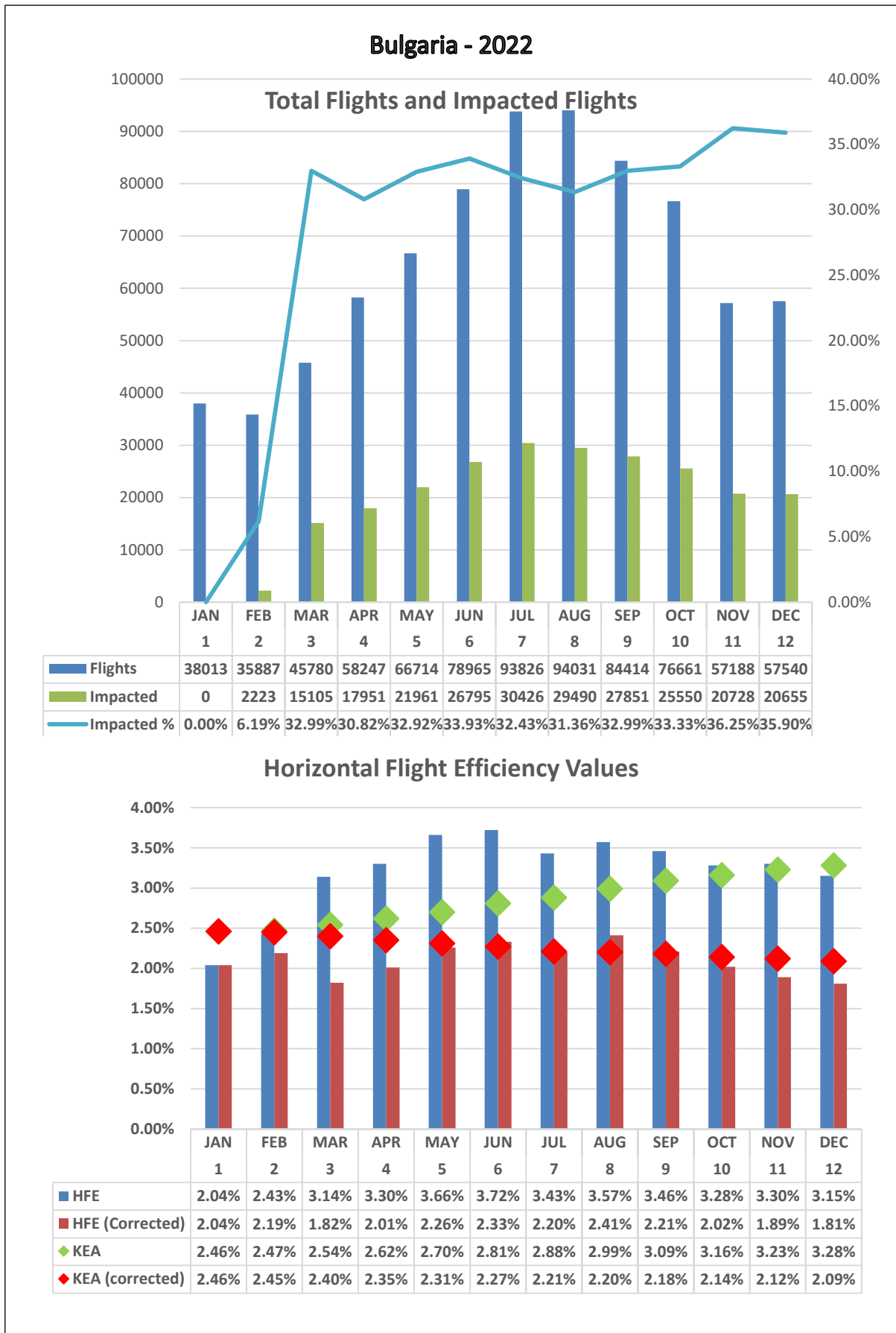
## 4.5 Belgium 2022



## 4.6 Belgium 2023

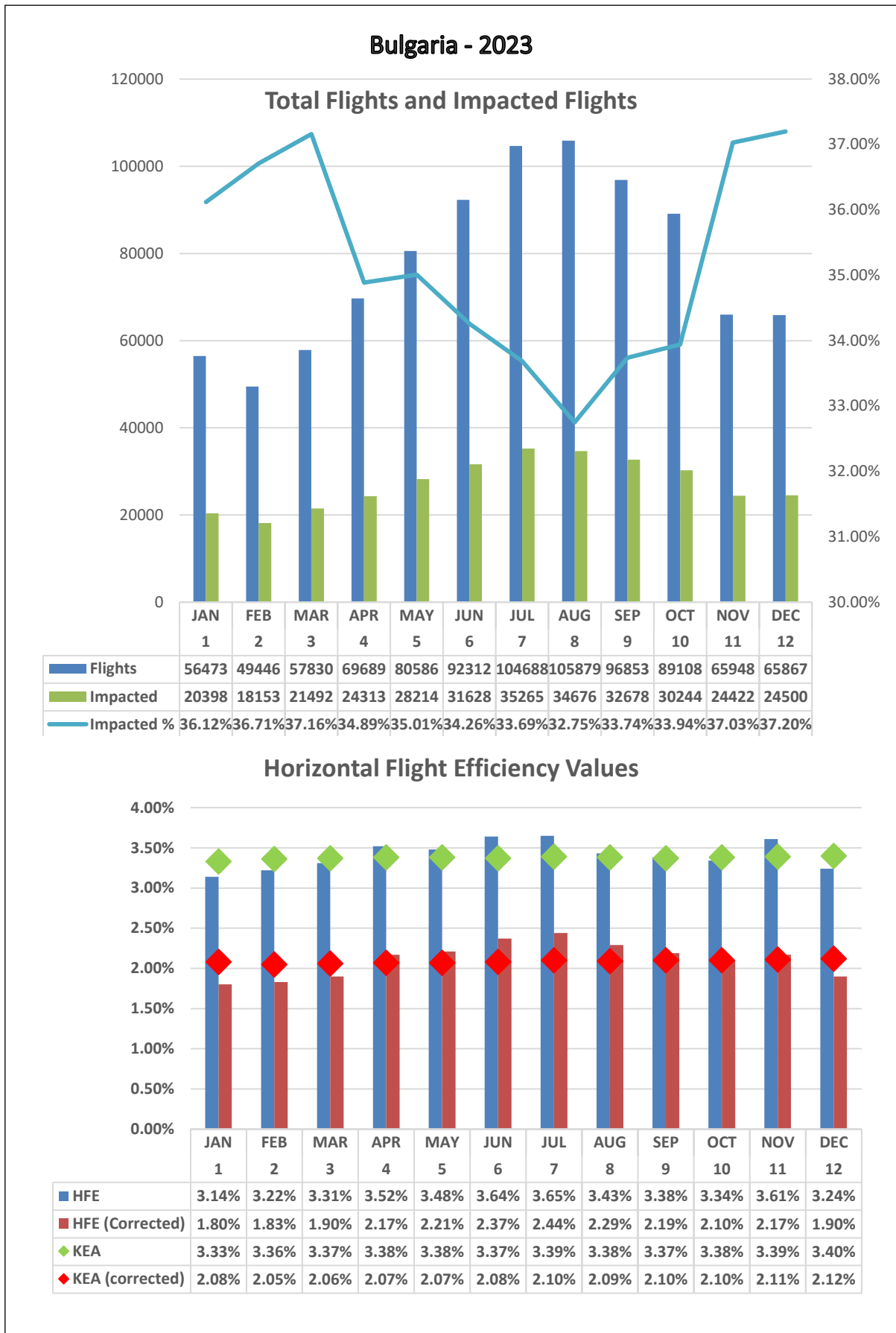


## 4.7 Bulgaria 2022

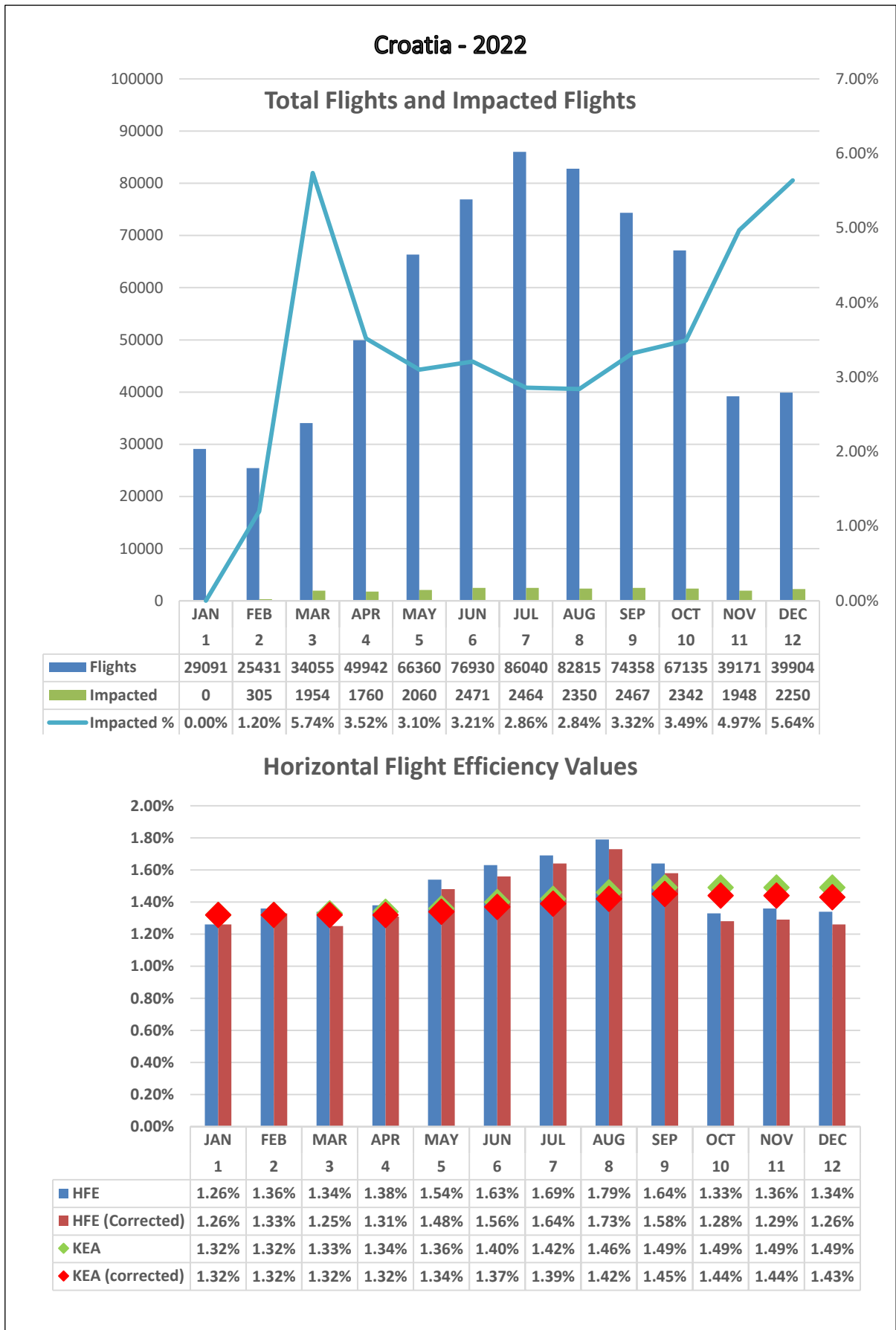




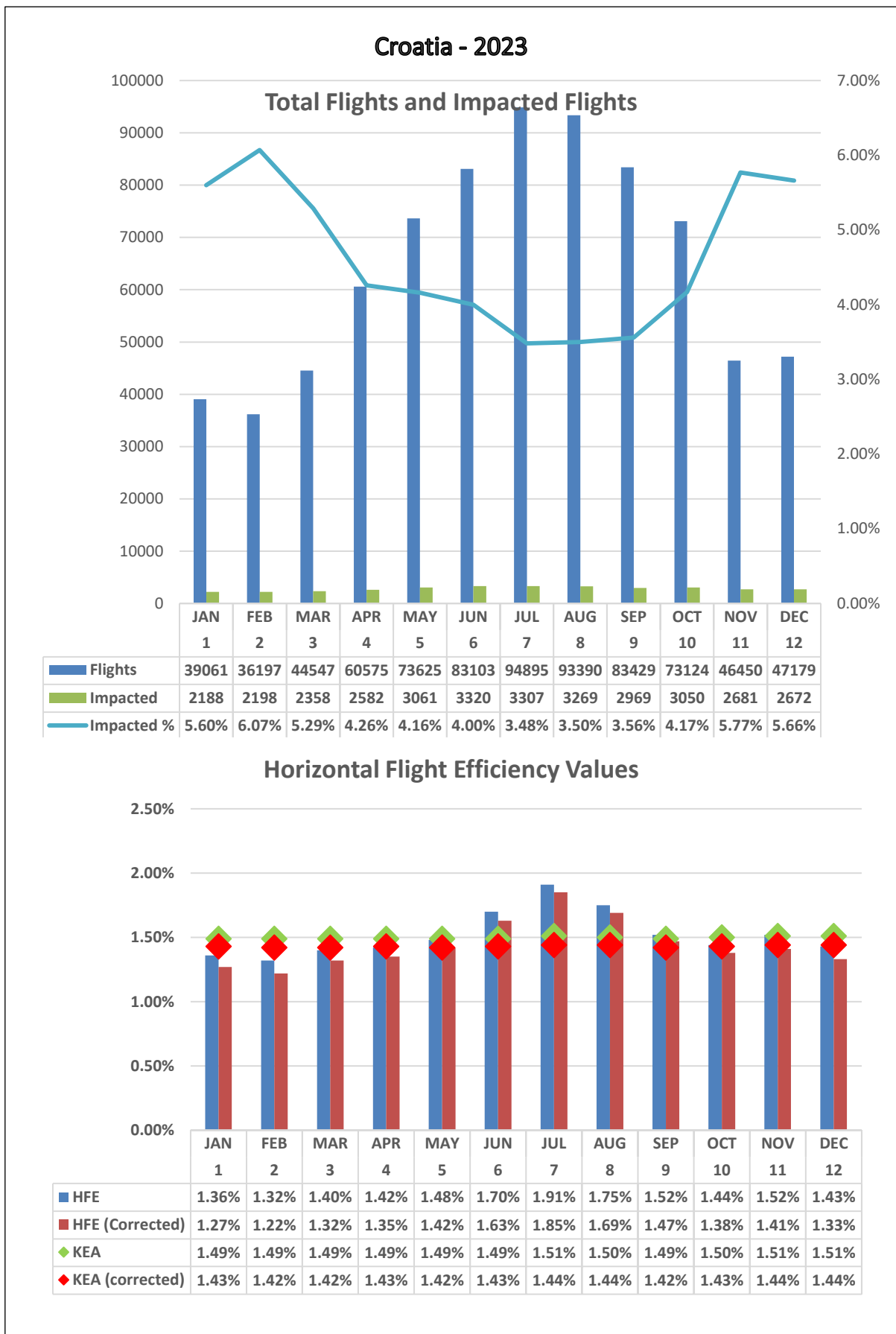
## 4.8 Bulgaria 2023



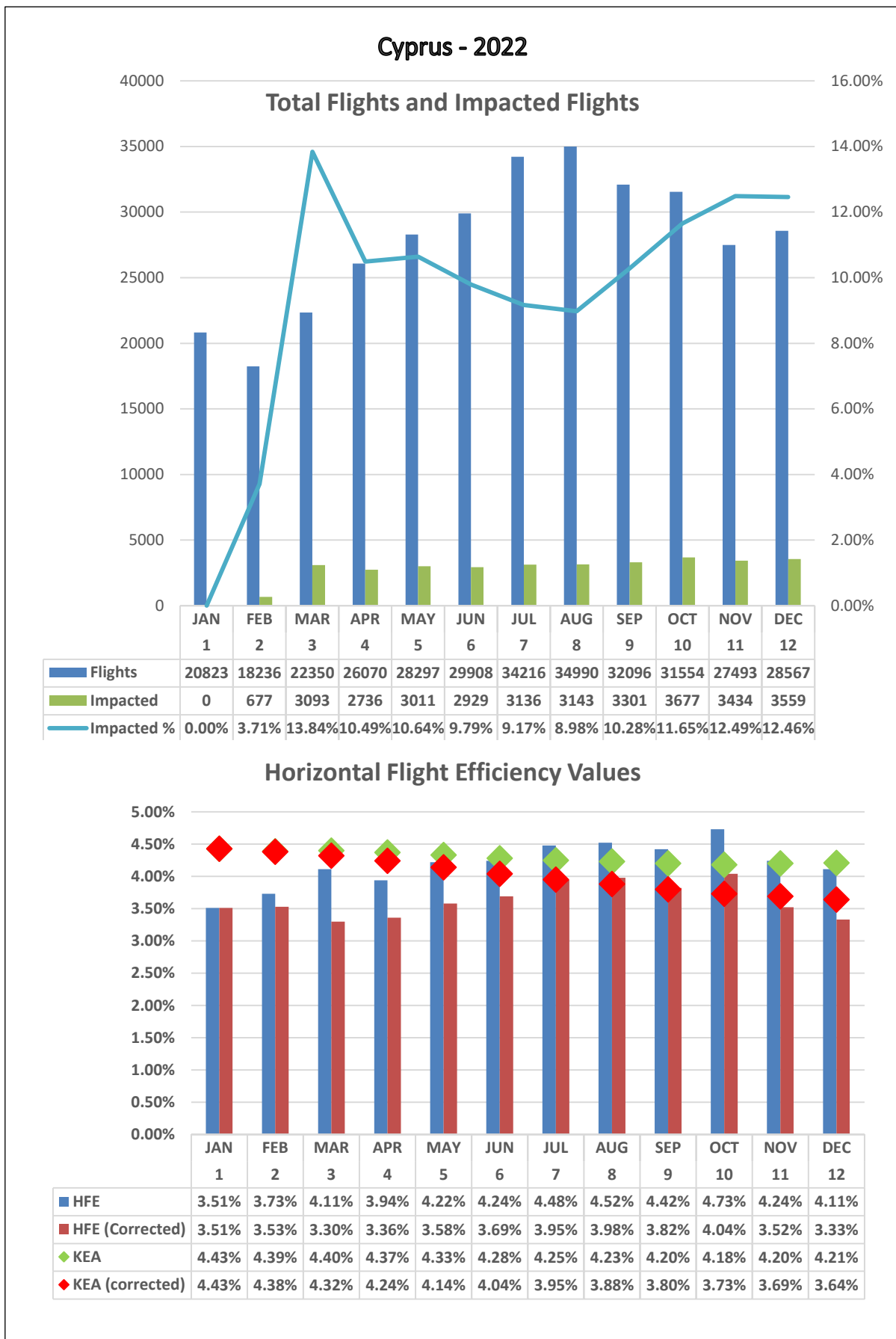
4.9 Croatia 2022



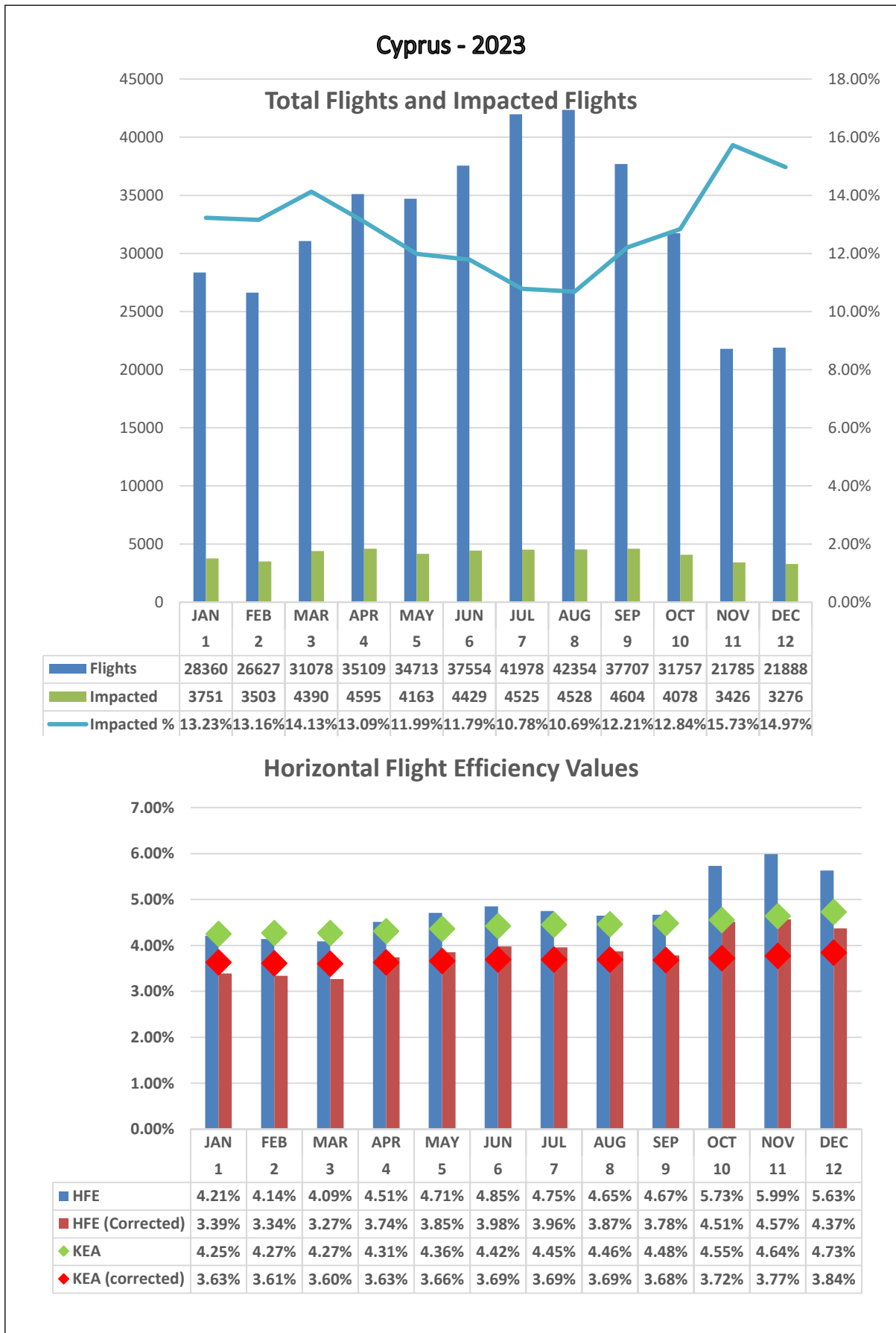
#### 4.10 Croatia 2023



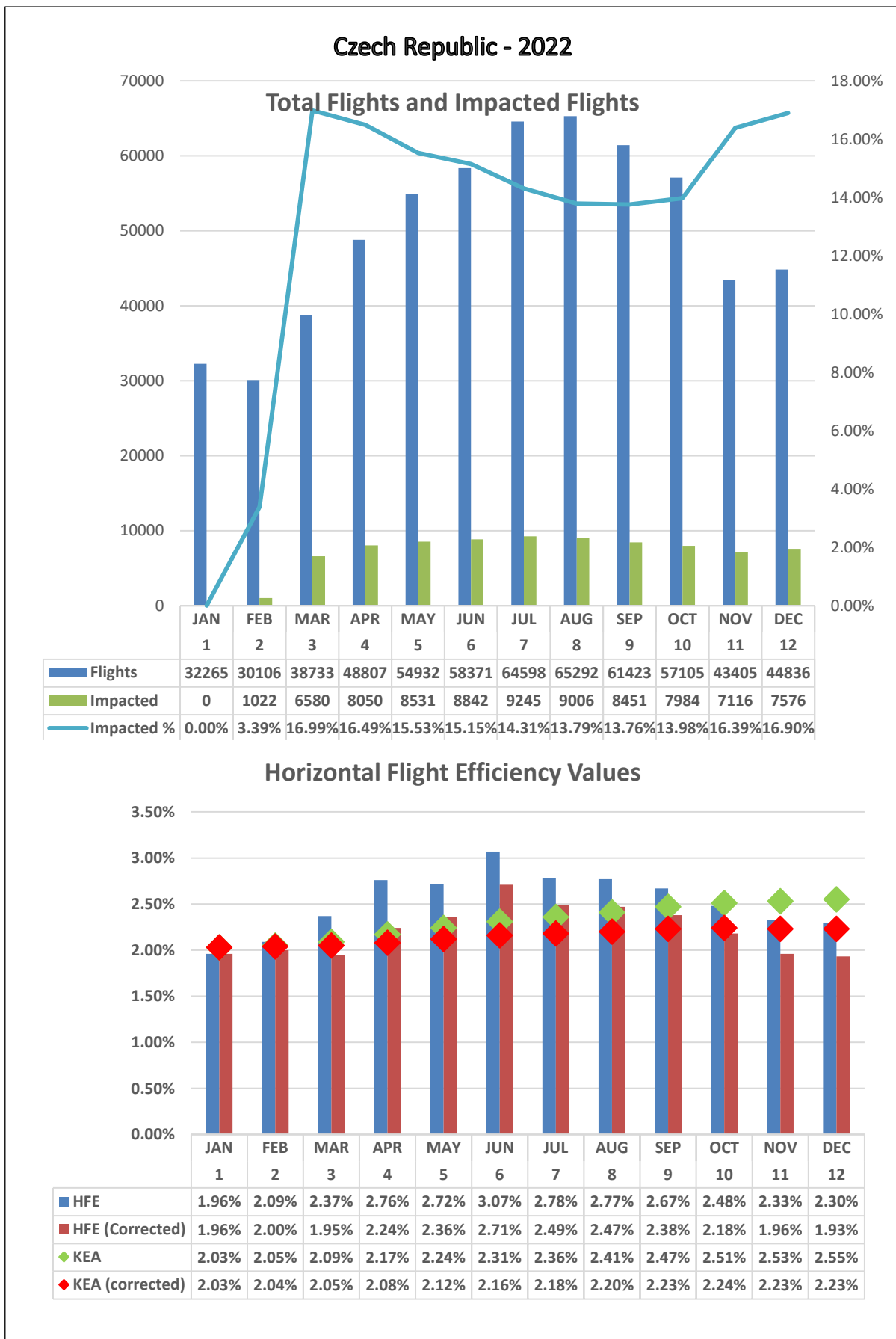
#### 4.11 Cyprus 2022



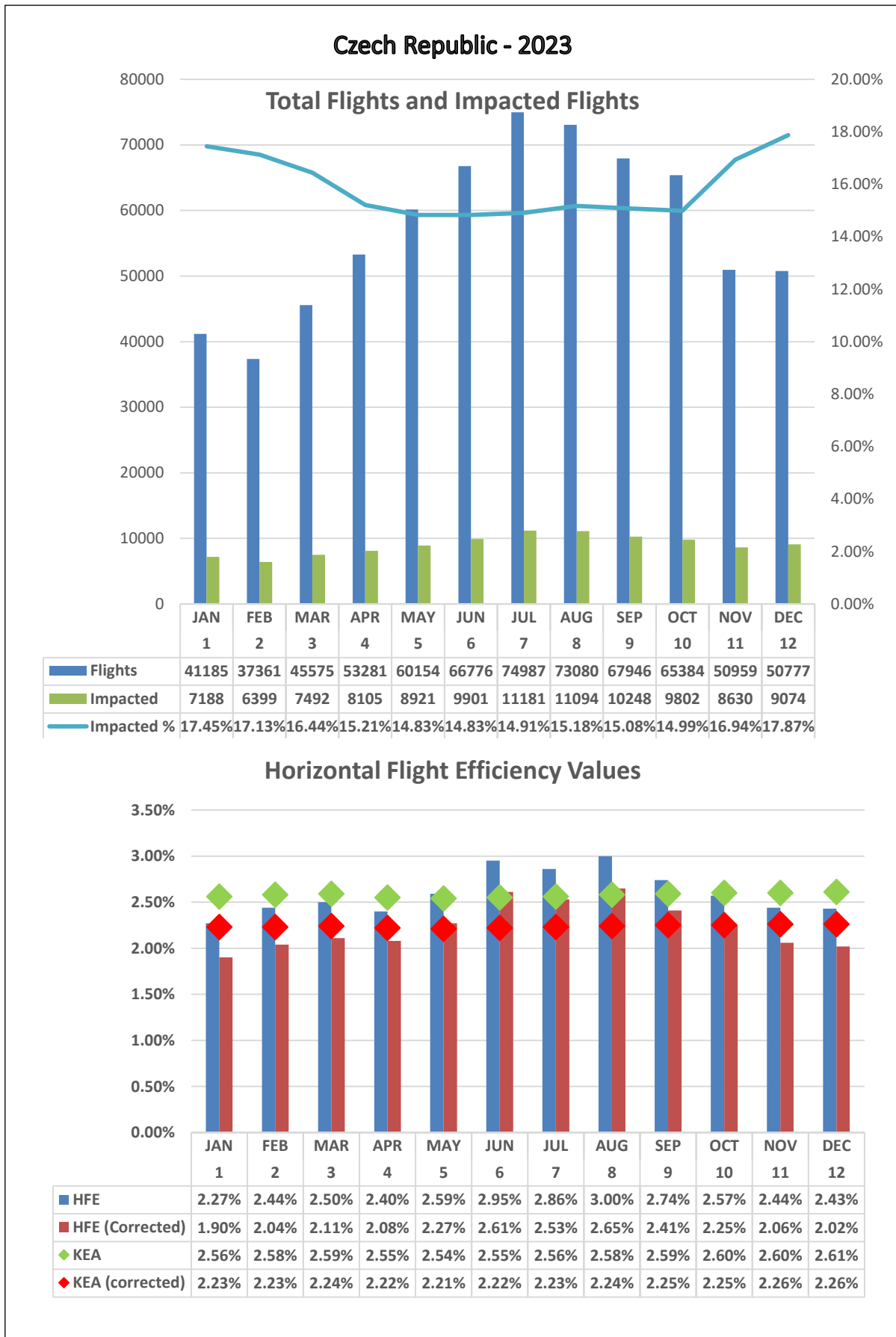
## 4.12 Cyprus 2023



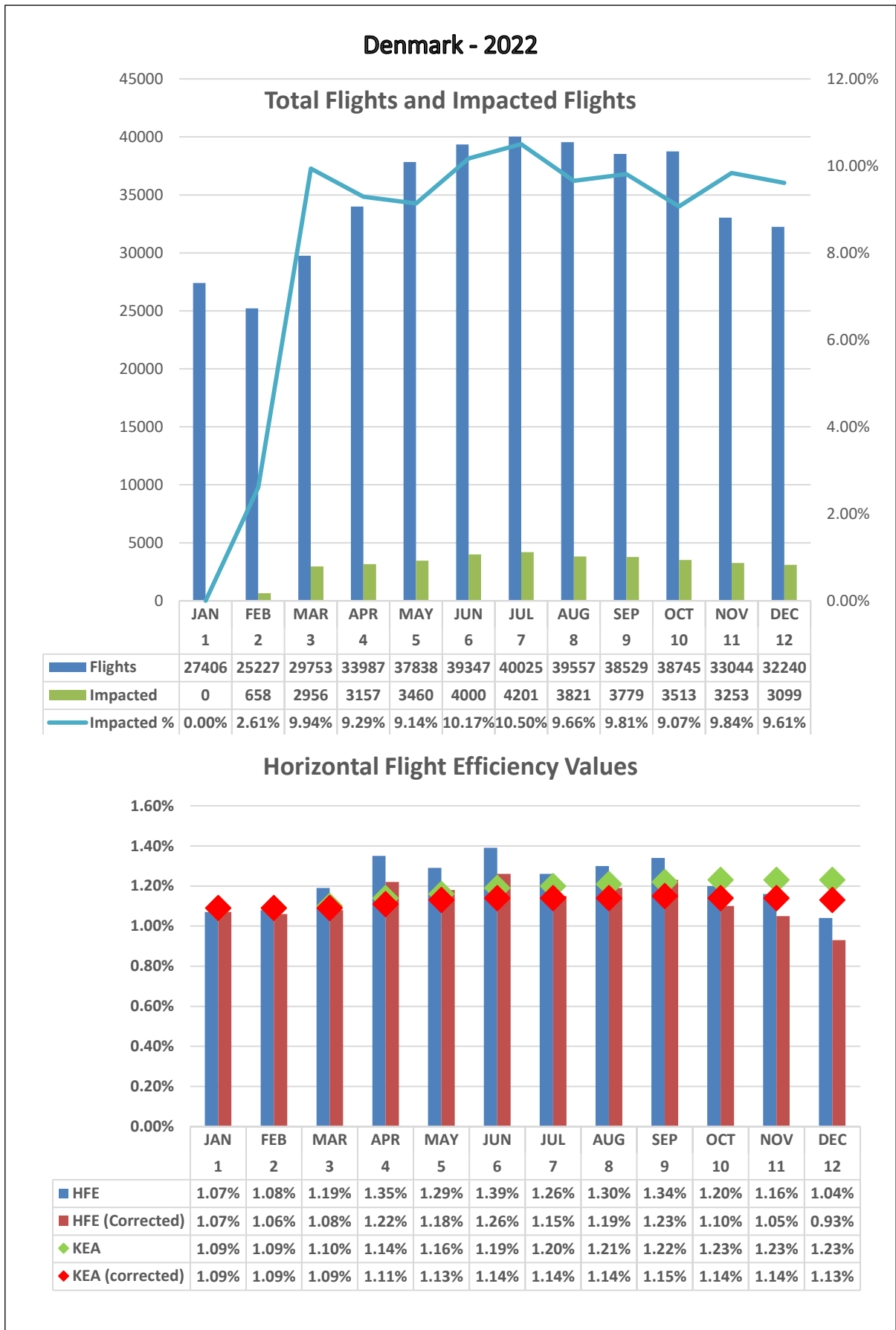
#### 4.13 Czech Republic 2022



#### 4.14 Czech Republic 2023

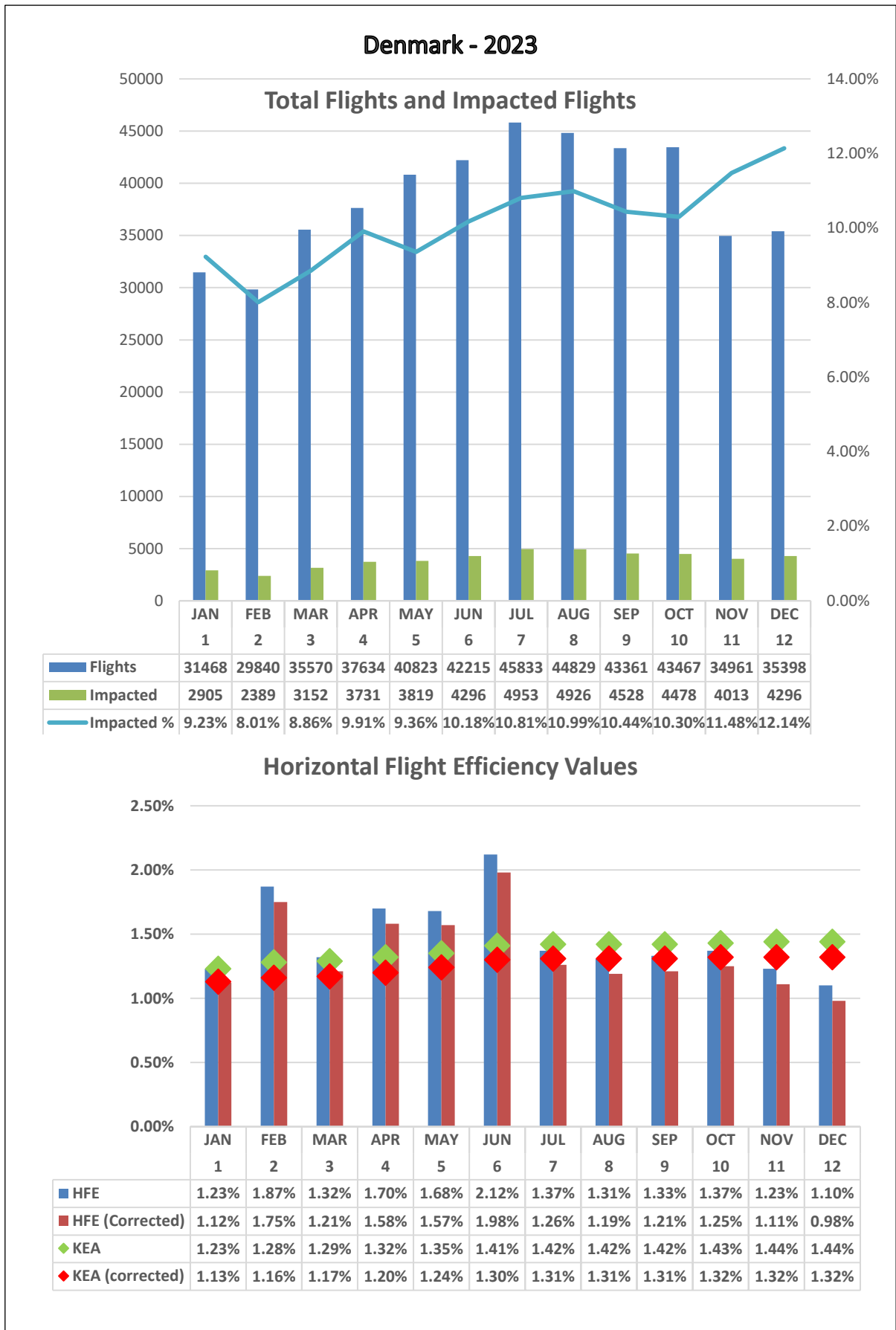


4.15 Denmark 2022

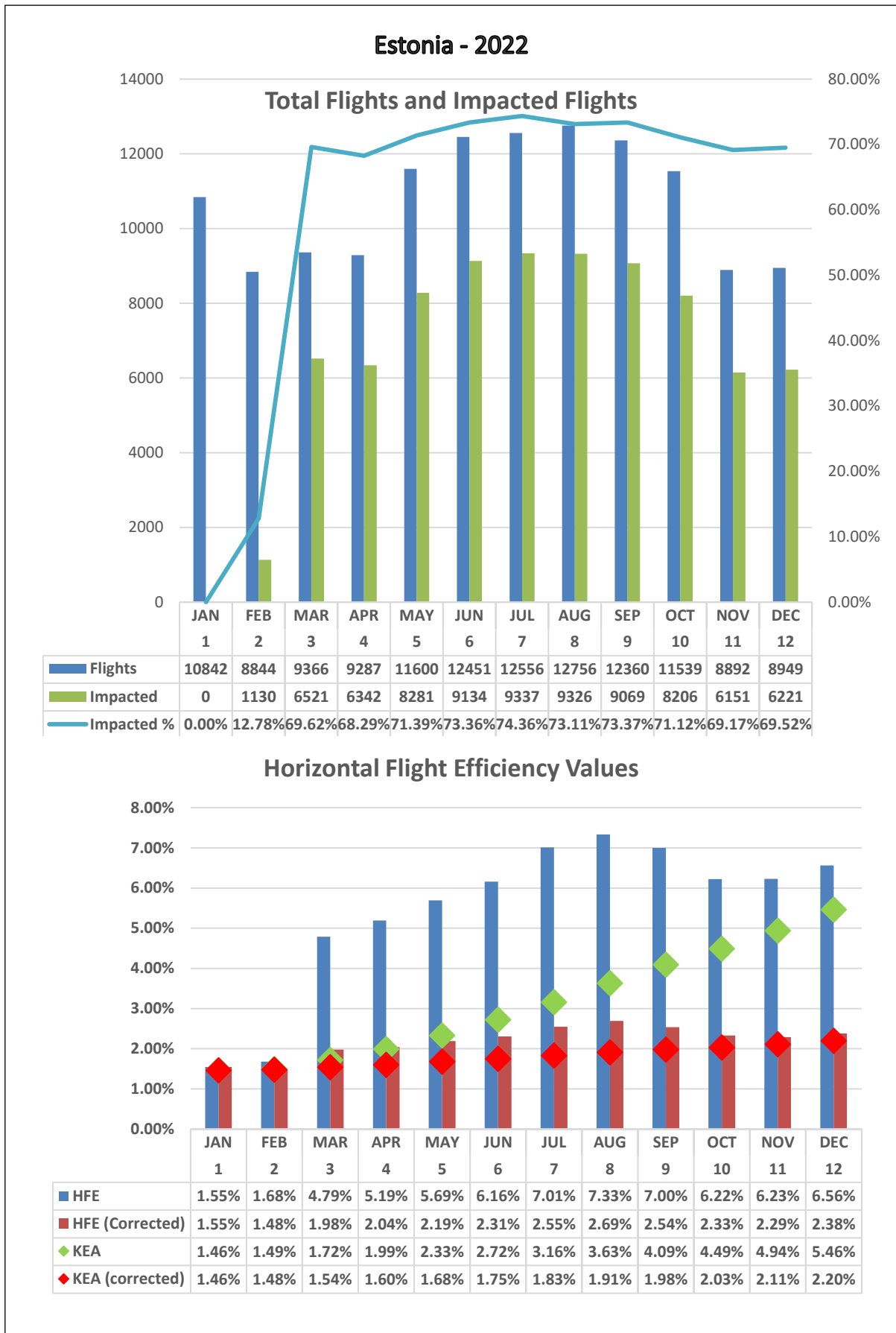




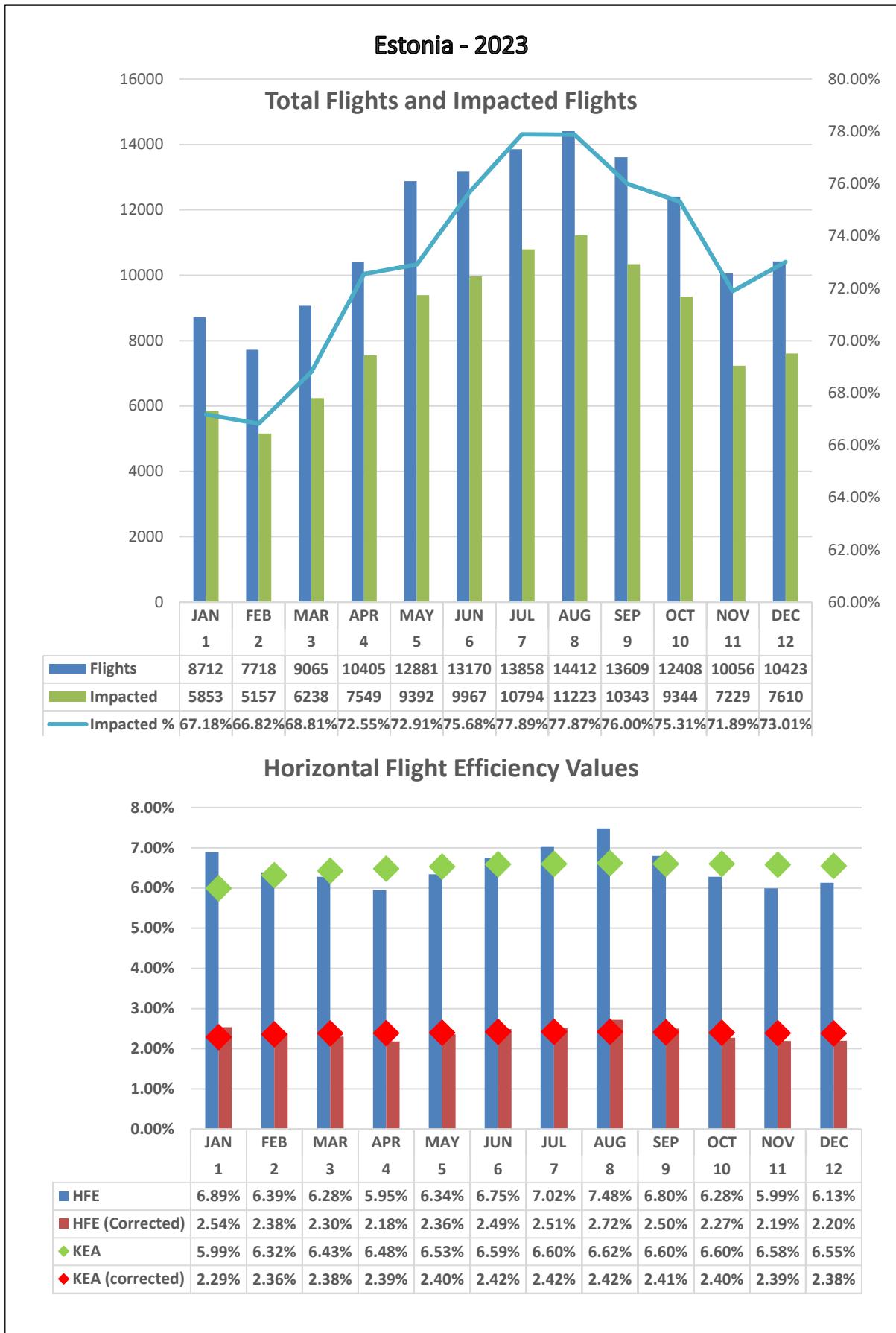
4.16 Denmark 2023



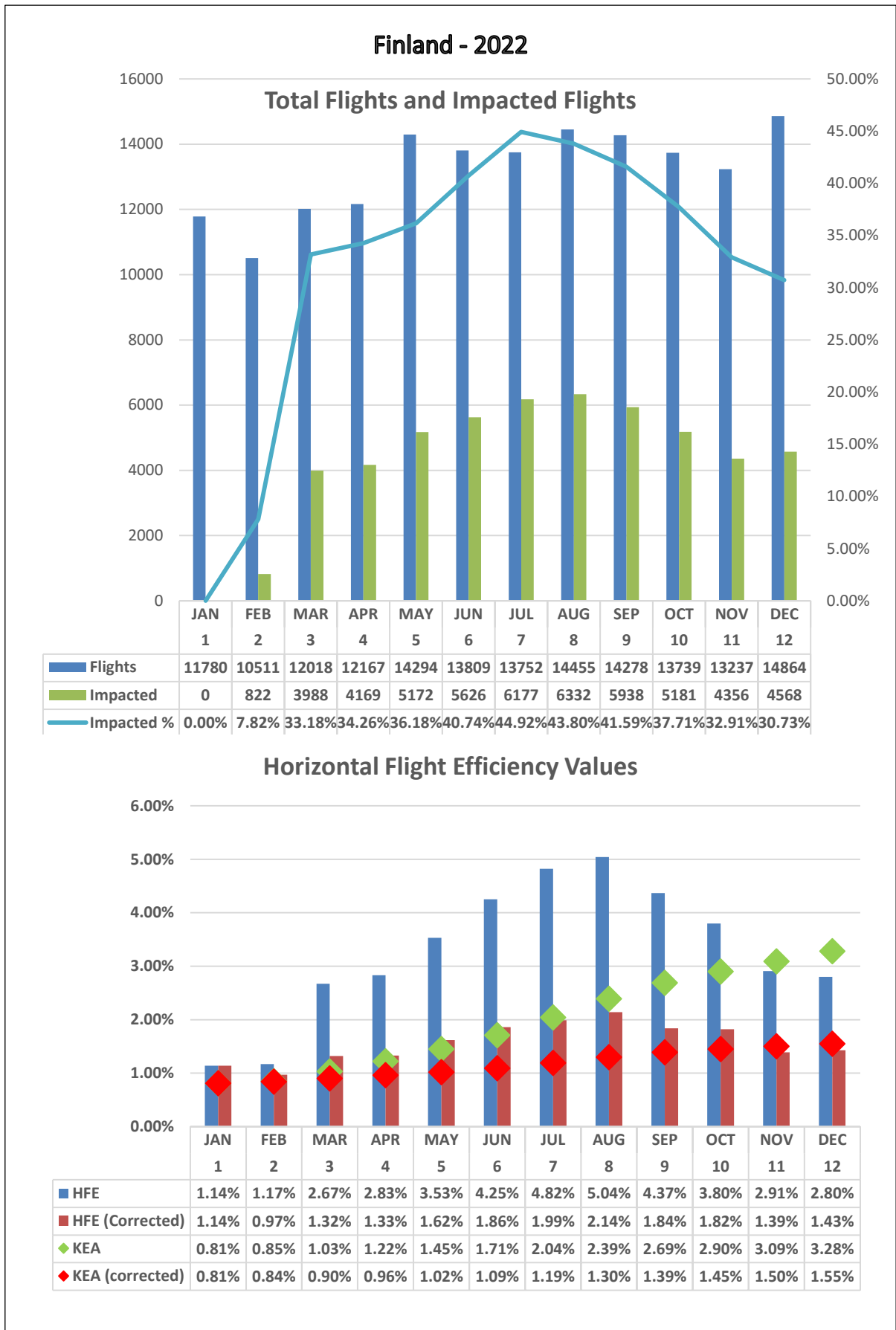
#### 4.17 Estonia 2022



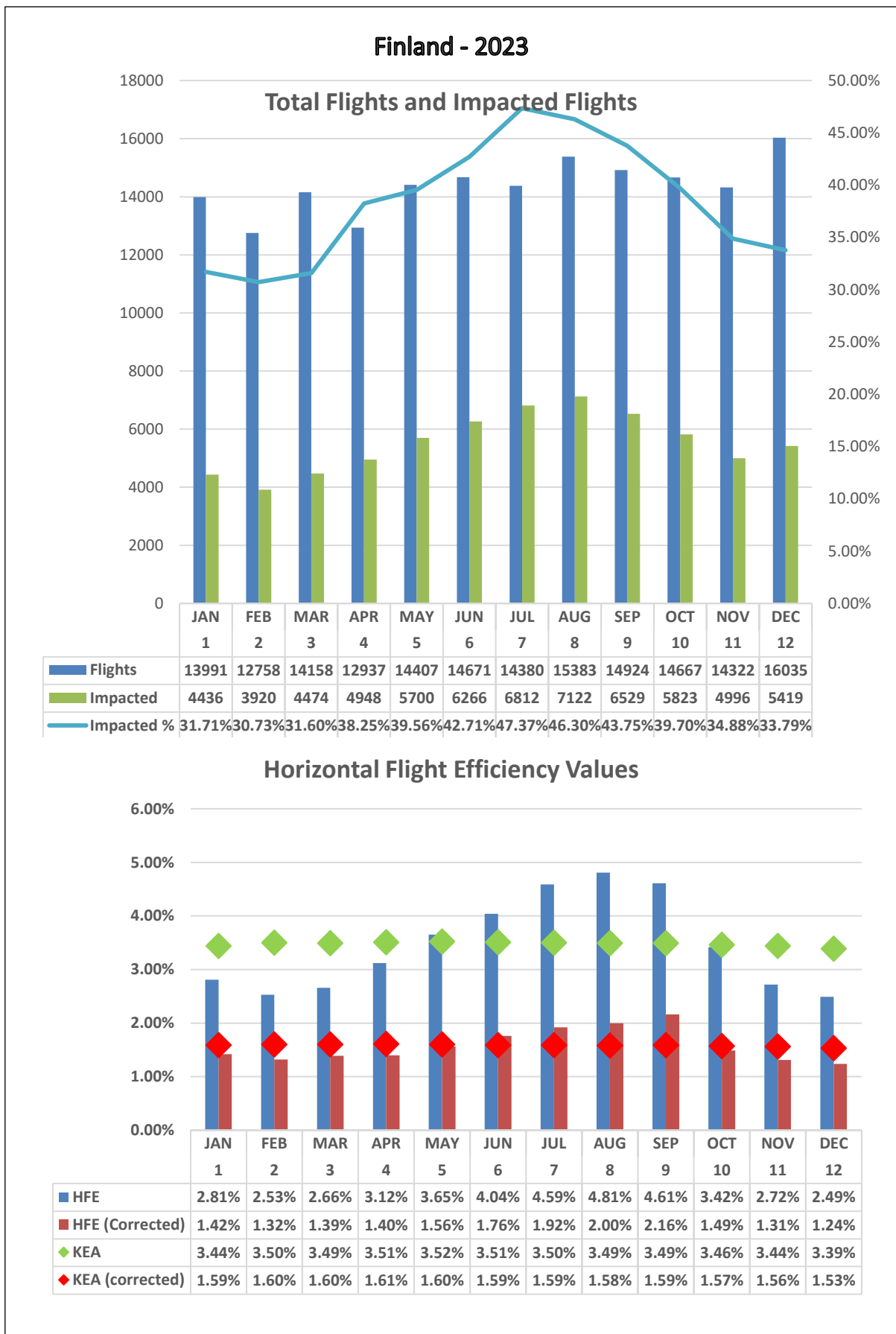
#### 4.18 Estonia 2023



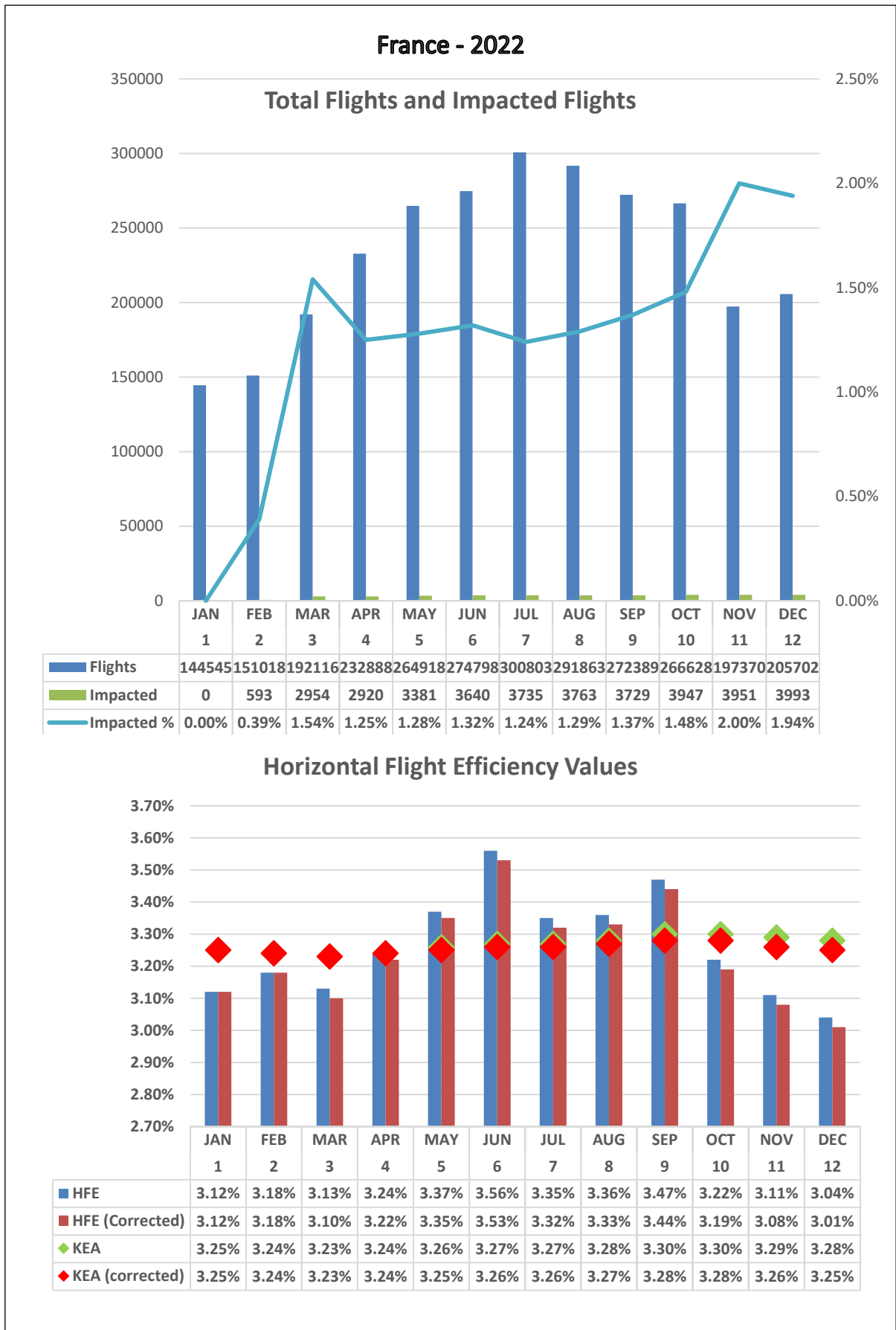
4.19 Finland 2022



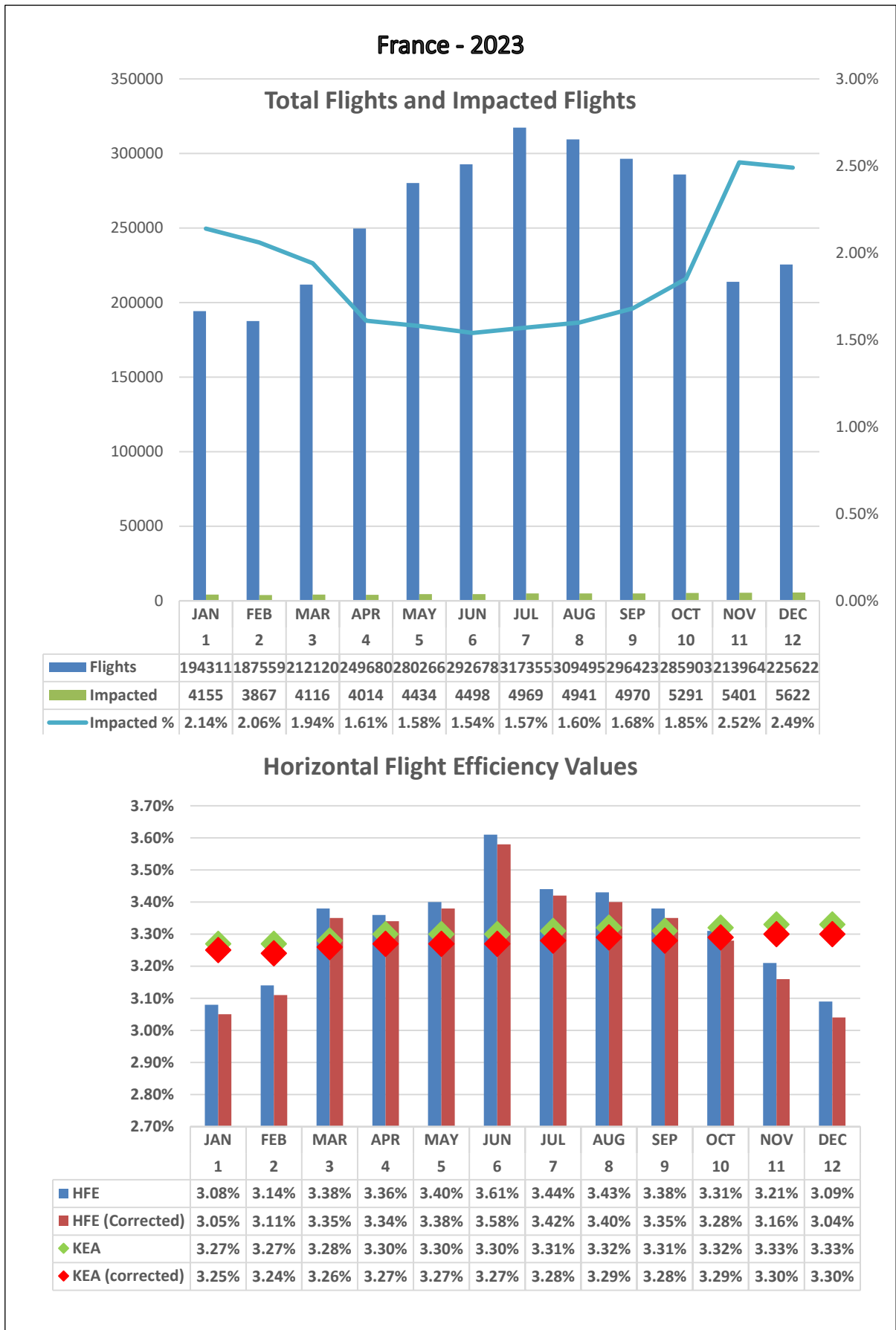
## 4.20 Finland 2023



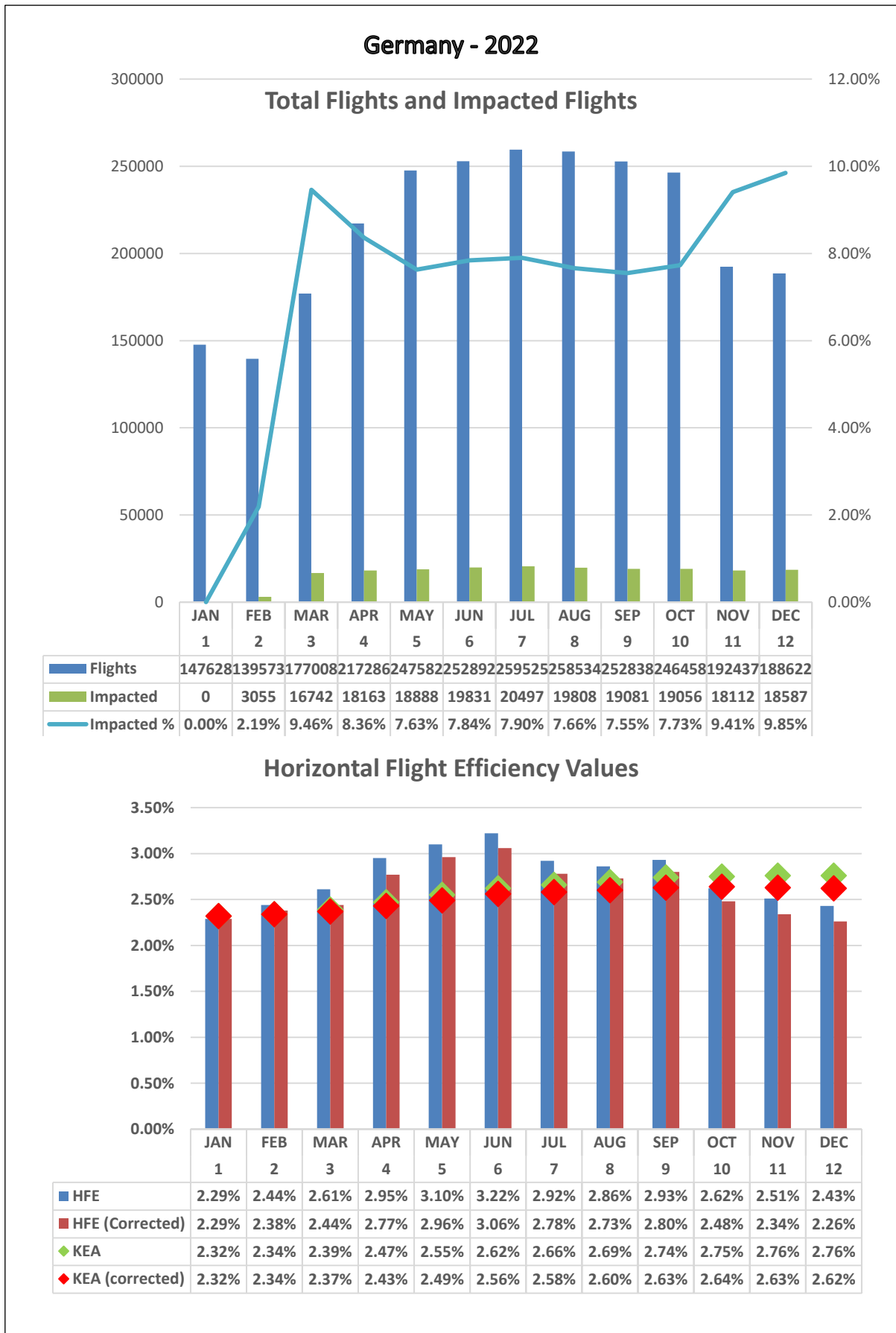
4.21 France 2022



4.22 France 2023

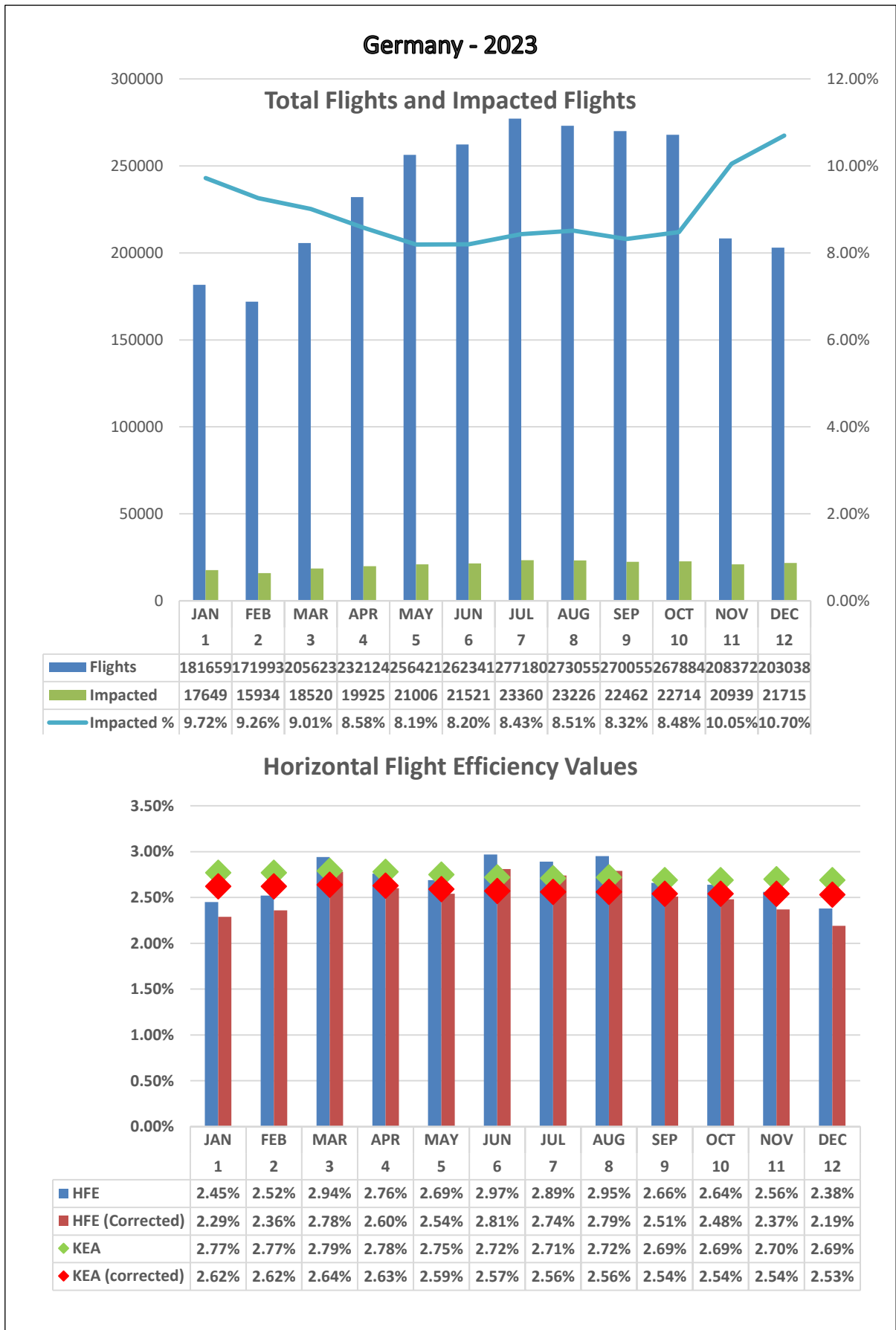


## 4.23 Germany 2022

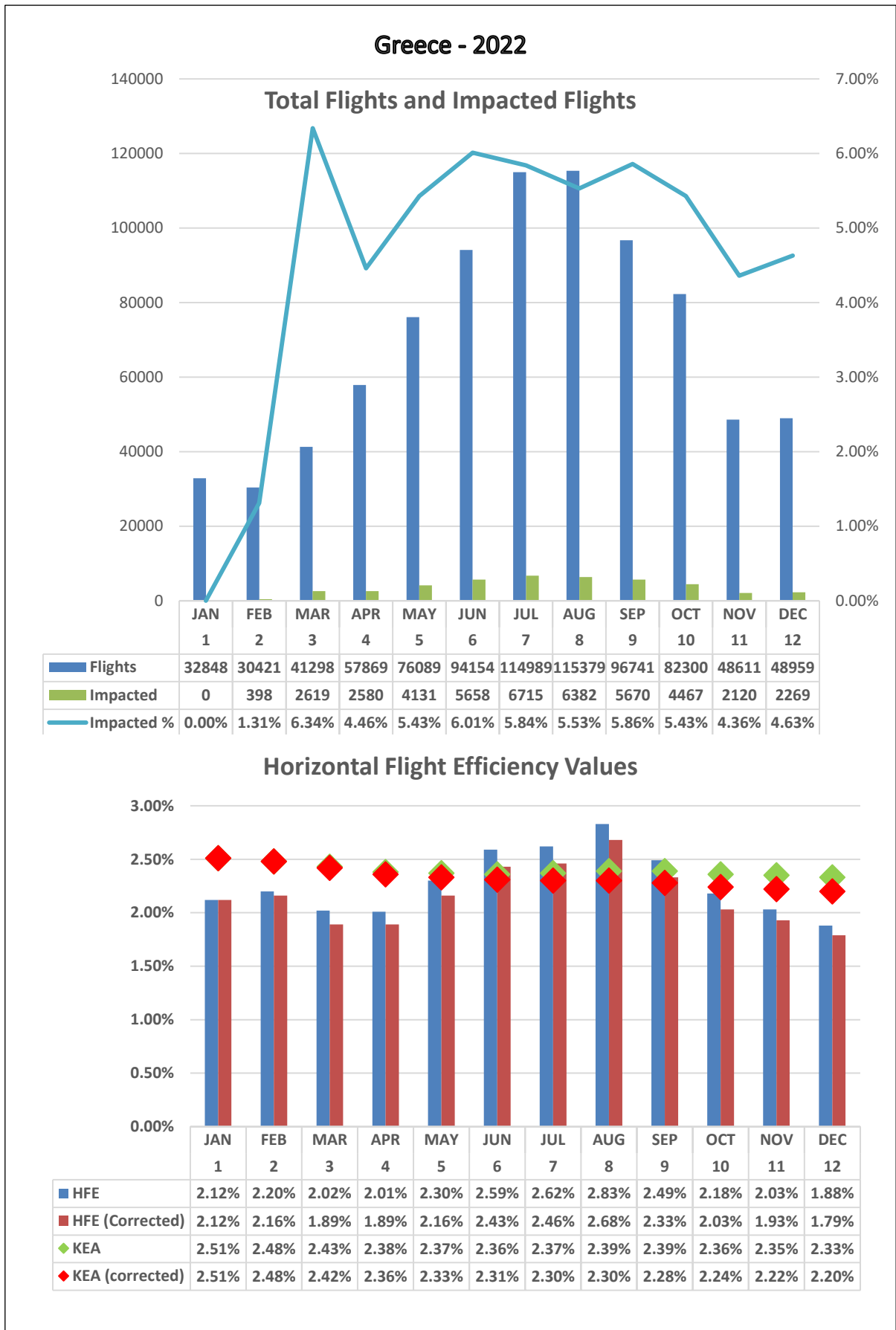




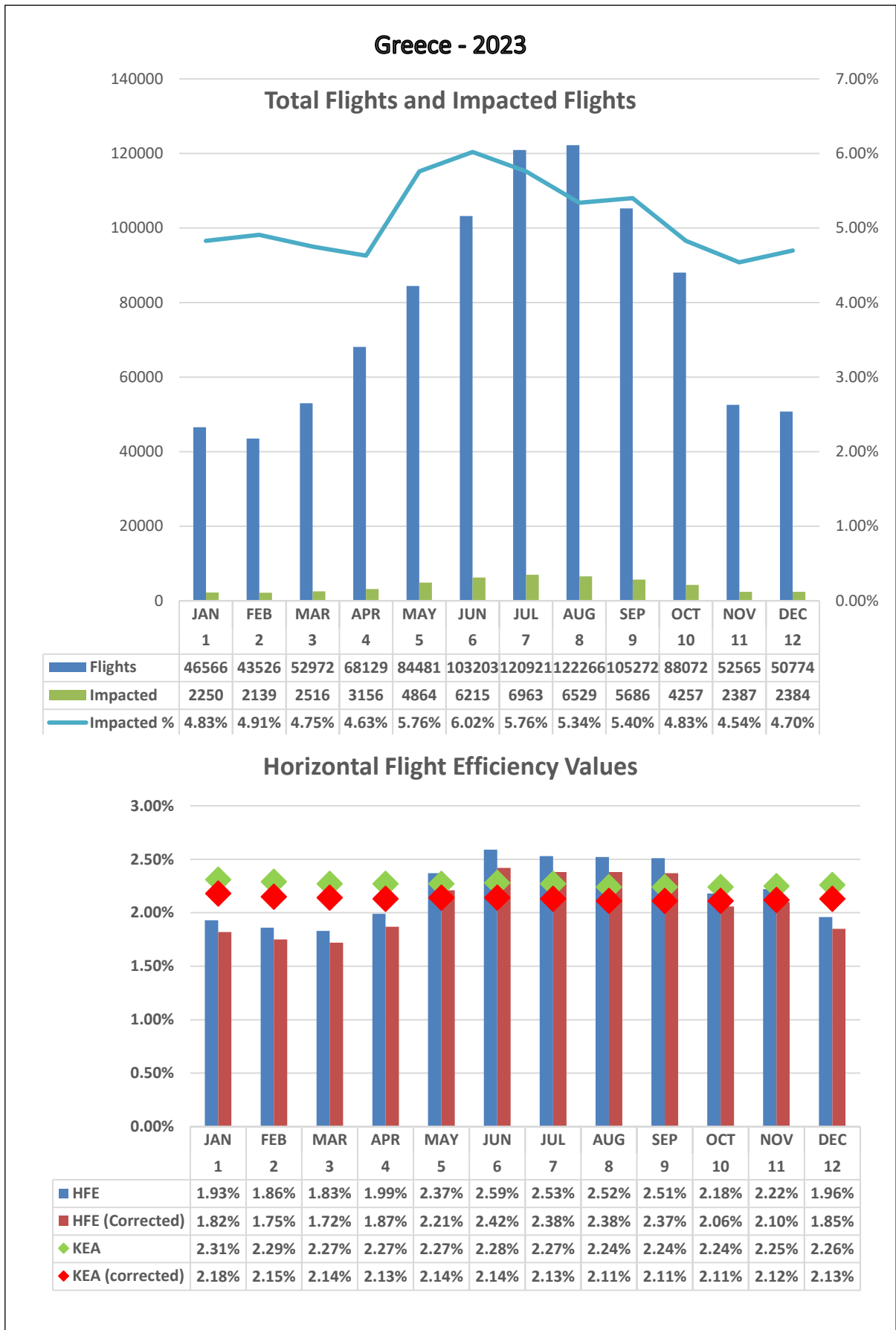
4.24 Germany 2023



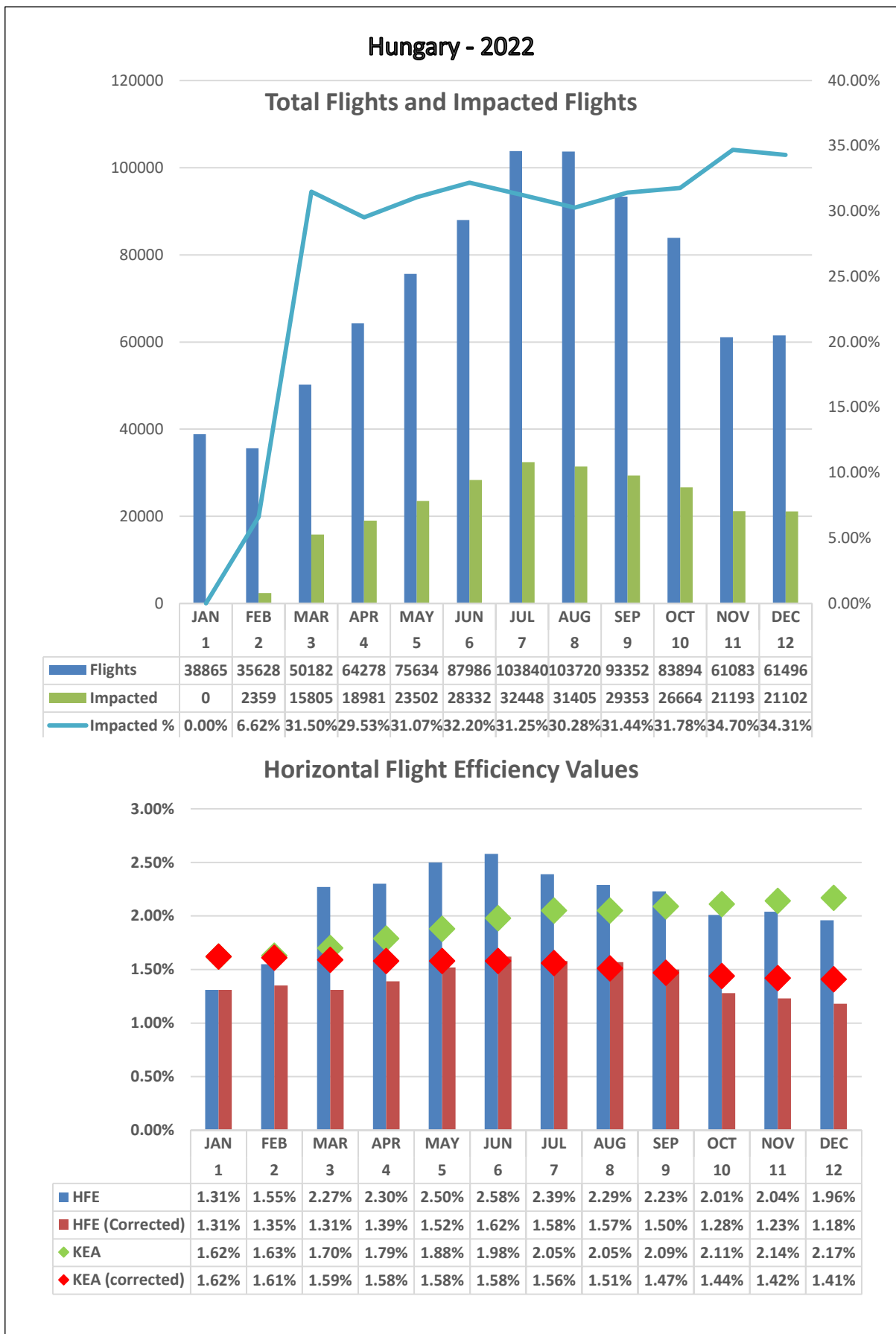
4.25 Greece 2022



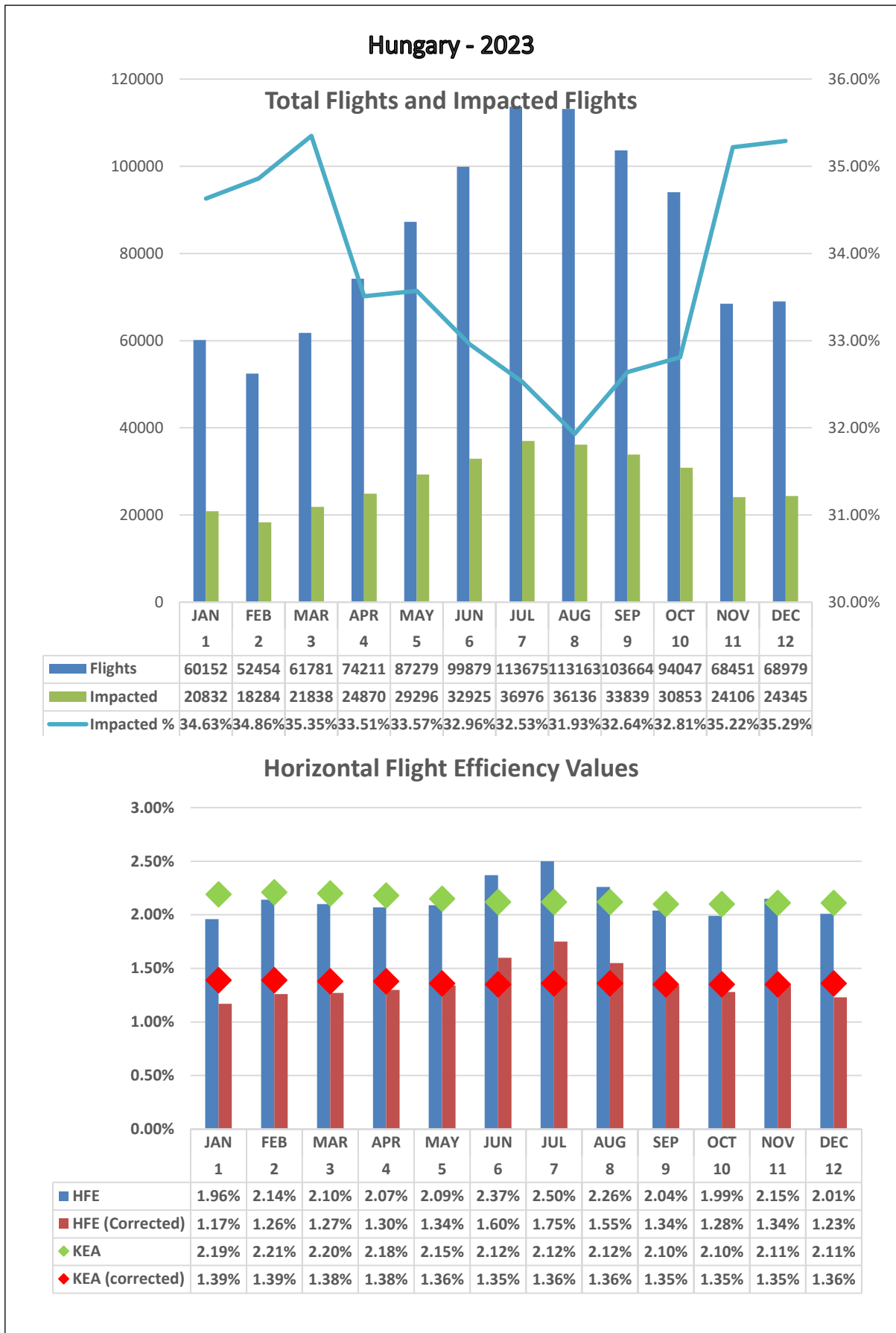
4.26 Greece 2023



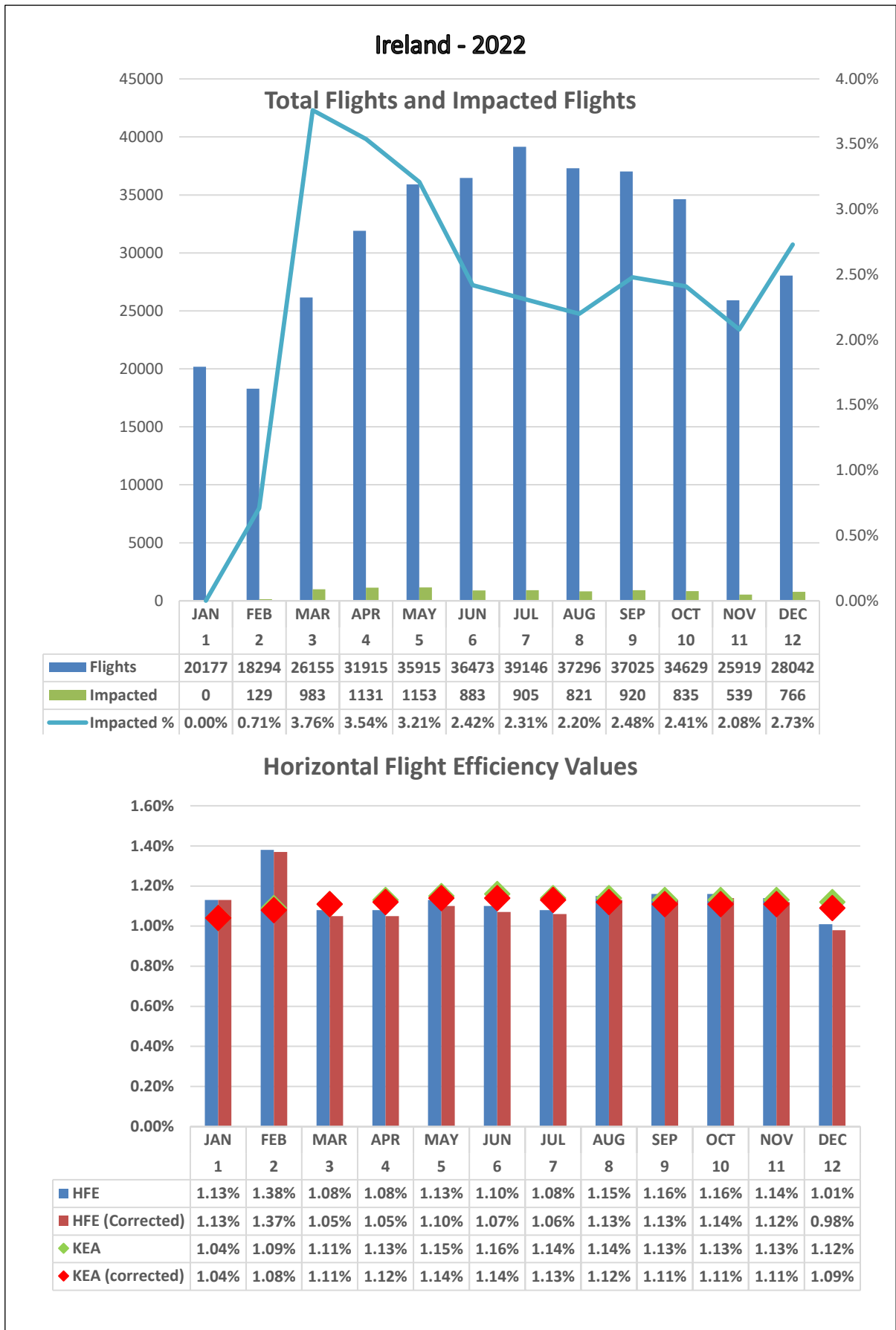
## 4.27 Hungary 2022



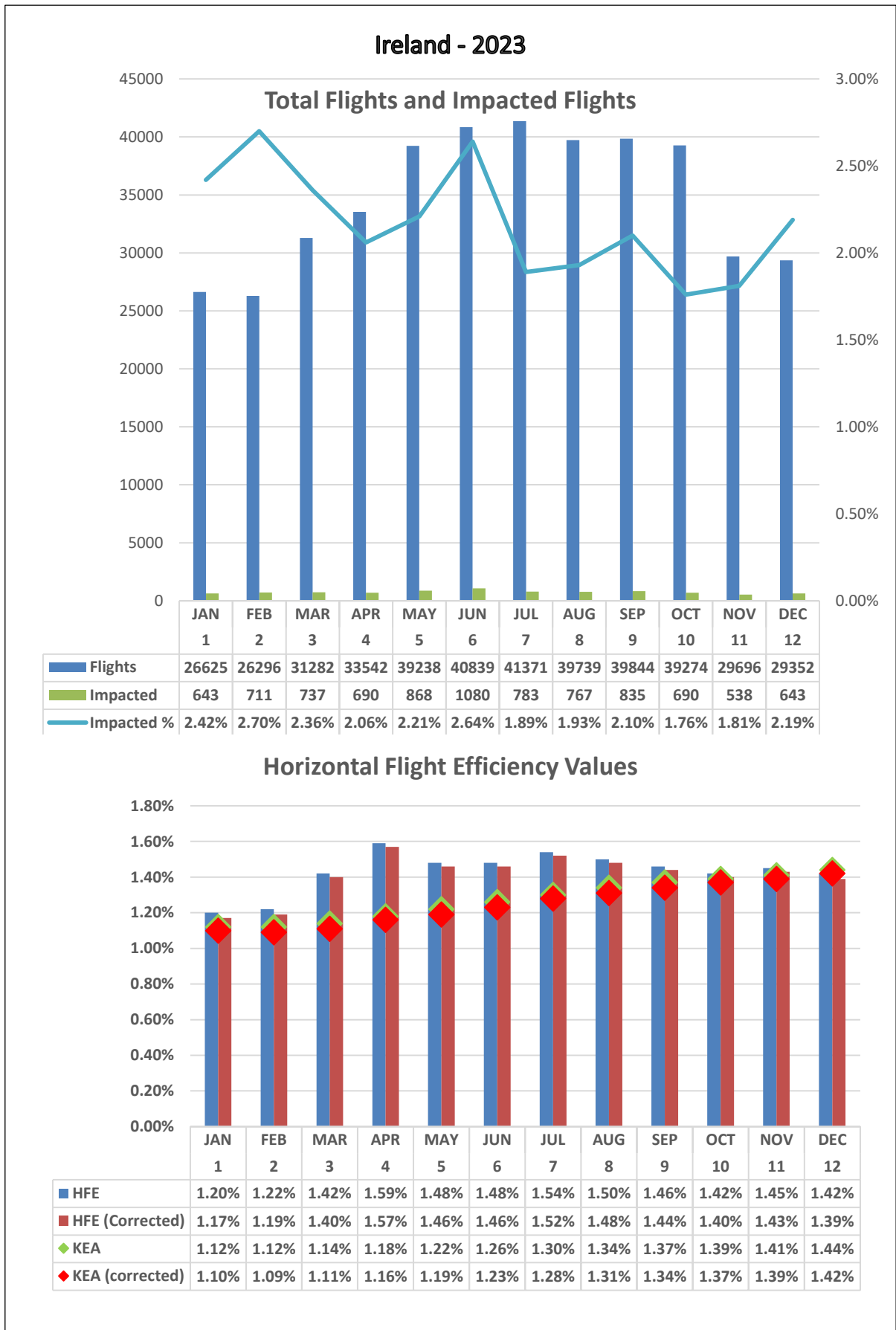
## 4.28 Hungary 2023



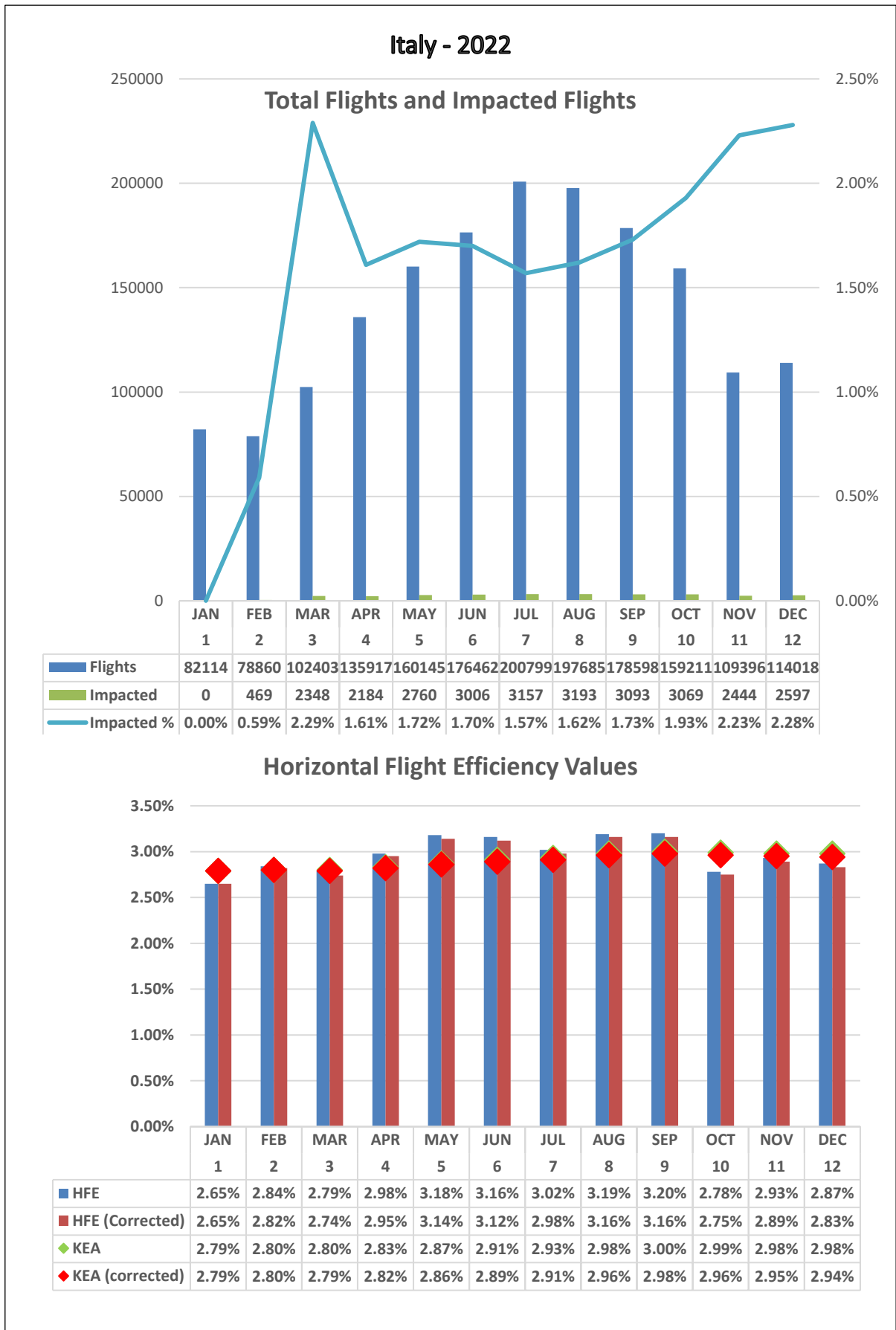
4.29 Ireland 2022



4.30 Ireland 2023

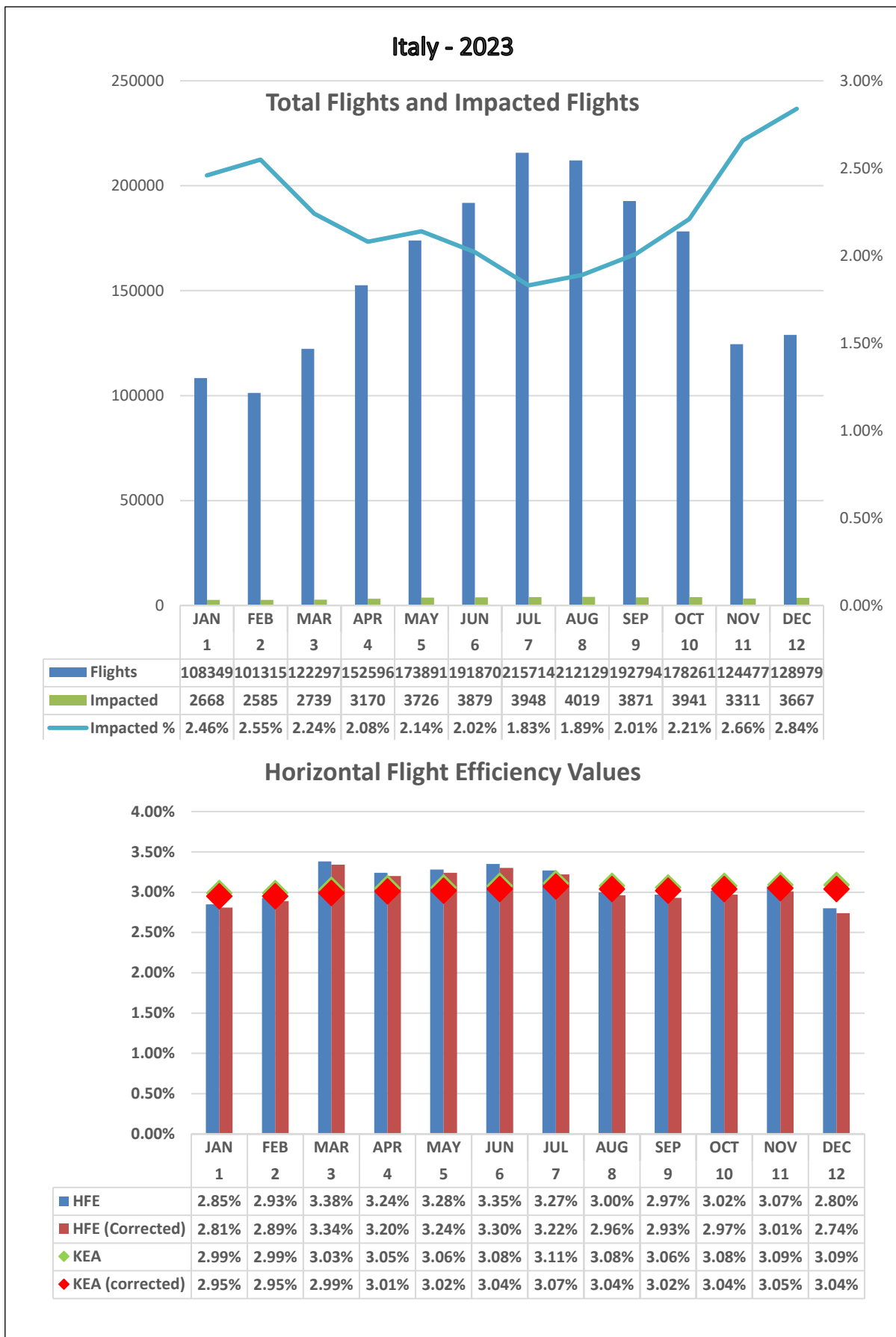


4.31 Italy 2022

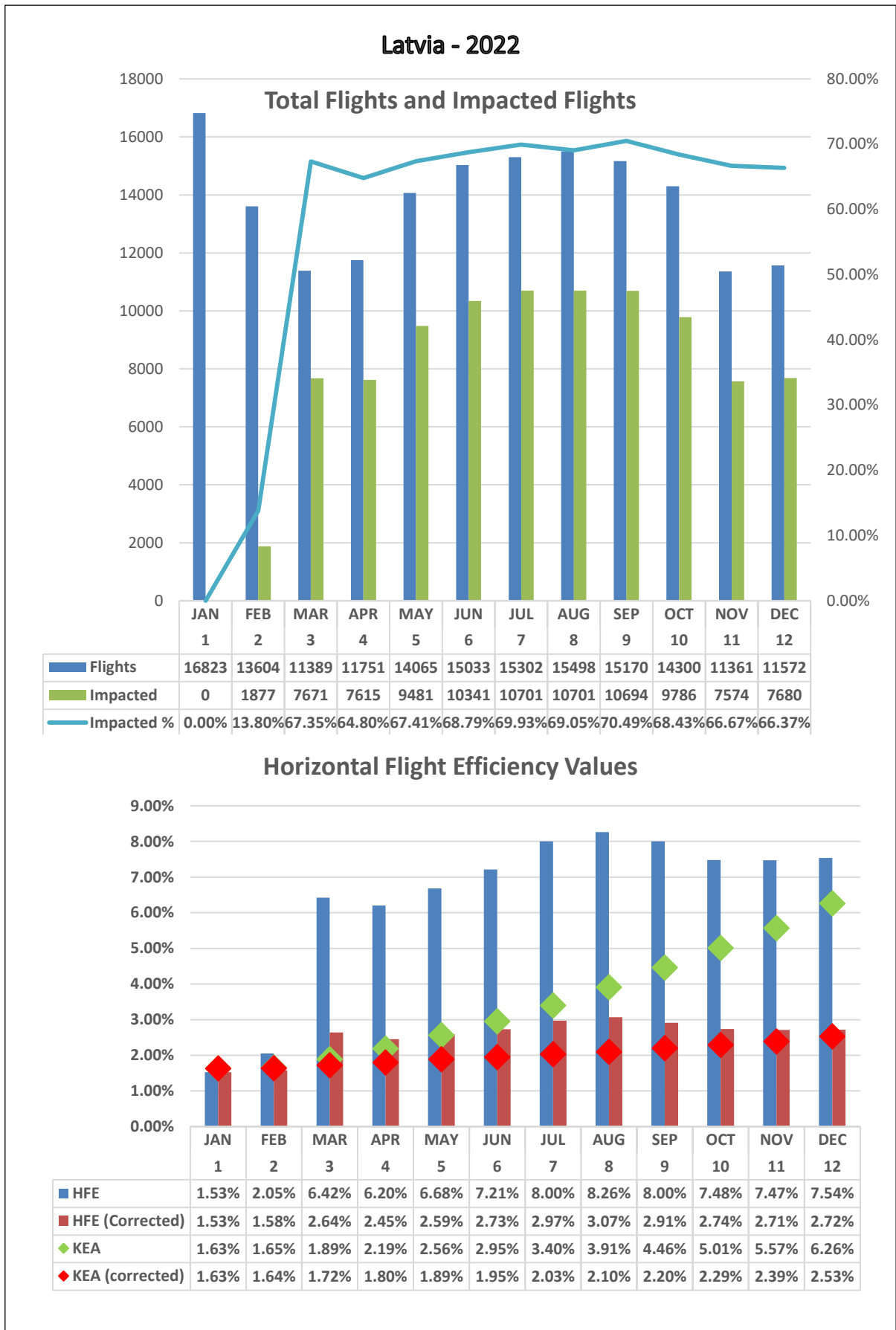




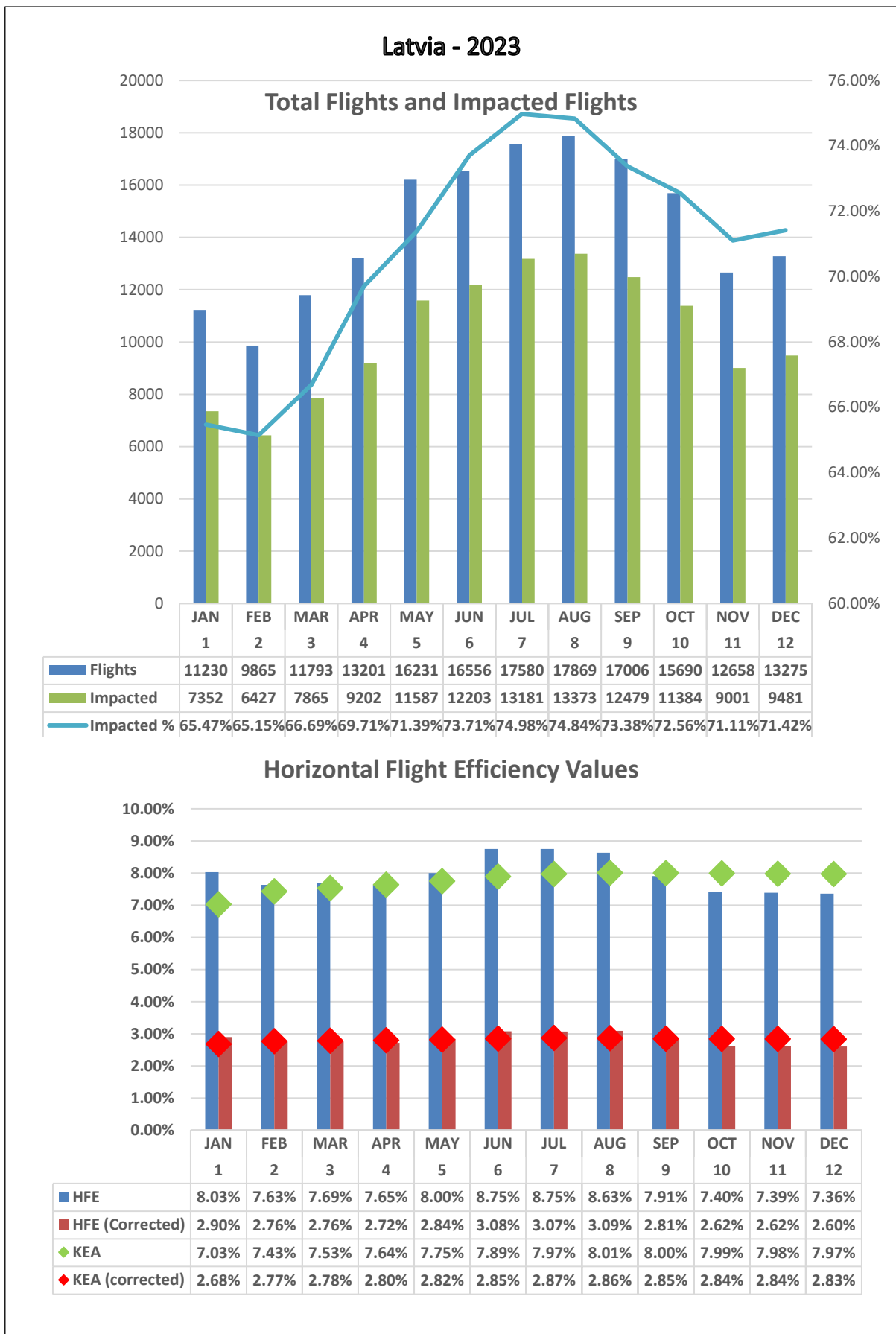
### 4.32 Italy 2023



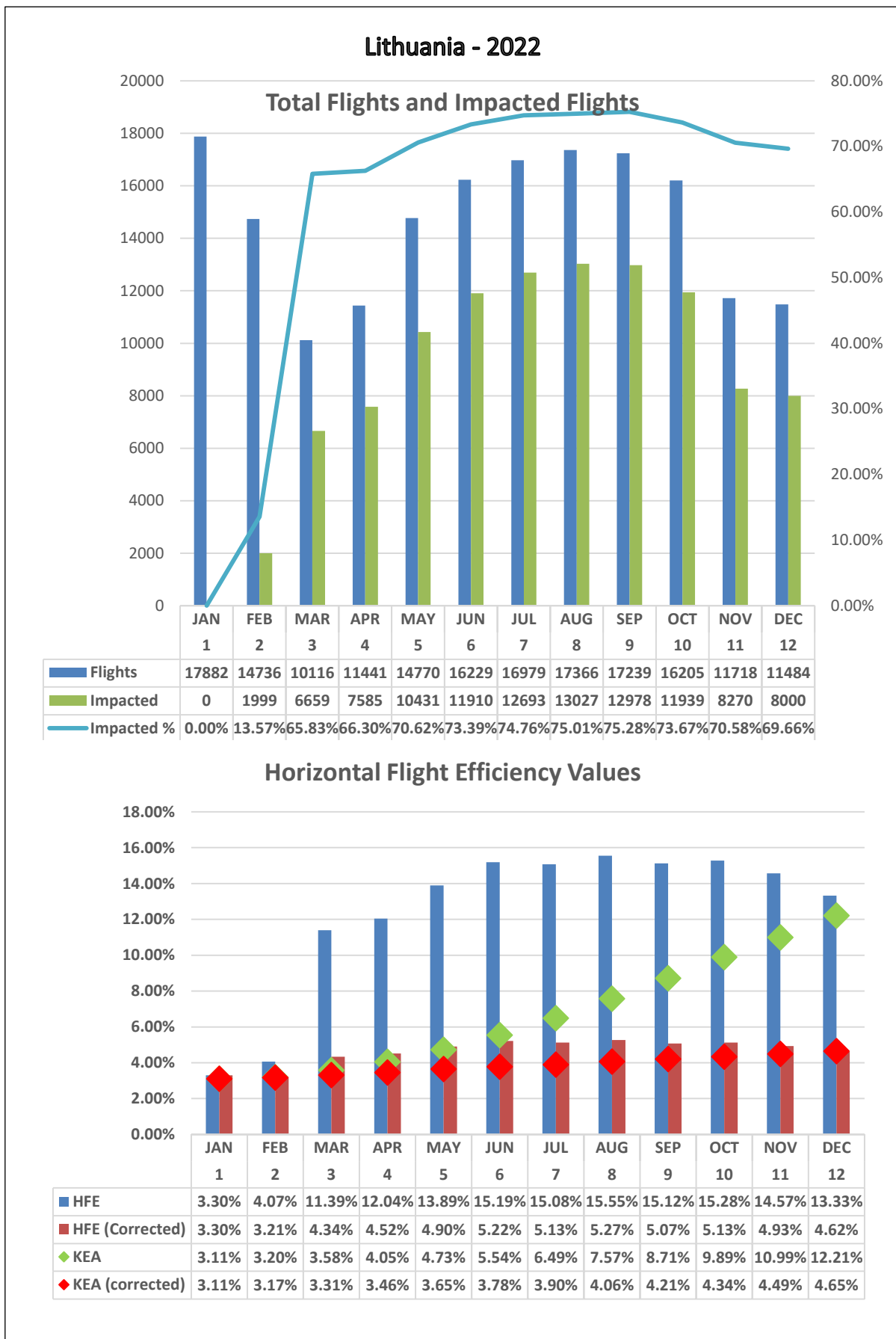
4.33 Latvia 2022



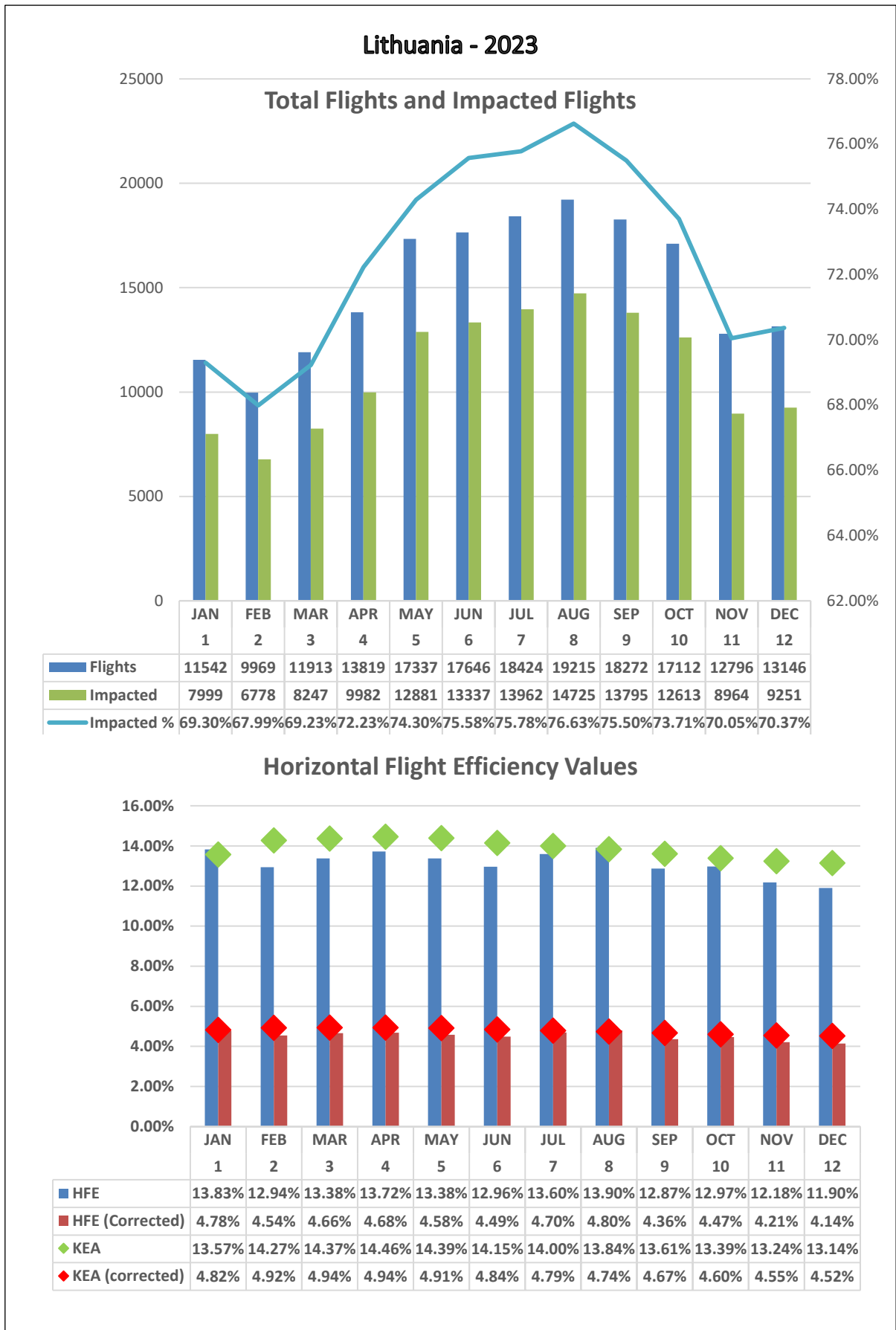
#### 4.34 Latvia 2023



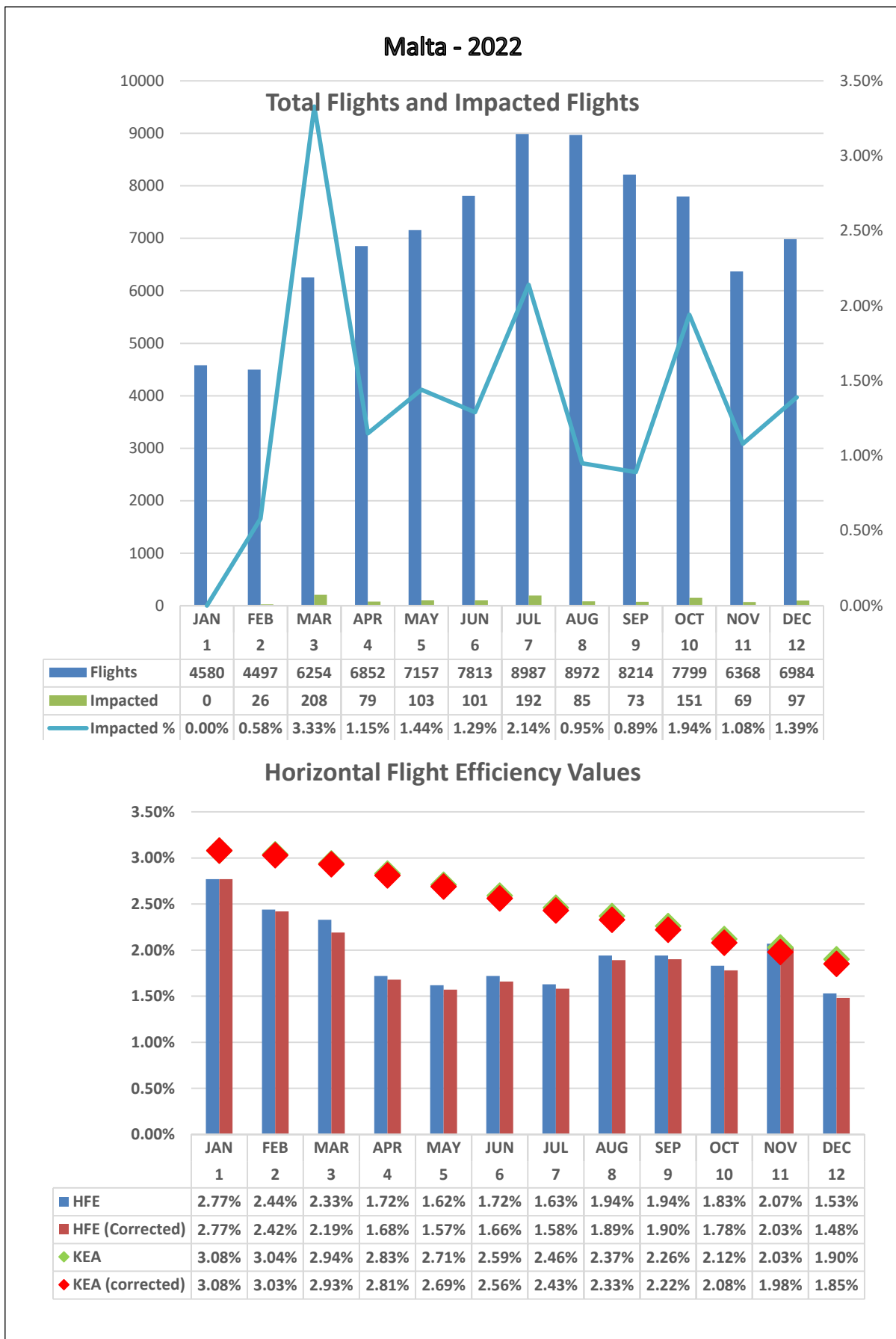
### 4.35 Lithuania 2022



4.36 Lithuania 2023



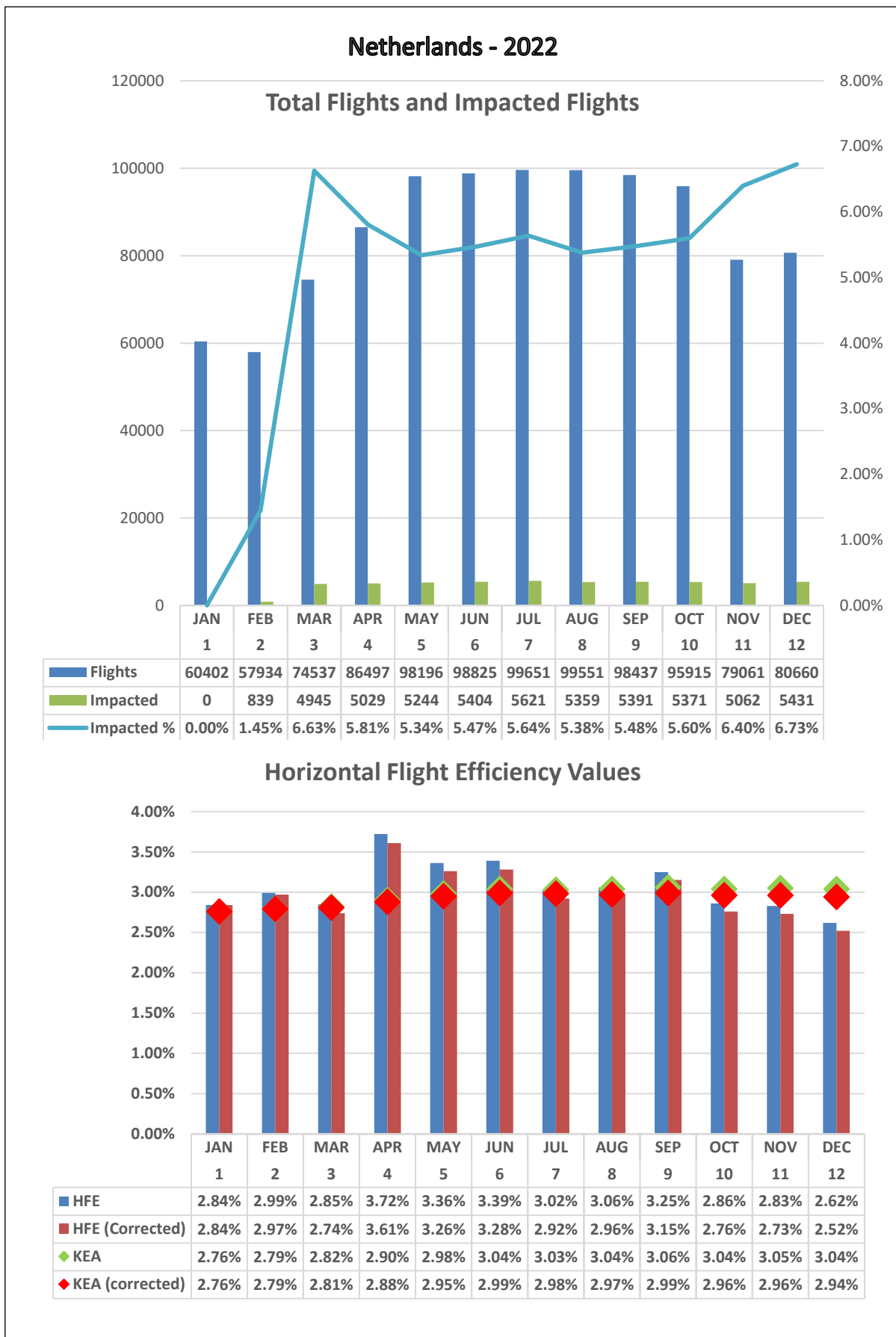
### 4.37 Malta 2022



4.38 Malta 2023

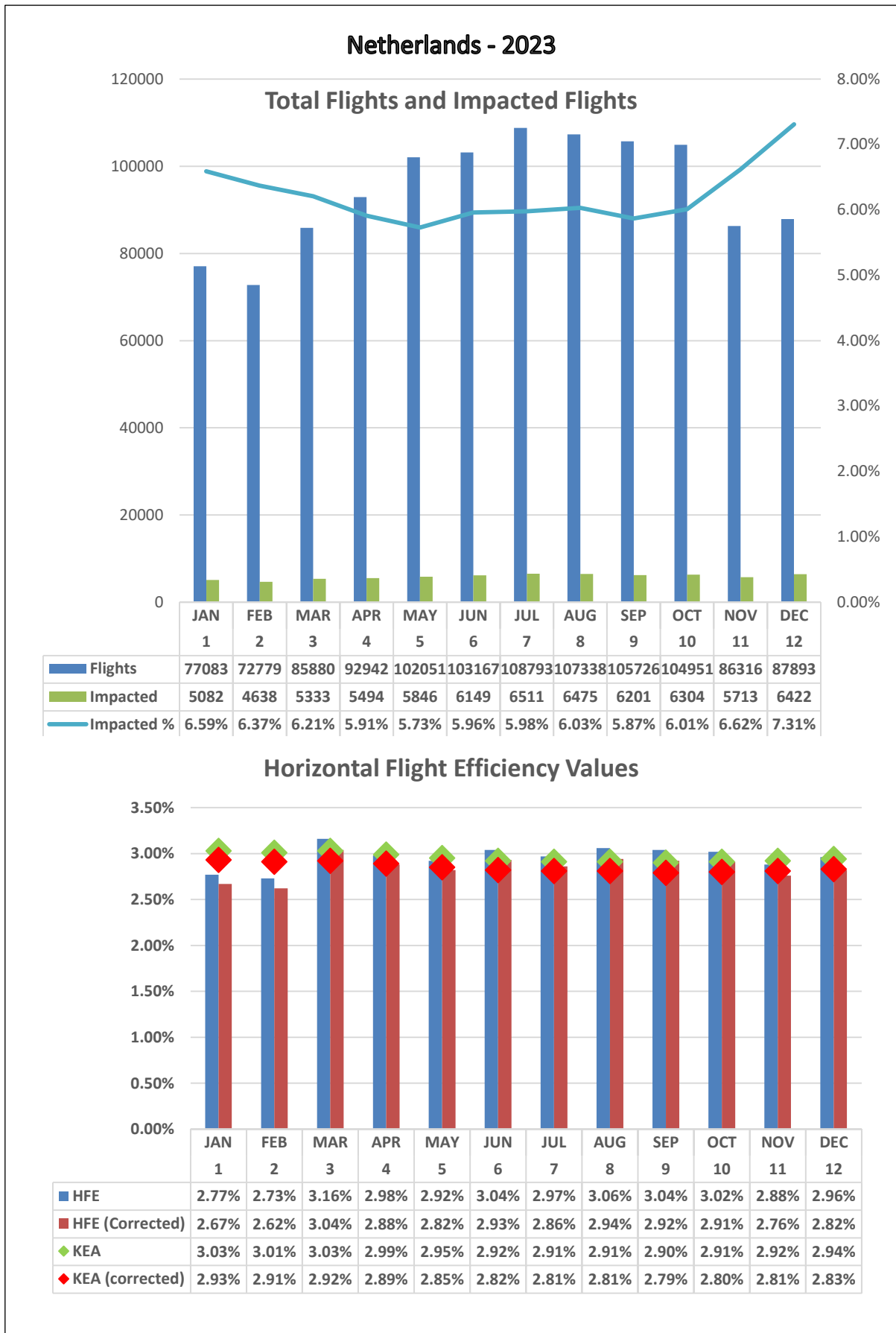


### 4.39 Netherlands 2022

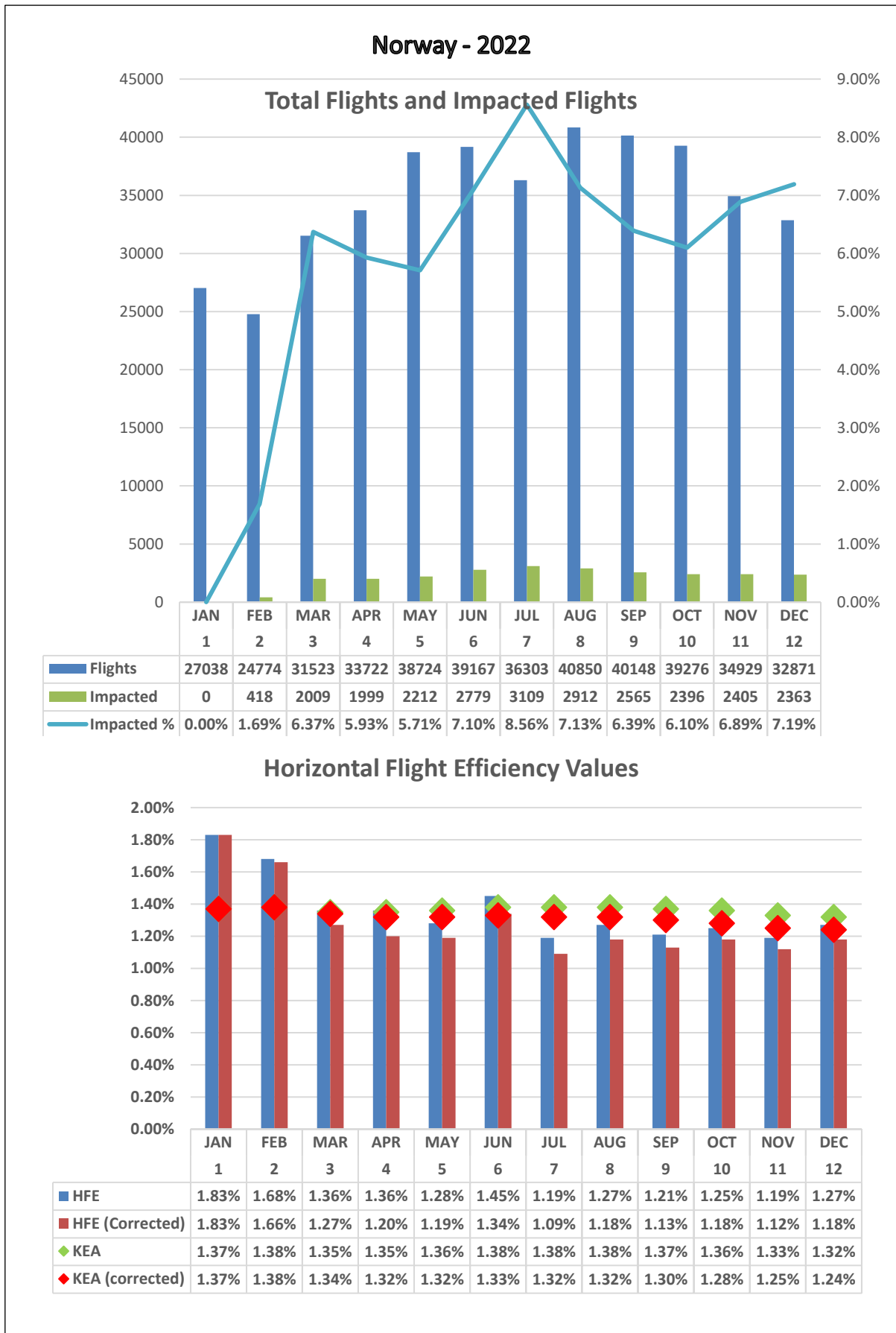




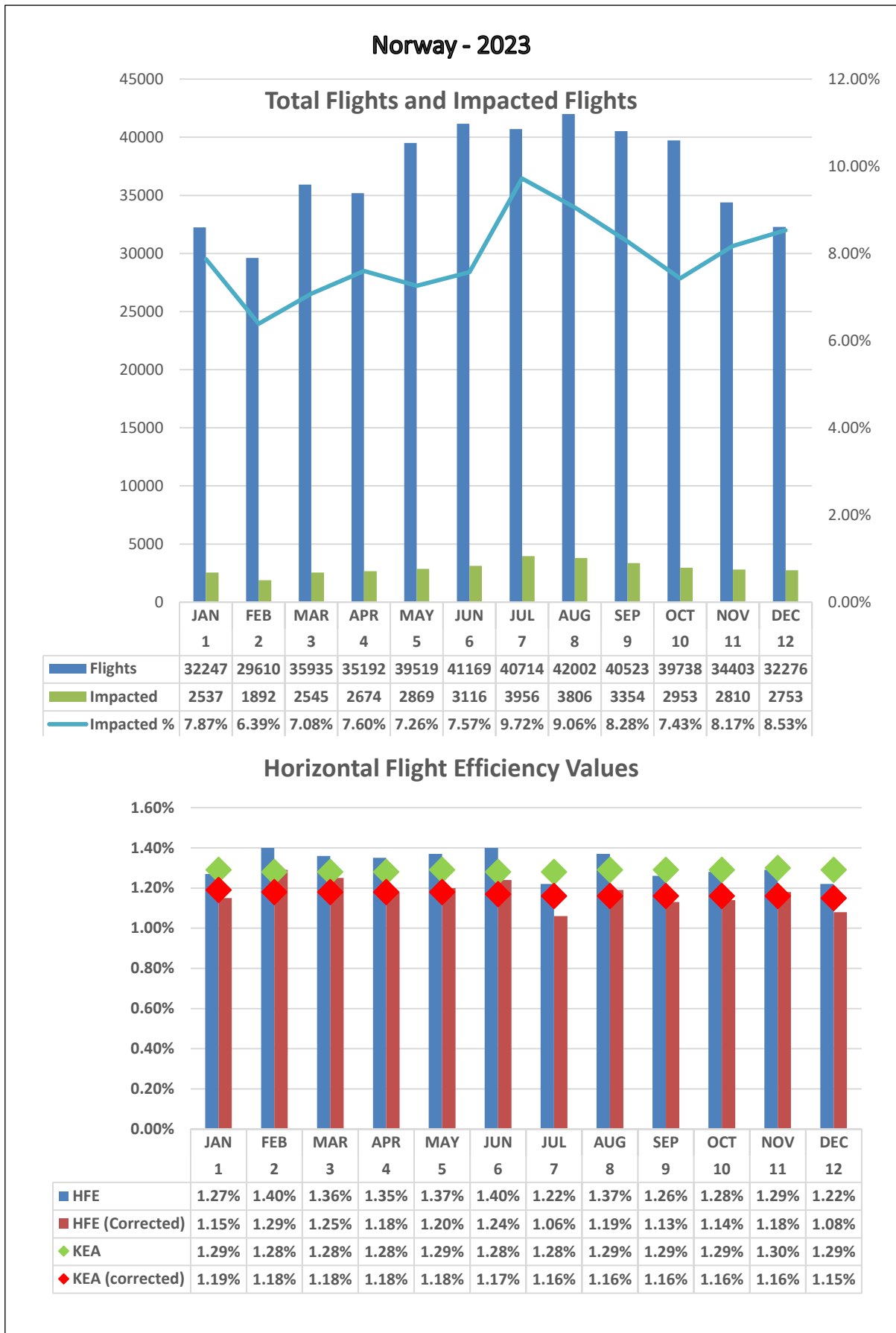
#### 4.40 Netherlands 2023



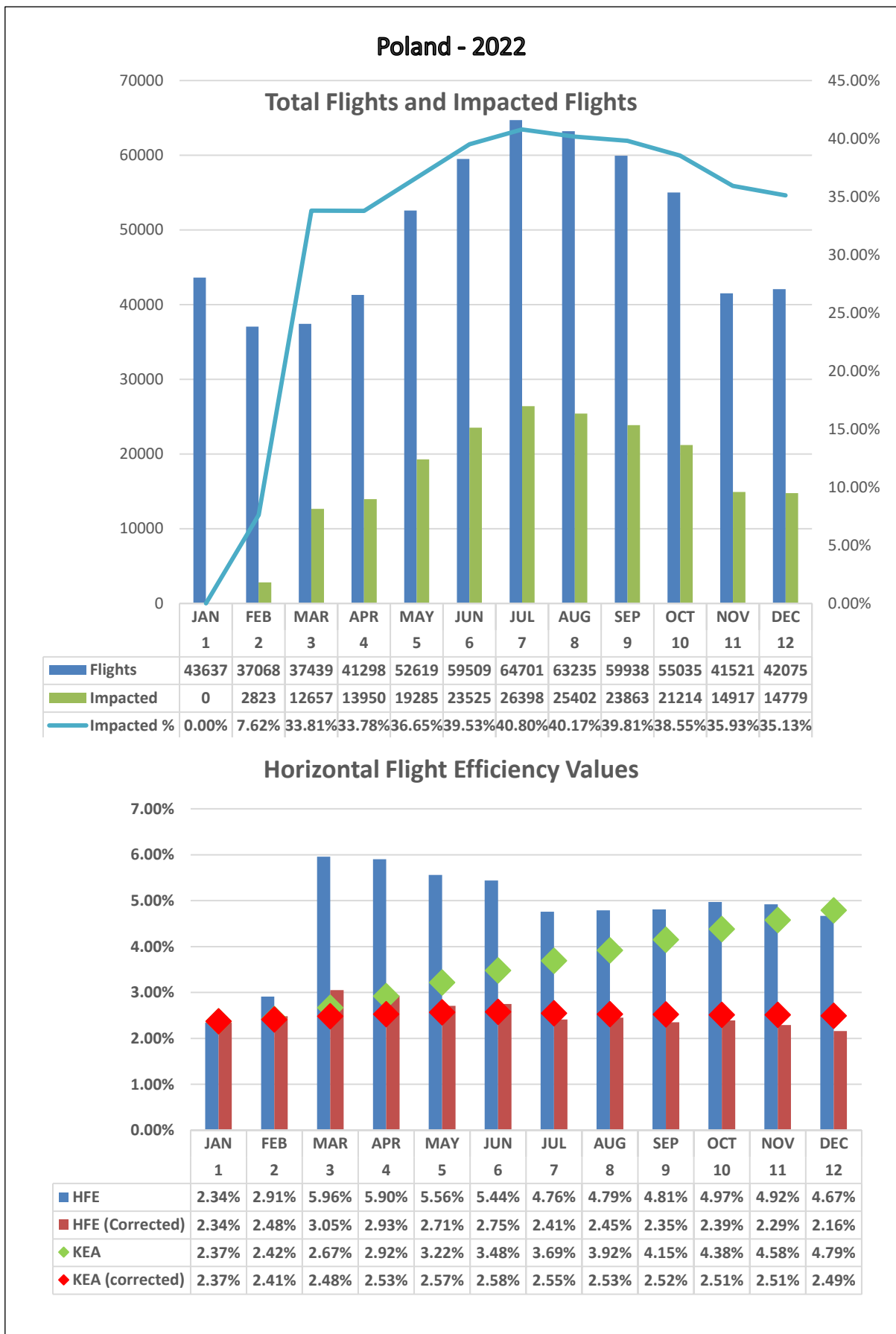
#### 4.41 Norway 2022



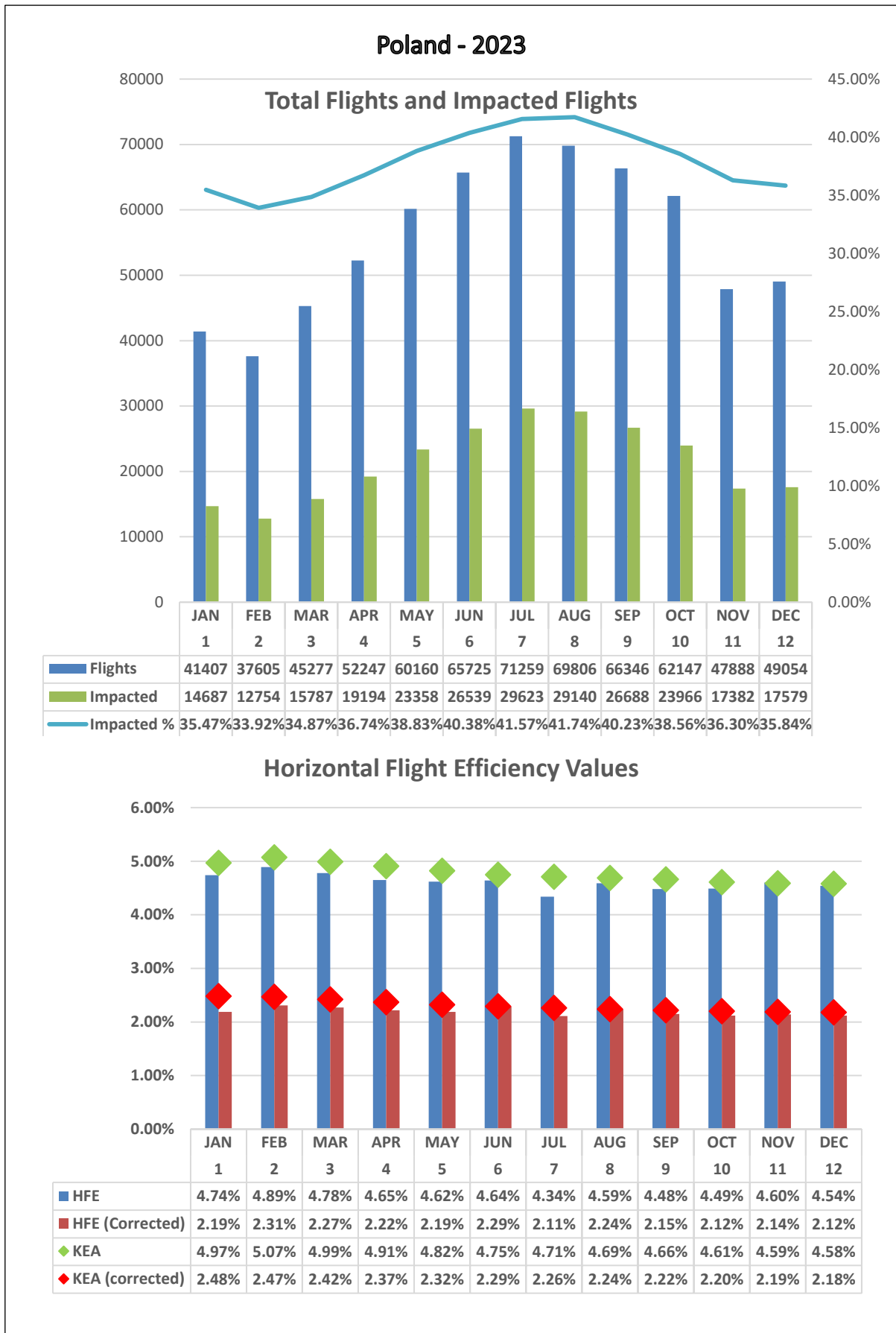
#### 4.42 Norway 2023



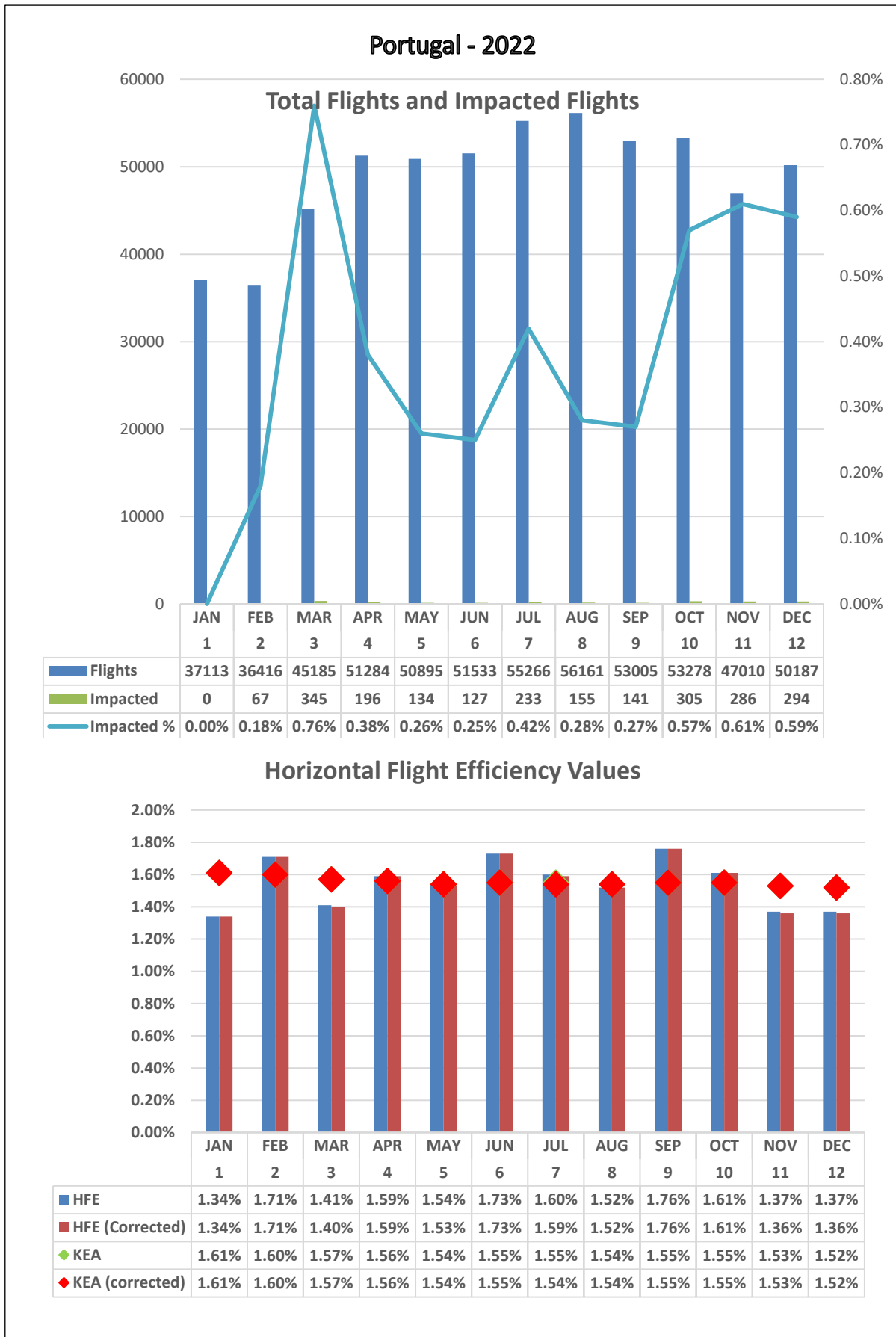
#### 4.43 Poland 2022



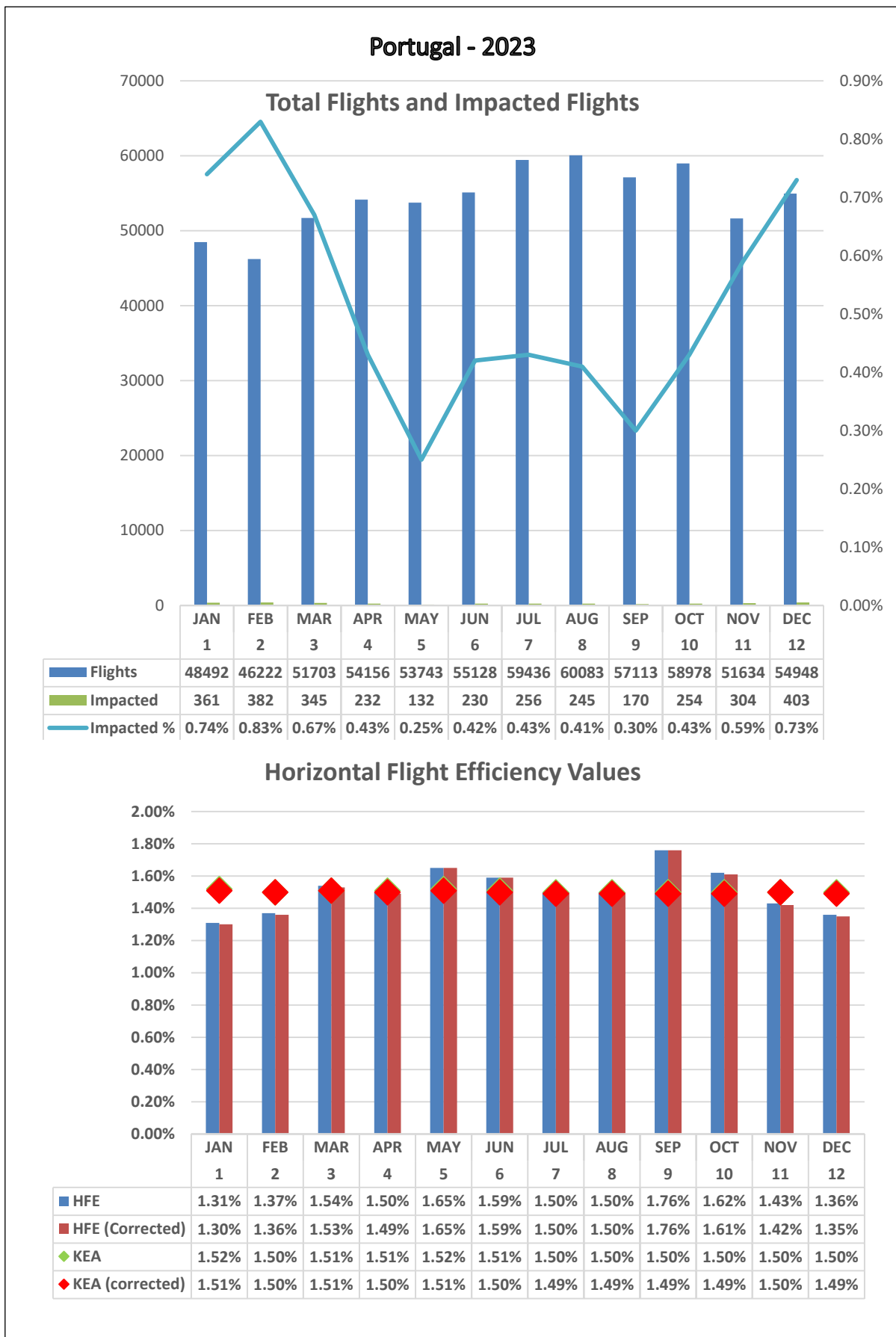
#### 4.44 Poland 2023



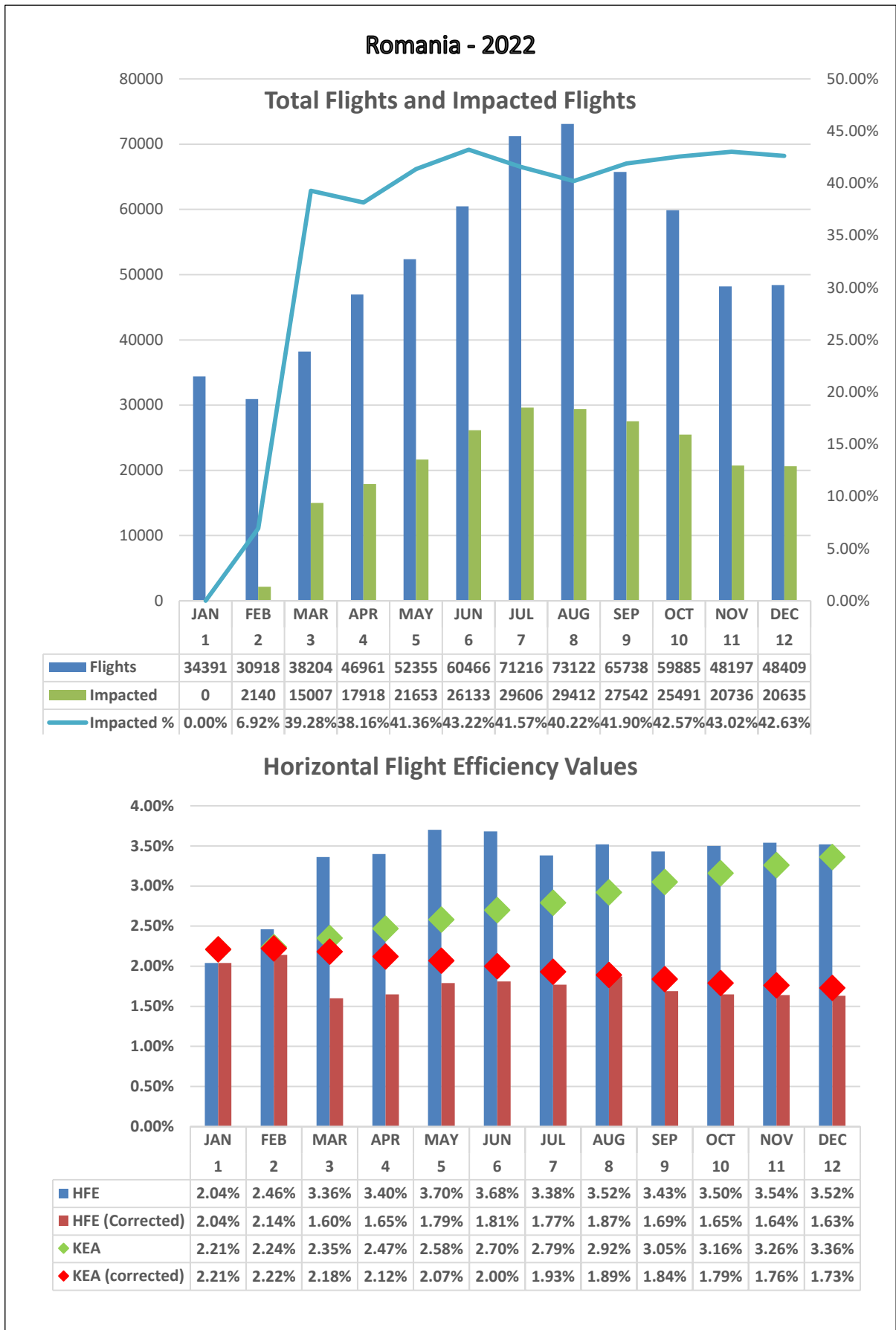
#### 4.45 Portugal 2022



#### 4.46 Portugal 2023

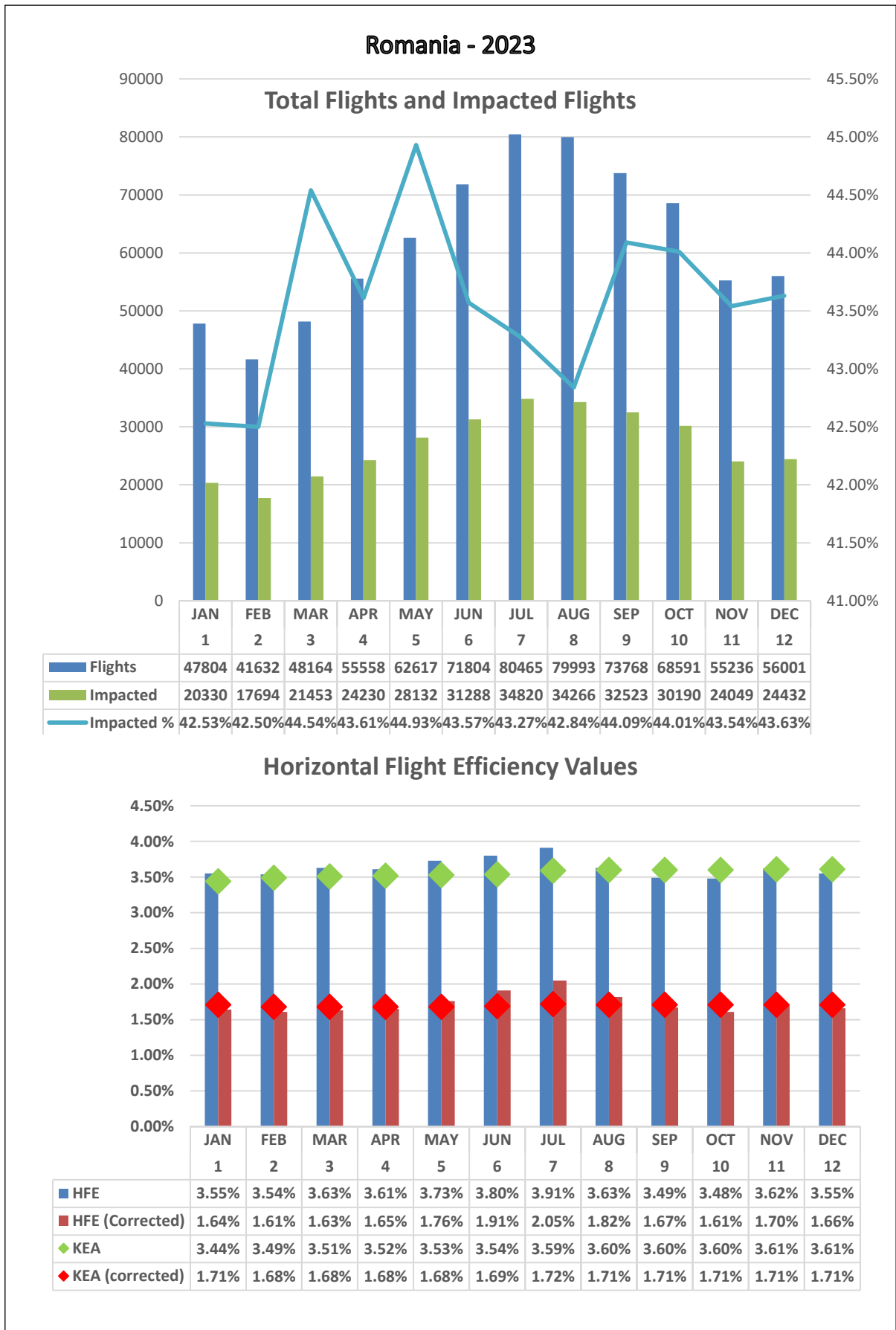


4.47 Romania 2022

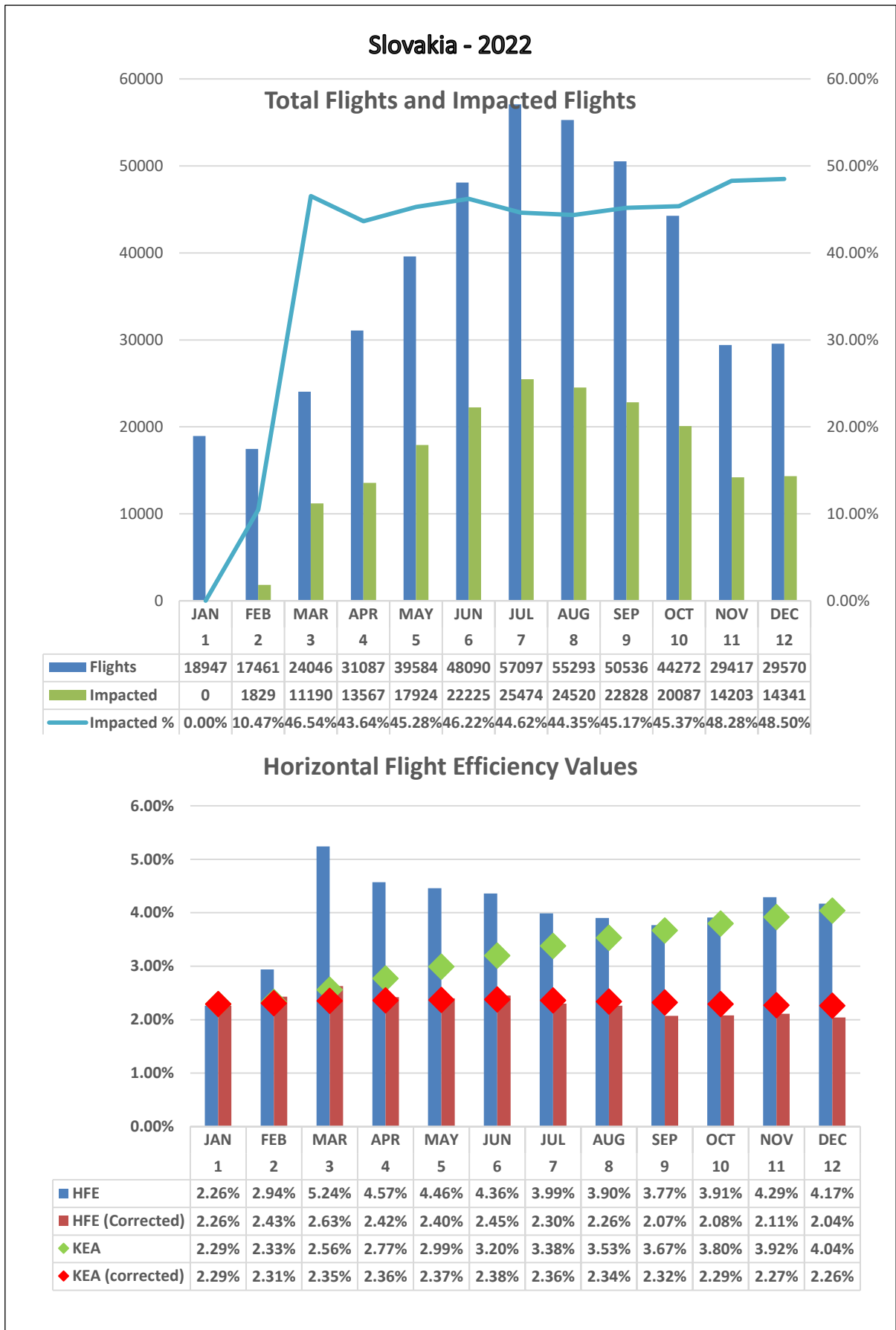




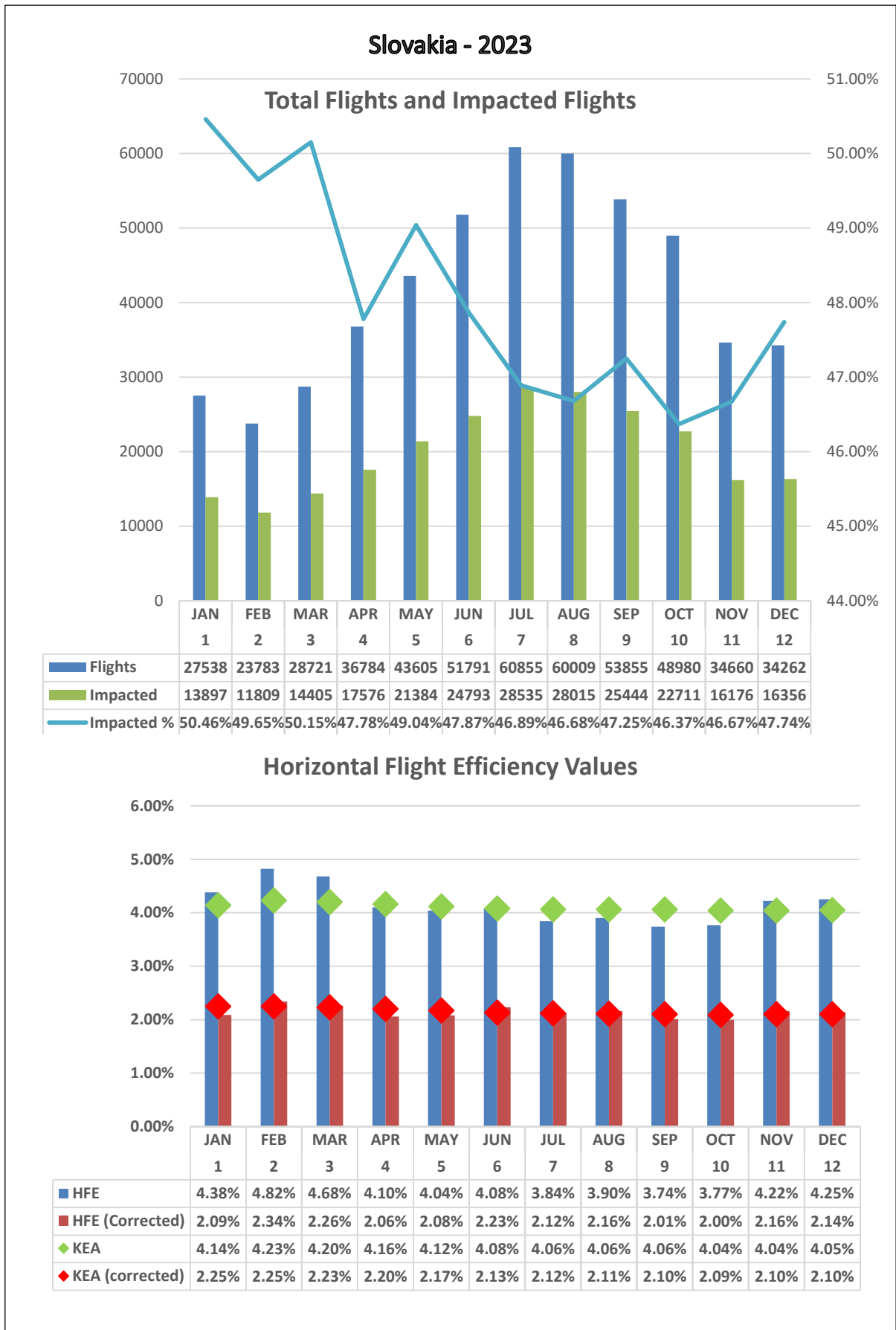
4.48 Romania 2023



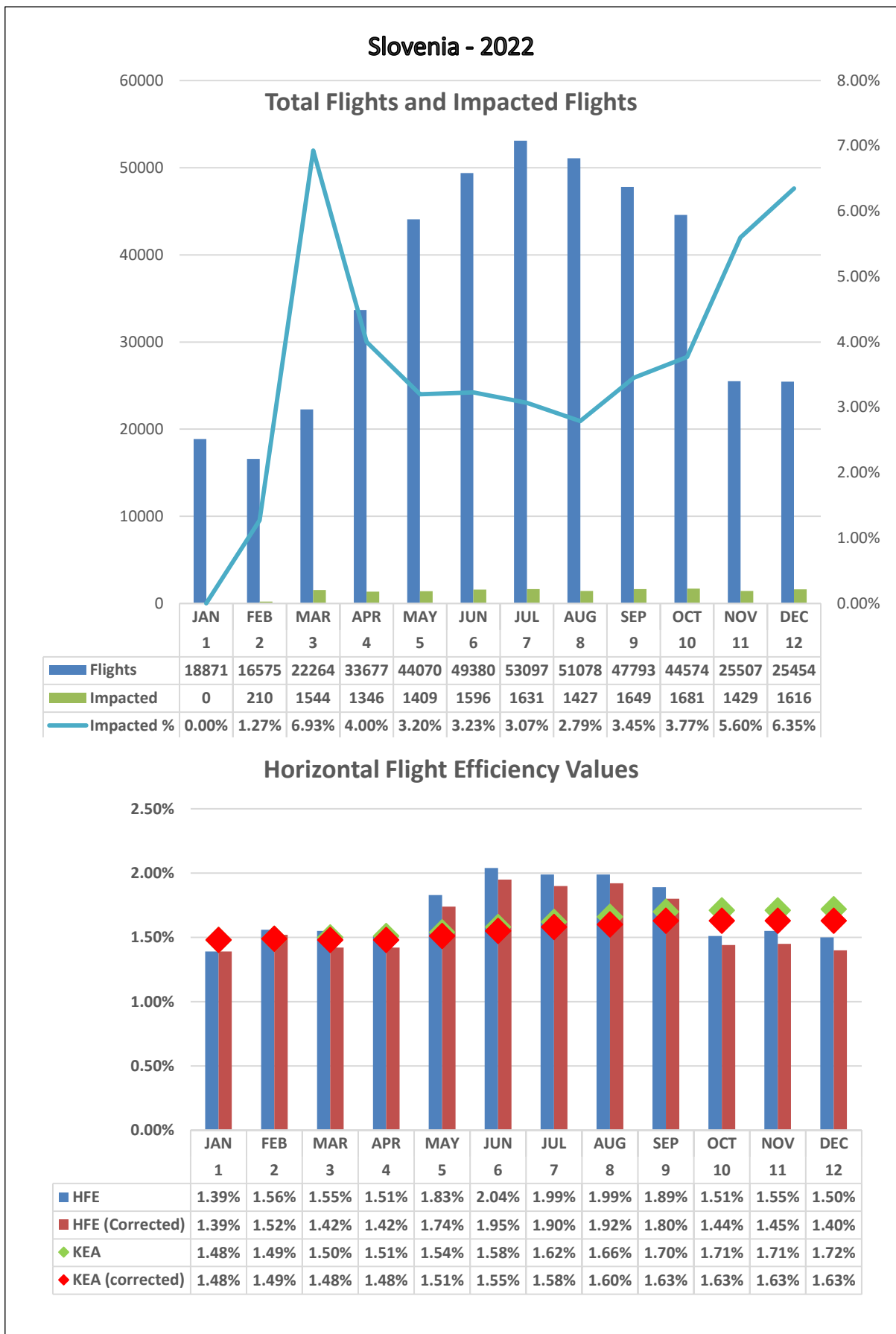
4.49 Slovakia 2022



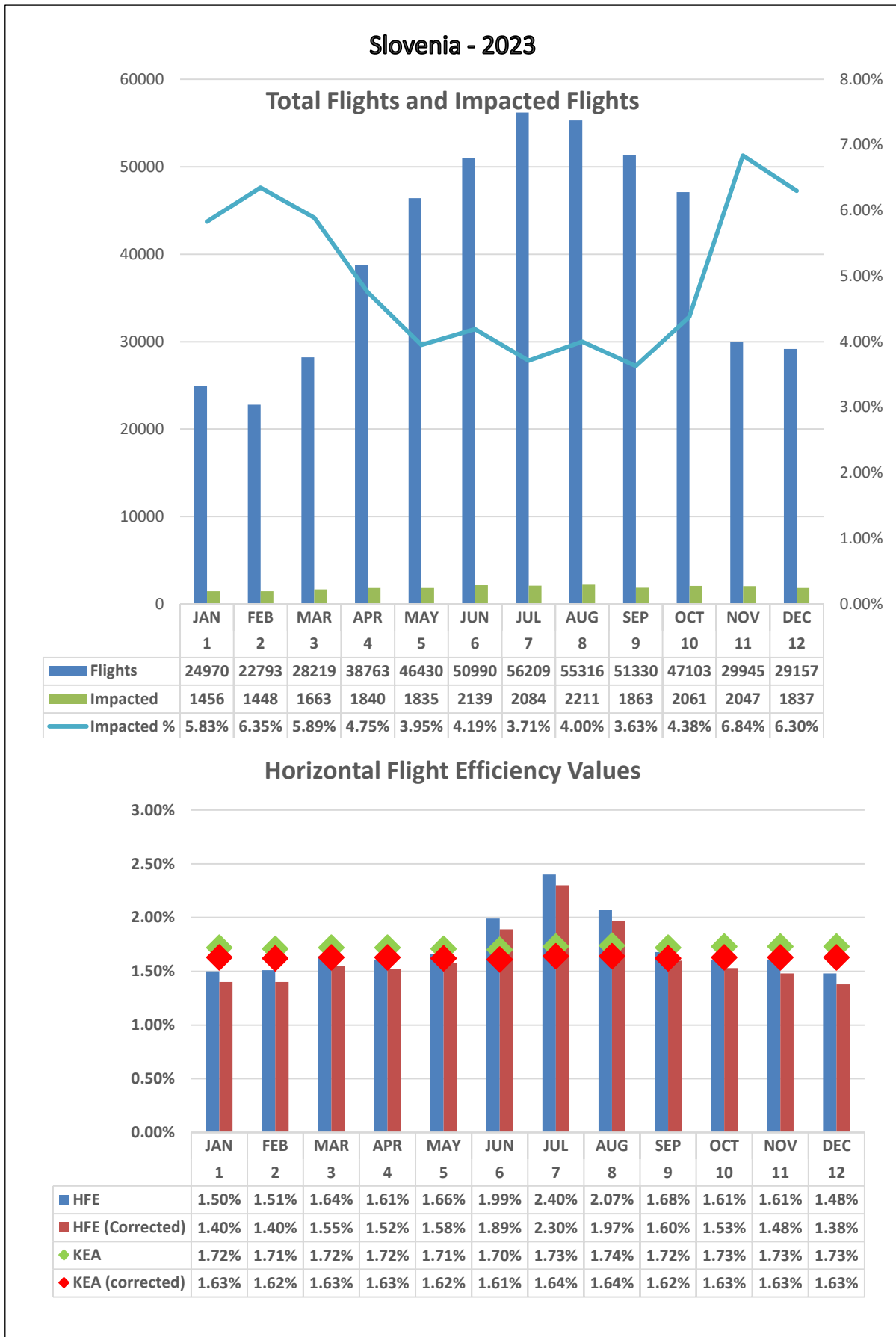
4.50 Slovakia 2023



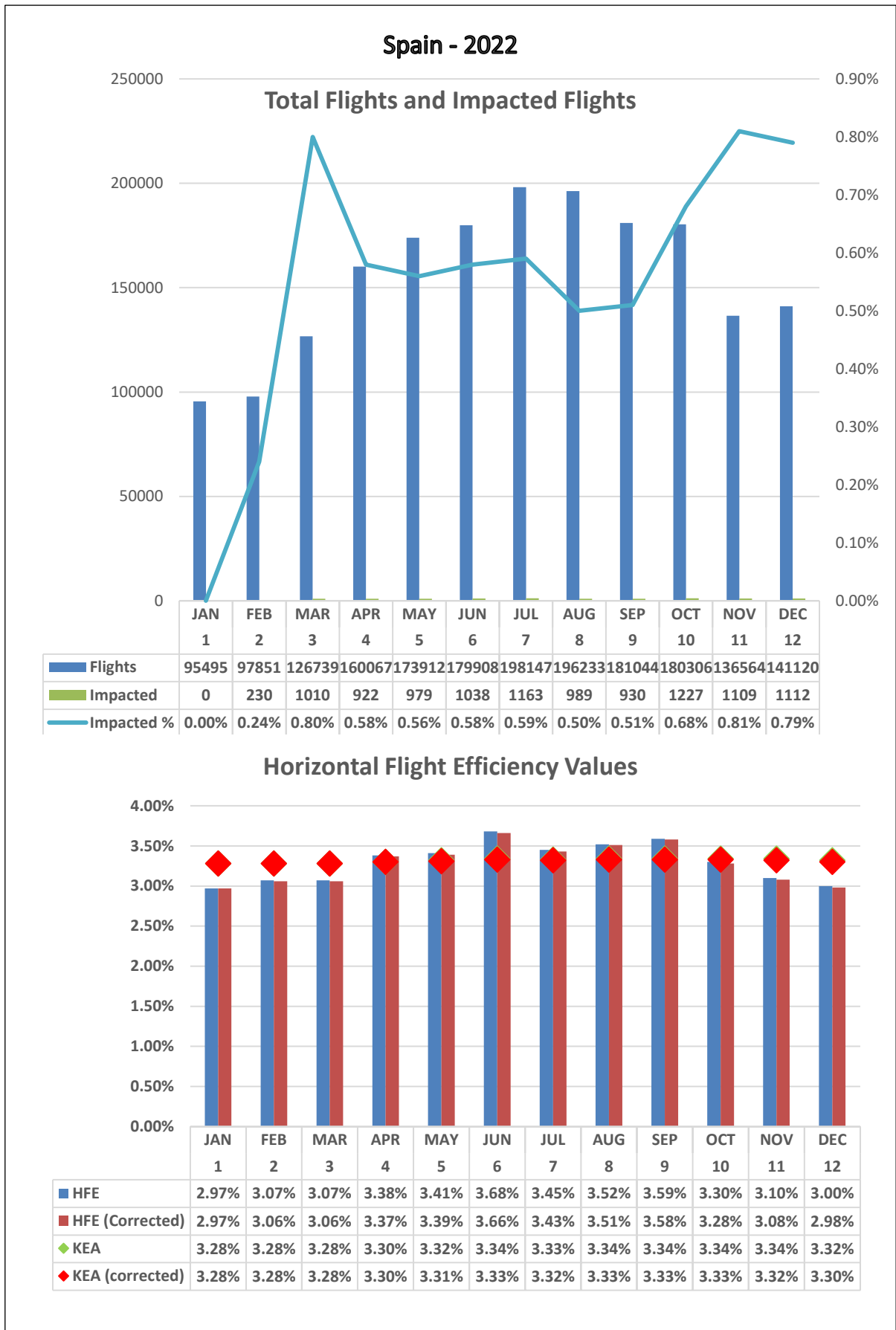
#### 4.51 Slovenia 2022



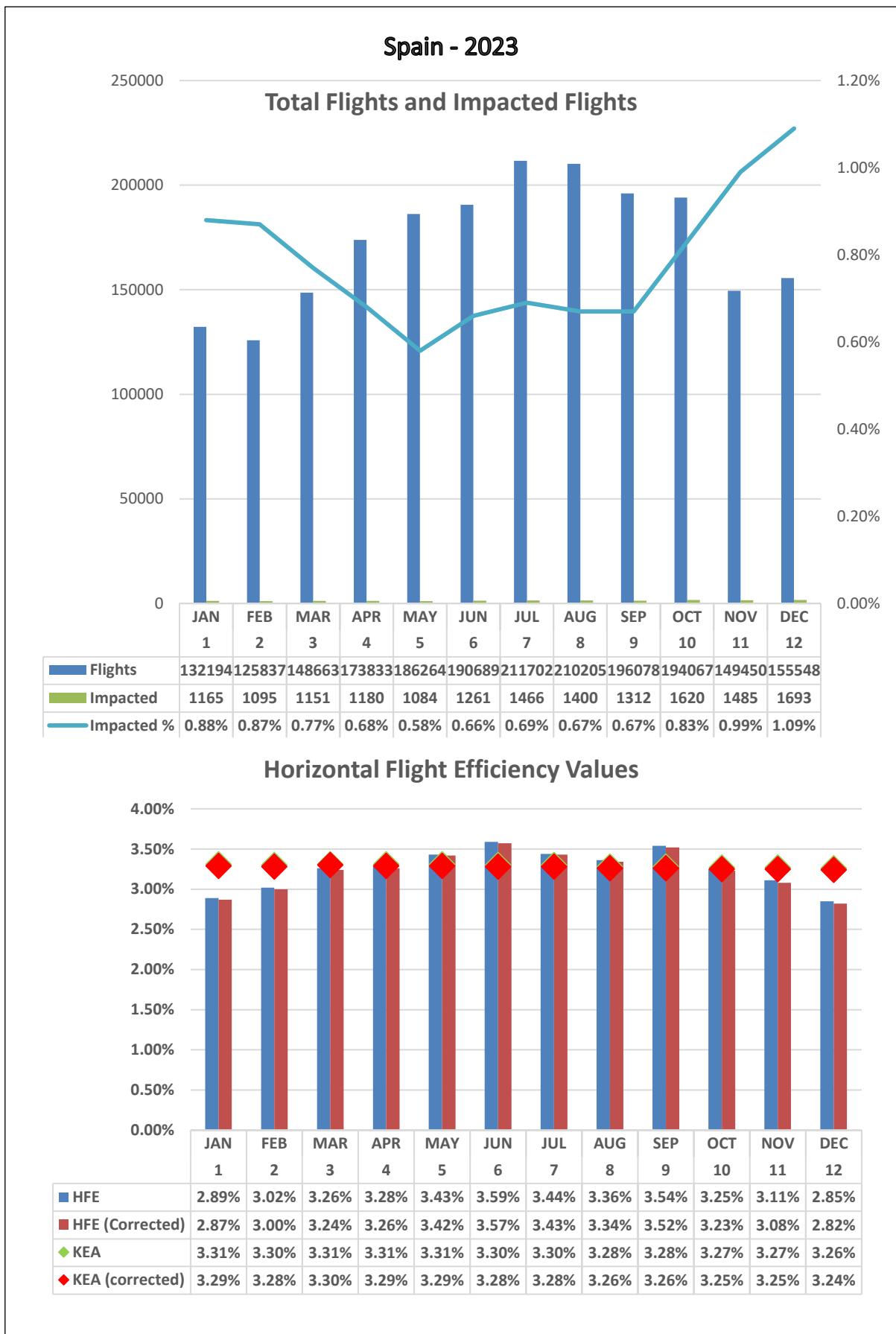
4.52 Slovenia 2023



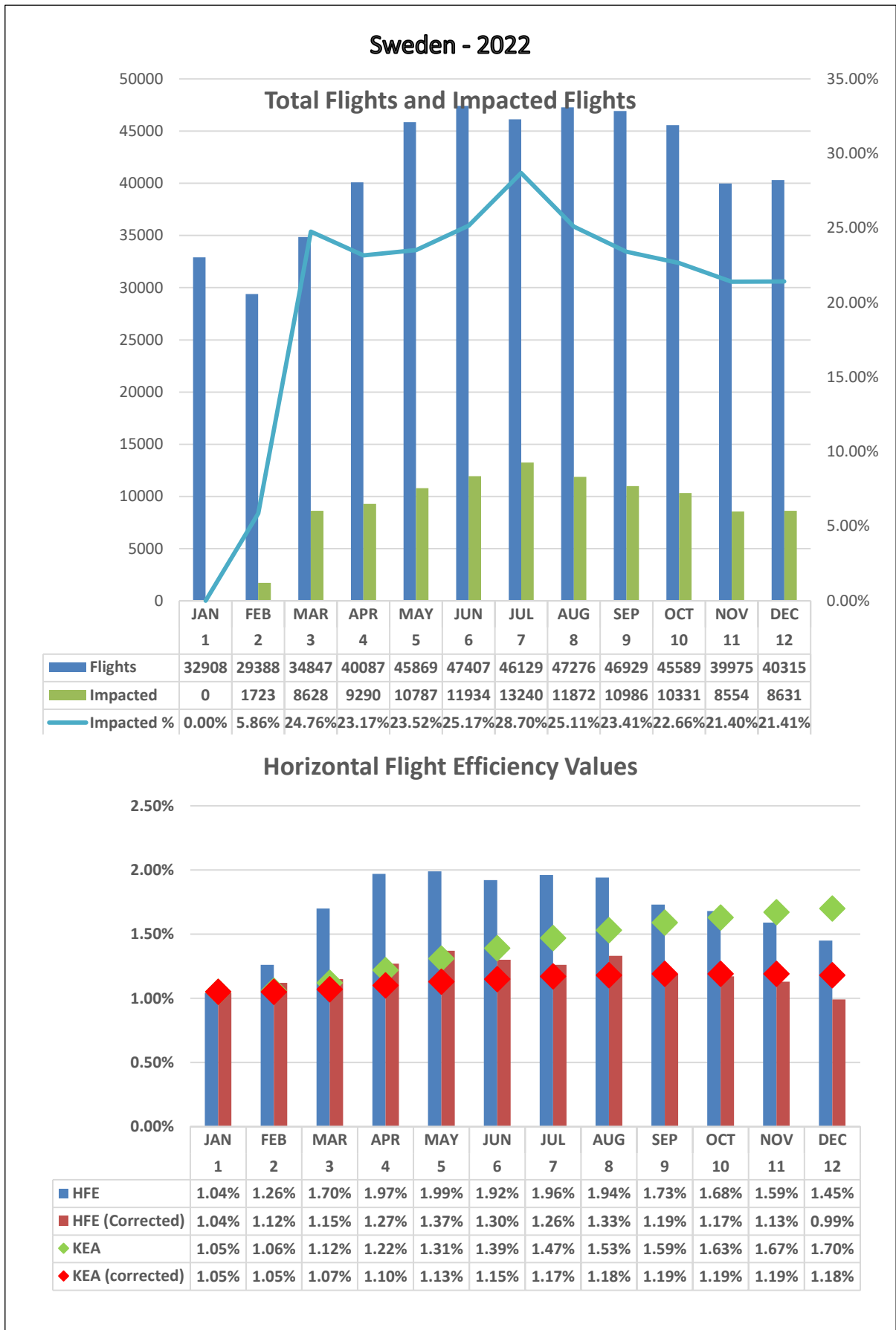
4.53 Spain 2022



#### 4.54 Spain 2023

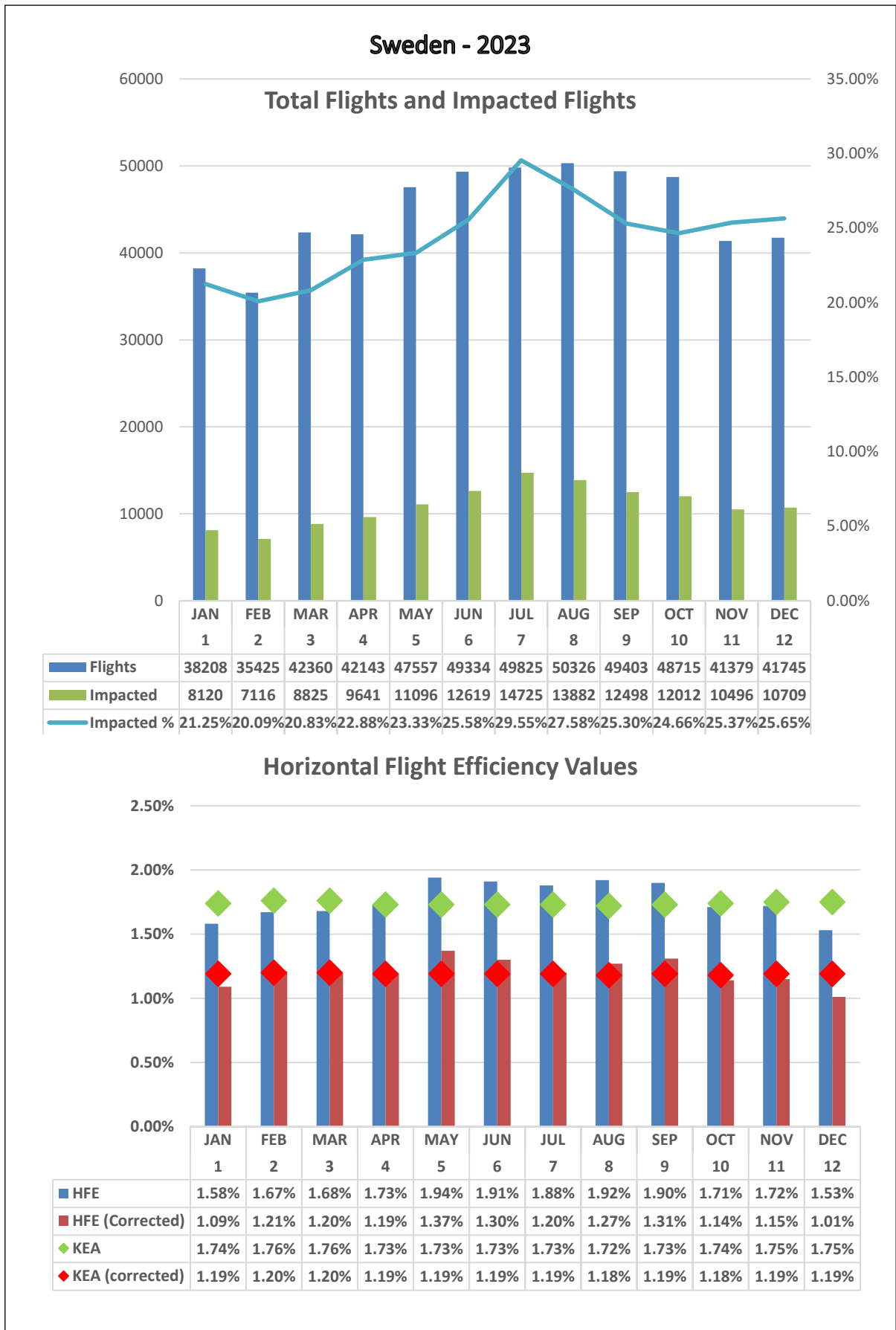


4.55 Sweden 2022

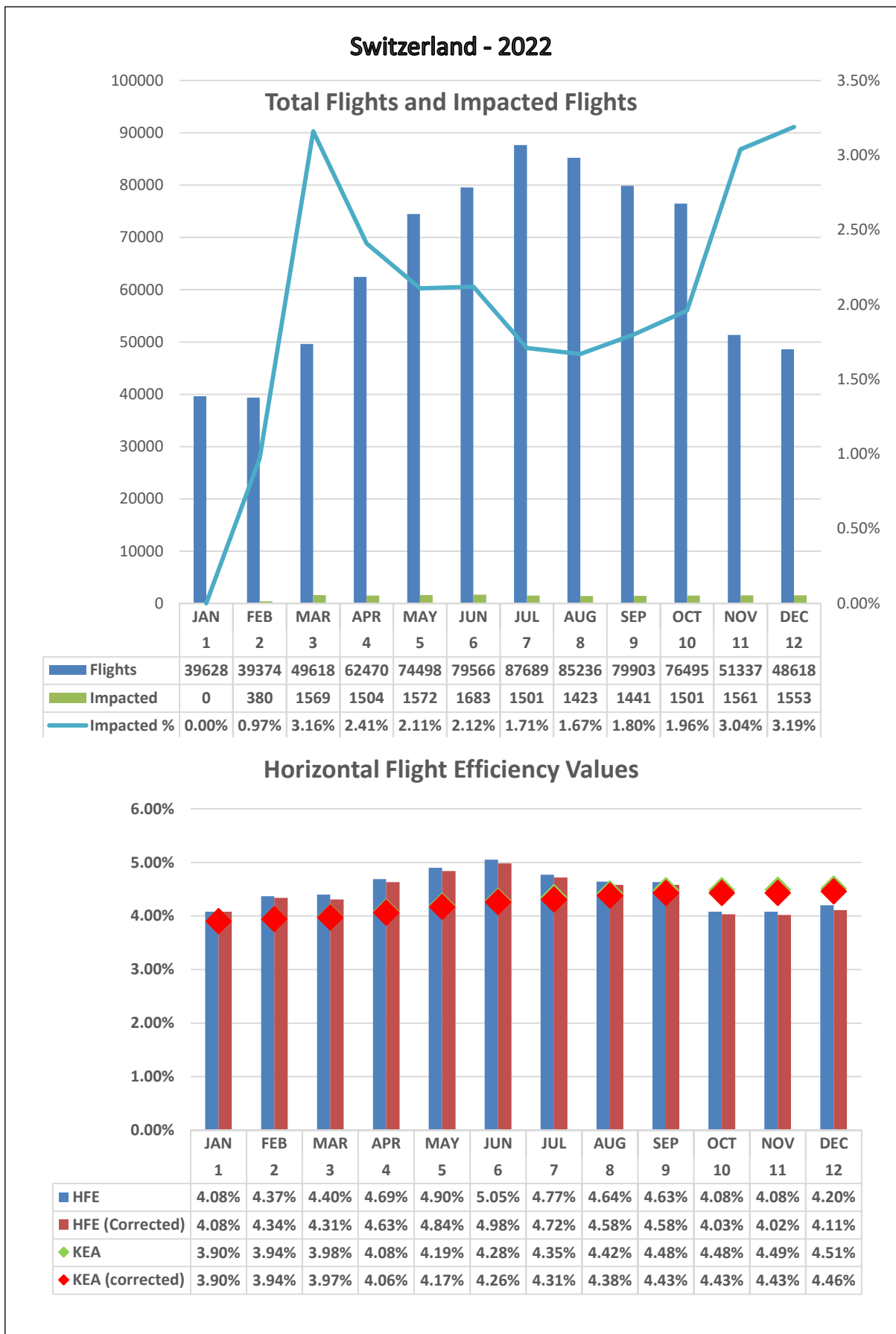




4.56 Sweden 2023



#### 4.57 Switzerland 2022



4.58 Switzerland 2023

