European Union Aviation Safety Agency

This project has received funding from the European Union's Horizon Europe Programme

RESEARCH PROJECT EASA.2022.HVP.01

D-3.3.2 - UNTAPPED BENEFIT OF FUEL REDUCTION SCHEMES: REVIEWING THE NPA-2016-06(A) ECONOMIC IMPACT ASSESSMENT

Digital transformation - Case studies for aviation safety standards – Data Science Applications (DATAPP)

An Agency of the European Union

Disclaimer

DELIVERABLE NUMBER AND TITLE:	DATAPP D-3.3.2 Untapped benefit of fuel reduction schemes
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DISTRIBUTION:	Public

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DATE: 30 September 2024

SUMMARY

Problem area

Data stays at foundation of decision-making, accelerating the digital transformation across industry. Strong data systems and new technology have been embraced in aviation with significant changes to the traditional working processes, business models, standards and regulations. In this context, EASA faces new challenges on what the required changes in safety standards and regulations are needed in response to the introduction of innovative solutions and processes. Anticipating what is to come in the industry in the field of data science applications is key to make sure safety levels are maintained without slowing innovation down.

The objective of this project is to identify and assess relevant changes to the existing aviation safety standards to support the deployment of the digital solutions under three case studies:

- Case Study 3: Flight training data for EBT/CBTA (Evidence-Based Training / Competence-Based Training and Assessment).
- Case Study 4: Digital fuel management.
- Case Study 5: Flight data models for safety.

The project aims to provide a comprehensive evaluation of benefits, constraints, standardisation and deployment issues, including the recommendations for adjusting safety regulations and related standards, and how new digital technologies could contribute to addressing the identified issues.

Description of work

This report belongs to the task "T-3.3 - Training material" of the "Digital Transformation – Case Studies for Aviation Safety Standards" project (EASA.2022.HVP.01- Horizon Europe Project). The purpose of this deliverable is to provide dissemination material designed to concretize some of the solutions identified within the project's context, particularly those that could represent potential quick-wins. This material aims to offer initial and independent reflections from the consultant, serving as a foundational resource for future initiatives by the Agency and the industry. By outlining these actionable insights, the document seeks to stimulate further exploration and implementation of effective strategies, ultimately contributing to the advancement and innovation within the sector.

Results and Application

The report delves into one of the solutions proposed in the context of the project, providing further details and a series of recommendations that could be applied to achieve an effective implementation of the solution. All of this is collected and provided in the form of training materials. Such training materials are intended to be used at EASA's discretion, for instance by including it in dissemination documents or in guidance material to help in the potential implementation of the solutions by the stakeholders. Thus, the output of this material provides additional information to EASA to support their decision on the evolution of the solutions proposed in the context of this project.

CONTENTS

ABBREVIATIONS

ACRONYM	DESCRIPTION
ACARS	Aircraft Communication Addressing and Reporting System
AMC	Acceptable Means of Compliance
AOC	Air Operator Certificate
ATO	Approved Training Organisations
AU	Airspace Users
CAT	Commercial Air Transport
CBTA	Competency-Based Training and Assessment
CS	Case Study
D4S	Data4Safety
EAA	European Aviation Authorities
EAFDM	European Authorities Flight Data Monitoring forum
EASA	European Union Aviation Safety Agency
EBT	Evidence-Based Training
ECA	European Cockpit Association
EOFDM	European Operators Flight Data Monitoring forum
FDAU	Flight Data Acquisition Unit
FDM	Flight Data Monitoring / Management
FDX	Flight Data Exchange
FSF	Flight Safety Foundation
GM	Guidance Material
IATA	International Air Transport Association
IFALPA	International Federation of Air Line Pilots' Associations
KPI	Key Performance Indicator
LFL	Logical Frame Layout
LOSA	Line Operations Safety Audit
MRO	Maintenance, Repair and Overhaul
NAA	National Aviation Authority
NOTAM	Notice To Airmen
OEM	Original Equipment Manufacturer
QAR	Quick Access Recorder
SMS	Safety Management System
SPI	Safety Performance Indicators
SRM	Safety Risk Assessment
UC	Use Case

1. Introduction

1.1 Scope of the document

This report represents one of the deliverables under the task "T-3.3 Training material" of "Digital Transformation – Case Studies for Aviation Safety Standards" project (EASA.2022.HVP.01- Horizon Europe Project). D-3.3 is complemented by 5 (five) individual deliverables covering the different case studies of the project, presented in Table 1-1 below.

Table 1-1 List of deliverables as D-3.3

Deliverable		Title	Case Study
D – 3.3	D-3.3.1	Standardised metrics and methods for instructor concordance assurance	CS3 - EBT
	D-3.3.2	**Untapped benefit of fuel reduction schemes: Reviewing the NPA-2016-06(A) economic impact assessment**	**CS4 - Fuel**
	D-3.3.3	Recommendations on assurance framework for analytical development and approval of fuel schemes	
	D-3.3.4	Training requirements for FDM analyst	CS5 - FDM
	D-3.3.5	Development of industry-agreed FDM algorithms and logics	

Within the context of the DATAPP project, the D-3.3.x deliverables are intended to provide dissemination material designed to concretise some of the solutions proposed during the project, particularly those that could represent potential quick-wins. Such materials are intended to be used at EASA's discretion, for instance by including it in dissemination documents or in guidance material.

This deliverable "D-3.3.2 - Untapped benefit of fuel reduction schemes: Reviewing the NPA-2016-06(A) economic impact assessment" focuses on replicating the economic impact assessment within the Regulatory Impact Assessment (RIA) performed by EASA in the context of the published NPA-2016-06 (A), specifically considering updated market figures and drivers. This update has been performed with the aim of having a vision or estimate adapted to the current reality regarding the possible fuel reductions that could be achieved through the variations implemented through the fuel schemes. In addition, the intention is to identify and estimate the current status of the implementation and application of these fuel reductions among operators to define the gap between what is currently in place and what could be achieved.

The present document is structured as follows:

- Section 1 presenting the scope of the document and the structure of the research.
- Section 2.1 as an introduction presenting the background scope of the document, including the rationale and the objective of the document.
- Section 2.2 presents an overview of the methodology followed for performing the study.
- Section 2.3 presents the main potential benefits to be achieved through the implementation of the fuel schemes.
- Section 2.4 provides a proposal of the mechanisms that could be used to activate fuel reductions.

- Section 3 includes the conclusions where the results of this deliverable have been summarised.
- Section 4 lists the reference material that have been used as a reference for developing this document.
- Annex A includes the table regarding the details of the fuel consumption and fuel burn estimates for short/medium flights, which has been considered for the study.
- Annex B includes the table regarding the details of the fuel consumption and fuel burn estimates for long-haul flights, which has been considered for the study.

2. Untapped benefit of fuel reduction schemes: Reviewing the NPA-2016-06(A) economic impact assessment

2.1 Background

2.1.1 Issue / rationale

In 2015, the European Union Aviation Safety Agency (EASA) initiated the Rule Making Task RMT.0573 'Fuel procedures and planning' to align its fuel management provisions with new ICAO standards (ICAO Doc 9976 Flight Planning and Fuel Management). This initiative resulted in a new European fuel policy with various performance-based schemes or levels of variations. The latest regulation, effective from 30th October 2022, provides flexibility to operators in their fuel management policies, allowing them to apply specific fuel reductions, with the consequential opportunity to reduce CO2 emissions and environmental impact. This new framework also offers significant efficiency gains and cost savings for operators. EASA's fuel schemes' concept introduces three frameworks for fuel/energy planning: a basic fuel scheme, which is mandatory, and two advanced schemes that are voluntary and offer increased flexibility, which are optional and represent an upgrade or evolution from the basic scheme. By establishing these progressive schemes, it is ensured that operators adopt suitable fuel strategies and a fuel scheme adapted to their operator control capabilities, enabling incremental benefits and flexibility once given the adoption of advanced digital fuel monitoring and management systems and solutions. In other words, they provide a bigger opportunity to reduce fuel consumption but take more resources to implement as they required enhanced digital capabilities from the airlines. It is important to highlight that, while these solutions can improve fuel control and optimisation, the need to ensure that an equivalent level of safety standards are maintained should never be neglected, guaranteeing sufficient fuel for unforeseen events such as approach delays or adverse weather conditions.

In the context of the DATAPP project, the key limitations concerning the analytical processes involved in the implementation and application of the fuel schemes have been identified from the perspective of both the operators and other key stakeholders such as authorities and digital solution providers. As a result of the collaboration through several interviews with these key stakeholders, the different digital-related challenges and limitations that they face in this area have been identified, and a series of solutions have been proposed for addressing these limitations. All of this is reflected in the "D-2.1 Development of case studies" document, which provides the full detail of the main processes, the different limitations and the proposed solutions. In addition, an economic impact assessment has been performed to estimate the impact that the implementation of those solutions that could be considered by EASA in future regulatory tasks could have, considering the positive and negative effects for the different stakeholders. In this respect, it is considered that introducing or applying some of the proposed solutions to overcome the identified limitations could lead to a higher implementation ratio of the fuel schemes by the operators. Consequently, this would also lead to a progressive increase in the number of approvals for variations, which could potentially result in the achievement of further fuel reductions.

Despite the widespread appetite in the industry, as captured by the participation in the different dedicated webinars organised by the Agency, the implementation of reduction schemes is still incipient, especially in a state of consolidation of reductions with more basic variations (SCF, STF...). However, what is the current state of adoption? What is the untapped benefit to be gained from the implementation of the proposed solutions and the consequent boost in the adoption of reduced schemes? At this point, and as a complement to the economic impact assessment developed, it would be interesting to have a clearer picture of the current situation with regard to the implementation of variations and the fuel reductions that could be achieved at industry level. Ultimately, this could also support justifying that there are economic benefits for the stakeholders implementing the fuel schemes, as reflected in the economic impact assessment performed regarding the proposed solutions.

In this regard, in 2016, an estimation was made regarding the potential fuel reductions that could be achieved through the implementation of fuel schemes within the context of EASA's NPA-2016-06 (A). This study provided an estimate of the level of fuel reductions that could be achieved, taking into account reductions in the different phases of flight and different adoption shares. However, the data used to calculate such estimates, such as traffic levels and fuel prices, have since changed, especially when taking into account the effects of COVID on aviation. Therefore, the analysis and the estimates made back then can be considered as a reference but require to be updated to provide a proper picture of the reductions that could potentially be achieved.

In addition, at the time the NPA estimates were made, there were very few operators implementing fuel schemes which incorporated fuel reductions. Progressively since then, more operators have implemented variations within their fuel schemes (e.g., statistical taxi fuel, statistical contingency fuel). From the interviews conducted in the context of the DATAPP project, it has been observed that almost all the interviewed operators have implemented some kind of variation, and that the different authorities have approved some of them in the context of the approval and monitoring of fuel schemes.

For this reason, this dissemination material aims to use the estimate developed in the NPA as a baseline and update it to obtain current savings figures, thereby allowing to assess the gap between the current situation with regard to fuel schemes and the estimated reductions that could potentially be achieved. In this way, this could provide the insight that there is still a long way to walk in the context of fuel schemes and reductions, as well as a lot of room for improving and for achieving fuel reductions. Moreover, this may help to encourage operators to pursue the implementation of further reductions given the potential economic and environmental performance benefits, which is still the main purpose.

2.1.2 What we want to achieve – Objectives

The main objective of this document is to provide an updated picture of the potential fuel reductions that could be achieved through the implementation of fuel reduction schemes, as well as to estimate the current situation to subsequently identify the potential existing gap between current savings and those yet to be exploited. In other words, the intention is that the conducted study could serve to reveal and highlight the untapped benefits of the fuel reduction schemes. Likewise, the document is intended to provide a substantiated basis for ensuring that there are still plenty of opportunities to achieve fuel reductions, and therefore also emission reductions, thereby encouraging operators to implement variations through their fuel schemes in pursuit of these reductions. To achieve this objective, the methodology explained in the following sections of the document has been followed.

2.2 How to achieve it – Methodology

In 2016, EASA conducted a Regulatory Impact Assessment (RIA) in the context of the Notice of Proposed Amendment 2016-06 (A), which is included in RMT.0573. The objective of the RIA was assessing the potential impacts of introducing a series of requirements and proposed amendments to the fuel schemes related regulations that were in place at that time. Such impacts were evaluated from the perspective of different dimensions such as safety, environmental, social, economic and proportionality. For the purpose of this document, the most significant dimension on which impacts were assessed is the economic dimension, since is the one that reflects the main effects of the potential fuel reductions. Hence, the analysis of the potential economic impacts conducted in that context has served as a baseline on which to develop the analysis and draw conclusions that apply to the current situation. With that aim, the following methodology has been followed:

➨ **Figure 2-1** Methodology followed for performing the study

2.2.1 Step 1 – Reviewing the methodology used within EASA's NPA 2016-06(A)

The first step consists in reviewing the methodology used for the RIA contained in the NPA conducted by EASA. In that regard, the RIA initially proposes 3 Options, each one with different implications:

- **Option 0:** no modifications, with no change in the current prescriptive requirements.
- **Option 1:** slightly amend the rules and introduce minimal reductions in fuel burn.
- **Option 2:** implement performance-based rules (PBRs) allowing to increase efficiency and flexibility with regard to fuel planning and management, depending on the maturity of the operator and the authority.

For the purpose of this document, the study has focused on Option 0, which implies maintaining the same status that existed at the time of the publication of the NPA, and Option 2, which is the one that would allow to achieve greater fuel reductions through increased flexibility for operators. Option 1 is neglected for the purposes of this document, as it refers to a regulatory scenario that was not implemented and does not apply to the present study. In addition, the explanation on the methodology that follows is exemplified through the figures of short/medium-haul flights. Nonetheless, final results for long-haul flights are also available as part of this work. All the details of the calculation for both type of flights are included in "Annex A. Fuel consumption and fuel burn estimates for short/medium flights" and "Annex B. Fuel consumption and fuel burn estimates for long-haul flights".

In the context of Option 0, the NPA provides a table containing information about an example of a flight which is used as a reference for all the study. The table presents the estimated fuel consumptions in kg for each of the phases or segments of a flight for a typical short-haul flight with a duration of 2 hours.

➨ **Table 2-1** Example of estimated fuel for a 2-hour flight in Europe

Estimated fuel for a 2-hour flight in Europe		
Phase	**Description**	**Fuel (in Kg)**
Total	Total consumed fuel	**7,300**
Taxi	20-min taxi	**250**
Trip	2 h	**4,000**
Contingency	5 %	**200**
Alternate		**1,550**
- Go-around		500
- Alternate Airport		1,050
Discretionary fuel		**300**

Final reserve	For a 30-min international standard atmosphere (ISA) 1 500 ft above the alternate aerodrome	**1,000**

In that way, there is an established reference for the fuel consumptions to be considered within the study, and to which the potential reductions that could be implemented in the context of the fuel schemes that include approved variations could be applied.

Then, with the aim of assessing the savings that the implementation of performance-based rules (Option 2) could entail in terms of fuel, and therefore in economic and environmental related terms, EASA's NPA-2016-06 (A) captures a series of assumptions about the reductions that could be achieved in each fuel related segment. The different considered assumptions are reflected in the following table, which shows the estimated fuel reductions at a percentage level for each flight phase, together with the share of flights to which each reduction would be applied (share of adoption of each reduction). Thus, the total fuel required for each segment is calculated, with the reductions already applied in the case of the Option 2. Finally, the totals for each segment can be aggregated to obtain the total fuel required for the reference flight in the case of options 0 and 2, from which the difference in fuel required can be extracted.

Table 2-2 Comparison between Option 0 and Option 2 from EASA's NPA

	Reference		**NPA Option 2**			
		fuel (kg)		**Fuel reduction**	**Flight share**	**Fuel (kg)**
Total		**7,300**				**6,844**
Taxi	20-mn taxi	**250**				**200**
			Relative share of the flights with reduction (e.g., STF)		100%	200
			Relative share of the flights with no reduction		0%	250
Trip	**2**	**4,000**	**Average**			**3,960**
			Relative share of the flights to get 1-% reduction in fuel trip	1%	100%	3,960
			Relative share of the flights without a reduction in fuel trip	0%	0%	4,000
Contingency	**5%**	**200**	**Average**	Contingency %		**70**
			Relative share of the flights to get a 1-% reduction in fuel trip for short	1.00%	50%	40
			Relative share of the flights with reduction in fuel	2.50%	50%	100
			Traditional contingency fuel	5.00%	0%	200
Alternate[1]		**1,550**				**1,473.75**
Go-around		500	**Average**			**451.25**

[1] Further considerations on the reductions for the "Alternate" component are detailed in section "2.4.3 - Specific fuel reductions through the approval of individual fuel schemes".

			5 % without a go-around due to no alternate	100%	5%	0
			95 % without reduced fuel for a go-around	0%	95%	475
Alternate airport		1,050	**Average**			**1,022.5**
			95 % of the flights will need a selection of an alternate	0%	95%	1,050
			5 % of the flights will not need to select an alternate aerodrome; in this case, additional fuel for 15-mn holding will be needed, corresponding to 50 % of the final reserve fuel	50%[2]	5%	500
Discretionary fuel		**300**	Reduction due to further confidence in the calculations and continuous monitoring by the OCC			**140**
			Relative share of the flights with a reduction of the discretionary fuel		80%	100
			Relative share of the flights without a reduction of the discretionary fuel		20%	300
Final reserve	For 30-min ISA 1500 ft above the alternate.	**1,000**				**1,000**

As can be observed, Option 2 would allow carrying 456.25 kg less fuel considering the implemented reductions for the different phases of the flight. Considering the lower fuel load, EASA's NPA-2016-06 (A) assumes that this leads to reductions in fuel consumption. Specifically, based on the inputs suggested by manufacturers, it is assumed that each reduced kilogram of fuel implies a 3% reduction in terms of fuel burn per hour, given that the aircraft consumes less fuel with a lower weight. Considering the reference flight, with a difference of 456.25 kg in a 2-hour flight, the following results are obtained:

Table 2-3 Benefits of less fuel on board

Primary outcome	
Fuel change (kg)	**456.25**
Benefit valuation - Approach with fuel burn savings	

[2] The reference NPA value has been changed from 25% to 50% because a typo was found on the original material which slightly affected the required amount of fuel. The corrected figure is: 15 minutes of additional fuel correspond to 50% of the Final Reserve Fuel.

Fuel burn savings (kg) per h	3% reduction	13.688
Fuel burn savings (kg) for the flight	27.375	
Fuel burn savings in kg per min	0.228	

Hence, this second option would allow less fuel to be loaded, specifically a difference of 456.25 kg, and, additionally, it would enable a fuel burn savings of around 27.38 kg. Based on these specific results regarding the reference flight, the NPA presents the calculation of the fuel reductions that could be achieved performed for the internal flights inside the EASA Member States and for those flights from/to countries outside the EASA Member States. Additionally, the fuel burn savings in kg per minute of 0.228 are used later on to calculate the general fuel savings for these specific flights, by multiplying it by the average duration in minutes of such flights.

For that, the following 2015 baseline data and drivers are used as inputs to estimate the economic impact at EASA Member States (MSs) level:

➨ **Table 2-4** General information for 2015 used as an input

General information for 2015			
Flights intra EASA MS	6,907,486	Average min/flight	84
Flights from/to EASA MS	1,458,576	Average min/flight	312
CS-25 aircraft fleet for EASA MSs	5,854		
Estimated aircraft fleet for flights intra EASA MSs	5,912		
Estimated aircraft fleet for flights from/to EASA MSs	942		
Cost of fuel in EUR/kg	0.7		

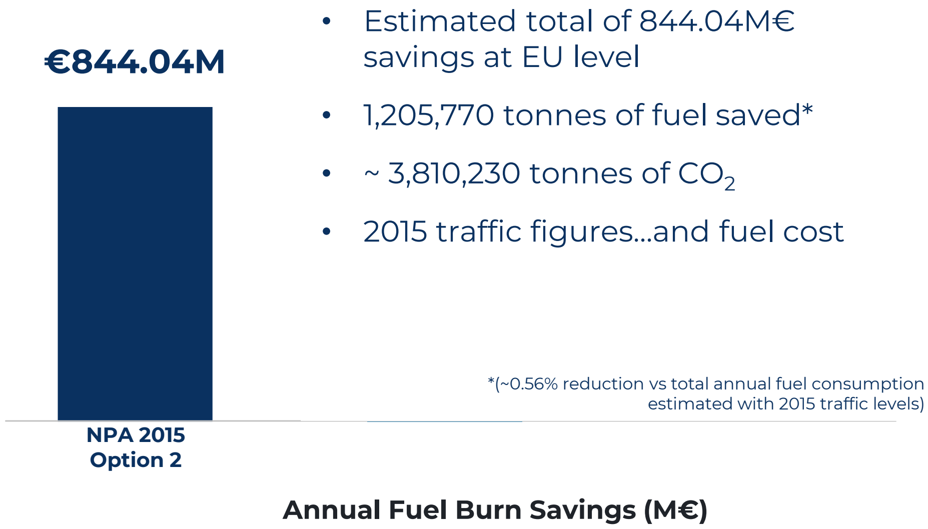
In that way, the potential economic impacts in terms of the fuel reductions that could be achieved through the Option 2 in comparison with the Option 0 are assessed, with the detailed results of the analysis contained in the following table differentiated by short-haul and long-haul flights:

➨ **Table 2-5** Economic impacts of Option 2 compared to Option 0, based on 2015 flights

NPA Option 0 vs Option 2 (2015)		
Type of savings per flight	**Short-haul flight**	**Long-haul flight**
Fuel load savings in kg (only on the first flight)	456.25	4,717.48
Fuel burn savings in kg per average flight	27.38	1,836.76
Overall fuel savings in kg	483.63	6554.24
Fuel burn savings in kg/min per flight (for the reference flight of 120 minutes)	0.228	2.359
Fuel burn savings in kg (for the average time of flight of flights intra and from/to EASA MSs)	19.163	735.927
One-off fuel load savings		
One-off fuel load savings in 1000t	2.70	4.44
One-off fuel savings (M€)	1.89	3.11
Total one-off fuel savings (M€)	**5.00**	
Annual fuel burn savings		
Annual fuel burn savings per type of flight 1000t	132.36	1,073.41
Overall fuel burn savings	1,205.77	
Annual fuel burn savings (M€)	**844.04**	

Applying the methodology used in EASA's NPA, the results provided the view that operators could save up to **844.04 M€ in fuel burn terms** through the application of fuel reductions. In addition, **5.00 M€** could be also saved in the first year **as a result of the fuel load savings**. In terms of the environmental impact that translates into a **reduction of 3,810,230 tonnes of CO_2** derived from the **1,205,770 tonnes of fuel burn savings**.

➨ **Figure 2-2** Annual fuel burn savings for the baseline scenario (Option 2 vs Option 0, 2015)



However, these results are applicable only if considering the 2015 relative data inputs, which are outdated for the purpose of this document. Hence, to have an updated overview of the potential fuel reductions to be achieved and the associated cost savings, it is necessary to adapt the inputs with updated data inputs and drivers.

2.2.2 Step 2 - Modelling the baseline scenario

Once the methodology followed in the NPA has been explained, it is proposed to replicate it with updated data to evaluate the maximum current benefit. For this purpose, the NPA exercise was remodelled in an excel file, parameterizing all the tables previously shown (Option 0 and Option 2 with 2015 data). The parametrised model allows introducing modifications to the inputs, which affect the final results that are automatically calculated from these inputs.

The purpose of this study is to compare this same scenario (Option 2) with data from 2015, considered as baseline scenario, and updated data in 2023. The purpose is to see what would be the maximum savings enabled by the regulation if we consider the current levels of traffic and fuel price, instead of those considered at the time of preparation of the study.

2.2.3 Step 3 – Updating implementation scenario with 2023 traffic levels and updated cost of fuel

Once the entire study has been parameterized, capturing Options 0 and Option 2 with 2015 data, the next step is to build the 2023 implementation scenario. The next step is then to update the key drivers used by the model in the estimation of Option 2, updating the traffic values and fuel prices used in the baseline scenario with 2023 figures. The traffic values for 2023 have been extracted from the "EUROCONTROL European Aviation Overview 2023". Regarding the fleet, it has not been possible to access the data sources necessary for the modelling of

this data input. Assuming the same fleet usability levels, the fleet / flight ratio is maintained as in 2015, projecting the figures for 2023. The fuel price has been adapted considering the jet fuel price for 2024 as per IATA [5]. Finally, the average time of flight for both flights intra and from/to EASA MSs from the baseline scenario have been maintained.
Thus, 2023 data inputs for obtaining the updated estimation of the impacts of the fuel reductions applied in the Option 2 are presented in the following table:

➨ **Table 2-6** General information for 2023 used as an input

Updated general information for 2023			
Flights intra EASA MS	7,905,900	Average min/flight	84
Flights from/to EASA MS	1,976,110	Average min/flight	312
CS-25 aircraft fleet for EASA MSs	7,316		
Estimated aircraft fleet for flights intra EASA MSs	6,767		
Estimated aircraft fleet for flights from/to EASA MSs	1,276		
Cost of fuel in EUR/kg	0.784		

Since the percentage of fuel reductions for each of the segments and the share of the flights to which they apply have not been modified compared to the baseline scenario, the fuel change is maintained in 456.25 kg and the fuel burn savings for the flight in 27.375 kg when comparing the reference Option 0 and the updated Option 2. Similarly, the fuel burn savings are also the same considering the reference flight, 0.228 kg/min. Once the inputs are adapted, the updated Option 2 (2023) can be compared with the Option 0, thus obtaining the following results for the short-haul and long-haul flights:

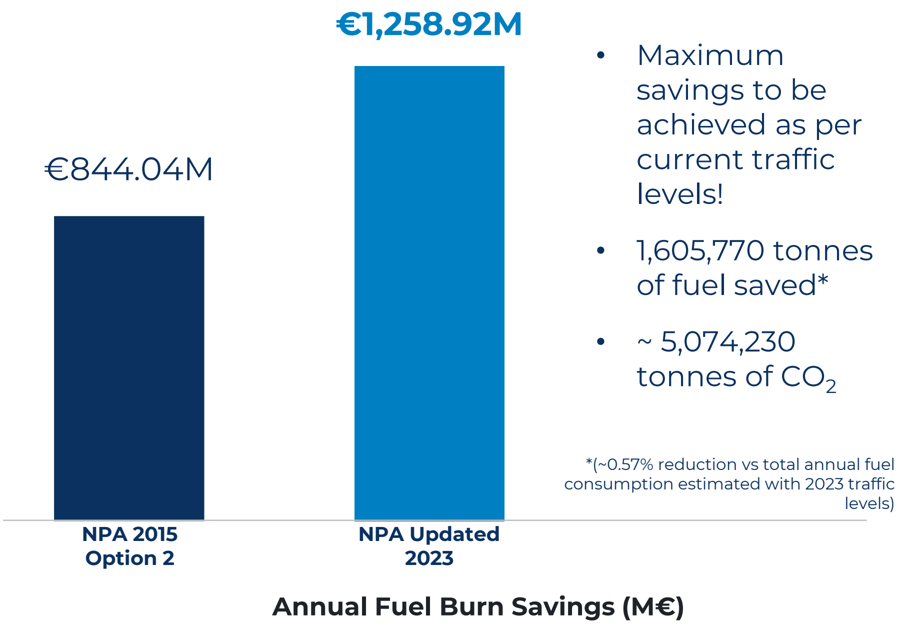
➨ **Table 2-7** Economic impacts of updated Option 2 compared to Option 0, based on 2023 flights

NPA Option 0 vs Option 2 (Updated implementation scenario: NPA 2023)		
Type of savings per flight	**Short-haul flight**	**Long-haul flight**
Fuel load savings in kg (only on the first flight)	456.25	4,717.48
Fuel burn savings in kg per average flight	27.38	1,836.76
Overall fuel savings in kg	483.63	6,554.24
Fuel burn savings in kg/min per flight (for reference flight of 120 min)	0.228	2.359
Fuel burn savings in kg (for the average time of flight of flights intra and from/to EASA MSs)	19.163	735.927
One-off fuel load savings		
One-off fuel load savings in 1000t	3.09	6.02
One-off fuel savings (M€)	2.42	4.72
Total one-off fuel savings (M€)	**7.14**	
Annual fuel burn savings		
Annual fuel burn savings per type of flight 1000t	151.50	1,454.27
Overall fuel burn savings	1,605.77	
Annual fuel burn savings (M€)	**1,258.92**	

Considering the updated traffic figures for 2023 and the updated fuel price, the updated estimation reflects that operators could save up to **1,258.92 M€ in annual fuel burn terms**. This represents a difference of 414.88

M€ compared to the 844.04 M€ initially estimated in the baseline scenario (2015). In addition, **7.14 M€** could be also saved in the first year **as a result of the fuel load savings**, 2.14 M€ more than the 5.00 M€ initially estimated.

➨ **Figure 2-3** Annual fuel burn savings updated with 2023 data



Regarding the potential environmental effects impact, the updated figures show a potential **reduction of 5,074,230 tonnes of CO2** as a result of the **1,605,770 tonnes of fuel burn savings**. In this case, the results show that, given the current traffic levels, it is possible to be even more optimistic about the savings that could be achieved through the application of fuel reductions.

Thus, once the estimation of the potential reductions that could be achieved, the next step is to estimate the current situation in terms of the reductions applied by the operators to be able to identify the existing gap.

2.2.4 Step 4 – Applying assumptions on fuel-reduction schemes adoption to estimate current scenario

At this point, we have been able to re-evaluate the maximum potential benefits that could be obtained at EU industry level through the adoption of fuel reduction schemes, considering the increase in traffic, fleet and fuel prices. The next question is: What is the existing benefit gap? How far are we from that maximum benefit captured in the Implementation scenario (Option 2 – 2023)?

The continuous engagement processes put in place in the context of the DATAPP project, including interviews, surveys and workshops, have provided a certain level of understanding of the types of variation implemented under different fuel schemes by European operators, as well as the capabilities of the Authorities responsible for their approval. As mentioned above, many of these reductions now take the form of reductions in contingency and cab fuel by statistical methods. However, despite the appetite, not all operators are following this widespread practice and therefore many of the estimates made in the context of NPA 2016-06(A) regarding the future adoption of reduction policies do not fully apply. The NPA contemplates, among other considerations, that 100% of the flights achieve reductions in taxi fuel, and that 100% of the flights achieve a 1% reduction in trip fuel, which, although it has been used to estimate the total reductions that could be achieved, does not reflect the current situation as it entails implementation of individual schemes that are yet to be adopted. Therefore, in this step, a series of assumptions have been considered based on the conducted stakeholder engagement activities to obtain a more realistic estimation of the current level of adoption of fuel reductions at industry level. As explained in Step 1, the estimate requires the level of adoption in terms of share of short-haul or long-haul flights, i.e. what is the percentage of flights in each category on which the airline is applying a specific reduction.

The estimate was made at European airline granularity, breaking down for each airline the volume of short-haul and long-haul flights, as well as the share of flights to which each reduction scheme is applied. This is then aggregated to obtain the overall adoption figures that are captured in the estimation tables. 2023 Total flight values are derived from OAG data source, which provides the total number of flights of each airline operating in the EASA Member States, as well as the percentage that they represent with respect to the total. Subsequently, based on the engagement initiatives with operators, it has been estimated which taxi and contingency fuel variations are being applied for each operator, and a percentage of flights, both for short-haul and long-haul, for which fuel reductions are achieved. The details of adoption at operator granularity are not provided in this work, for reasons of confidentiality with the collaborating operators. A first aggregated estimation of adoption was shared in the "4th EASA Fuel Management Webinar", where a live questionnaire was also launched with the aim of gathering more information on the reductions that are currently being applied by operators. In this regard, (22) replies were received, which served to fine-tune the initial considerations, complementing the information available from the interviews and providing concrete data on the variations applied by each operator. Specifically, the participants provided information on the percentages or shares of flights currently achieving reductions on taxi fuel and contingency fuel, with a distinction being made between short and long haul. The tables below provide a generic example of the structure that has been used for calculating the effects of the reductions at operator level:

Table 2-8 Generic example table containing stakeholders' contingency fuel variations and flight shares

Carrier	Short-haul flights	Share flights EU – Short-Haul	Long-haul flights	Share flights EU – Long-Haul	Variations in CF	Assumption share (%) Short-Haul	Assumption share (%) Long-Haul	Short-Haul flights considered for CF	Long-Haul flights considered for CF
Op. 1	90,000	3%	5,600	2%	Statistical Contingency Fuel	75%	75%	67,500	4,200

Table 2-9 Generic example table containing stakeholders' taxi fuel variations and flight shares

Carrier	Short-haul flights	Share flights EU – Short-Haul	Long-haul flights	Share flights EU – Long-Haul	Variations in TF	Assumption share (%) Short-Haul	Assumption share (%) Long-Haul	Short-Haul flights considered for TF	Long-Haul flights considered for TF
Op. 1	90,000	3%	5,600	2%	Statistical Taxi Fuel	25%	25%	22,500	1,400

With all this input data, it has been possible to estimate the adoption share in taxi and contingency fuel across EU, that is, the amount of flights with specific levels of reductions and thus the estimated saving figures for the current situation. Note that at the time of this exercise, no operator has introduced reductions beyond these two types of variation, as far as the researchers are aware.

The following table reflects the comparison between Option 0 from the NPA, used as reference, and the current scenario, which reflects the assumptions on the reductions applied in each phase based on the interviews and the questionnaires, applicable for the short haul flights. Thus, the total fuel required for each segment can be calculated, with the reductions already applied in the case of the scenario representing the current situation. Finally, the totals for each segment can be aggregated to obtain the total fuel required for the reference flight, from which the effects of the reductions can be extracted comparing both scenarios.

➡ **Table 2-10** Comparison between Option 0 and estimated current situation

	Reference		Current situation			
		fuel (kg)		Fuel reduction	Flight share	Fuel (kg)
Total		**7,300**				**7,117**
Taxi	20-mn taxi	**250**				**232**
			Relative share of the flights with reduction (e.g., STF)		36%	200
			Relative share of the flights with no reduction		64%	250
Trip	**2**	**4,000**	**Average**			**4,000**
			Relative share of the flights to get 1-% reduction in fuel trip	1%	0%	3,960
			Relative share of the flights without a reduction in fuel trip	0%	100%	4,000
Contingency	**5%**	**200**	**Average**	Contingency %		**151.80**
			Relative share of the flights to get a 1-% reduction in fuel trip for short	1.00%	5%	40
			Relative share of the flights with reduction in fuel	2.50%	41%	100
			Traditional contingency fuel	5.00%	55%	200
Alternate[3]		**1,550**				**1,473.75**
Go-around		500	**Average**			**451.25**
			5 % without a go-around due to no alternate	100%	5%	0
			95 % without reduced fuel for a go-around	0%	95%	475
Alternate airport		1,050	**Average**			**1,022.5**
			95 % of the flights will need a selection of an alternate	0%	95%	1,050
			5 % of the flights will not need to select an alternate aerodrome; in	50%[4]	5%	500

[3] Further considerations on the reductions for the "Alternate" component are detailed in section "2.4.3 - Specific fuel reductions through the approval of individual fuel schemes".

[4] The reference NPA value has been changed from 25% to 50% because a typo was found on the original material which slightly affected the required amount of fuel. The corrected figure is: 15 minutes of additional fuel correspond to 50% of the Final Reserve Fuel.

			this case, additional fuel for 15-mn holding will be needed, corresponding to 50 % of the final reserve fuel			
Discretionary fuel		**300**	Reduction due to further confidence in the calculations and continuous monitoring by the OCC			**260**
			Relative share of the flights with a reduction of the discretionary fuel		20%	100
			Relative share of the flights without a reduction of the discretionary fuel		80%	300
Final reserve	For 30-min ISA 1500 ft above the alternate.	**1,000**				**1,000**

As can be observed in the table above, the main assumptions applied with respect to the previously presented scenarios (baseline scenario and updated baseline scenario) are the following:

- The percentage of flights applying taxi fuel reductions is set at 36% instead of 100%.
- The percentage of flights with a 1% reduction in fuel consumption has been reduced from 100% to 0%, as of the date of this study there are virtually no operators implementing individual fuel saving schemes.
- The percentage of flights applying contingency fuel reductions is distributed as follows:
    - 5% of flights use a value equivalent to 1% of the fuel trip as contingency fuel, instead of the 50% of flights initially considered.
    - 41% of flights apply a 2.5% for contingency fuel, instead of the 50% flight share initially considered.
    - 55% of the flights apply the traditional calculation for contingency fuel (5% of trip fuel), instead of the 0% flight share initially envisaged.
- In terms of discretionary fuel, it is considered that 20% of flights will apply a reduction because of increased confidence from the pilots, reducing the flight share initially considered (80%).

Thus, these assumptions lead to an estimation which indicates that, under current conditions, operators would be carrying 182.68 kg less fuel if the defined variations are applied. Following same estimations, it is assumed that each reduced kilogram of fuel implies a 3% reduction in terms of fuel burn per hour, as suggested by the manufacturers. Considering the reference flight, with a difference of 182.68 kg in a 2-hour flight, the following results are obtained:

Table 2-11 Potential obtained benefits of less fuel on board considering the current situation

Primary outcome	
Fuel change (kg)	**182.68**

Benefit valuation - Approach with fuel burn savings		
Fuel burn savings (kg) per h	3% reduction	5.480
Fuel burn savings (kg) for the flight	10.961	
Fuel burn savings in kg per min	0.091	

In addition to the 182.68 kg difference regarding the fuel to be loaded, there would be estimated fuel burn savings of around 10.96 kg for the reference flight, which translates into fuel burn savings of 0.091 kg per min.

As for the inputs needed to obtain the results for the flights inside the EASA Member States and for those flights from/to countries outside the EASA Member States, the same 2023 traffic, fleet and fuel price figures used to update the NPA estimations have been considered for the estimation of the current situation. Similarly, the data on the average minutes per flight for short and long haul have also been maintained. Hence, applying the reductions explained above and considering the defined inputs, the following results are obtained for the scenario that reflects the estimation of the current situation:

Table 2-12 Economic impacts of estimated current situation scenario compared to Option 0

NPA Option 0 vs Current situation		
Type of savings per flight	**Short-haul flight**	**Long-haul flight**
Fuel load savings in kg (only on the first flight)	182.68	1,208.65
Fuel burn savings in kg per average flight	10.96	470.59
Overall fuel savings in kg	193.64	1,679.24
Fuel burn savings in kg/min per flight (for reference flight of 120 min)	0.091	0.604
Fuel burn savings in kg (for the average time of flight of flights intra and from/to EASA MSs)	7.672	188.549
One-off fuel load savings		
One-off fuel load savings in 1000t	1.24	1.54
One-off fuel savings (M€)	0.97	1.21
Total one-off fuel savings (M€)	**2.18**	
Annual fuel burn savings		
Annual fuel burn savings per type of flight 1000t	60.66	372.59
Overall fuel burn savings	433.25	
Annual fuel burn savings (M€)	**339.67**	

By considering the updated traffic figures for 2023 and the updated fuel price, together with the assumptions regarding the currently applied reductions, the estimation of the current situation provides an insight that operators would be currently saving an amount of **339.67 M€ in annual fuel burn terms**. This would leave a margin of 504.37 M€ with respect to the potentially achievable reductions comparing to the 844.04 M€ initially estimated in the baseline scenario. The margin would widen to 919.26 M€ if compared to the 1258.92 M€ from the updated baseline scenario. Moreover, **2.18 M€** would be also being currently saved in the first year **as a result of the fuel load savings**, 2.82 M€ less than the 5.00 M€ initially estimated in the baseline scenario and leaving a margin of 4.96 M€ with respect to the 7.14 M€ from the updated baseline scenario. Regarding the potential environmental effects impact, the updated figures show an approximated current **reduction of 1,369,070 tonnes of CO2** as a result of the **433,250 tonnes of fuel burn savings**. In that regard, the obtained results suggest that there are still key benefits in both economic and environmental related impact aspects that could be achieved through the implementation of variations in the context of fuel schemes, potentially achieving fuel reductions in the different flight segments. These results are further detailed and compared in the following sections of this document.

2.3 Potential benefit available through the adoption of fuel-reduction schemes

This sub-section aims to break down the results derived from the update of the study conducted under NPA 2016-06(A), as well as to compare the different scenarios. As a reminder, the scenarios modelled under this work are detailed:

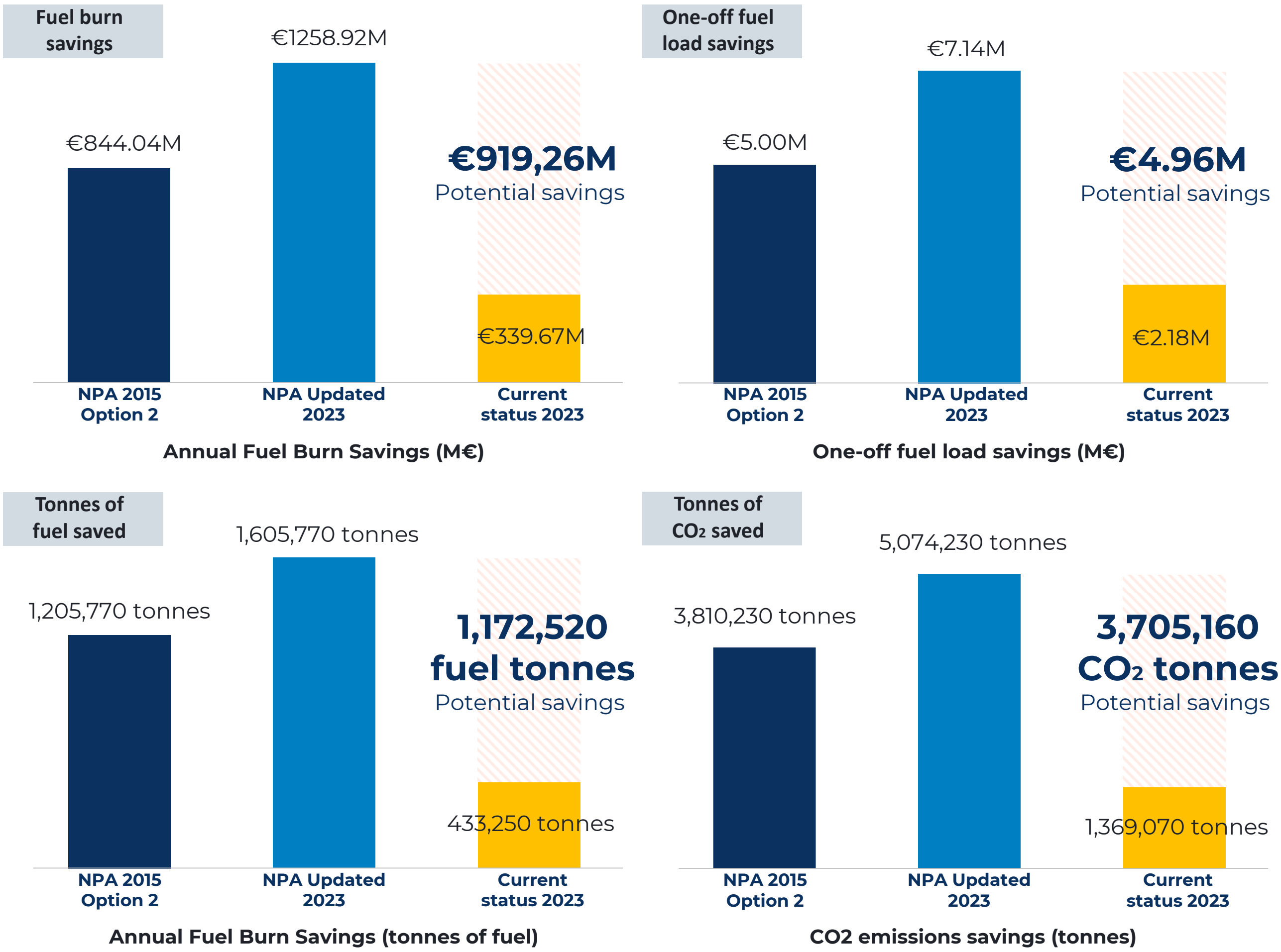
- **Baseline scenario: NPA 2015 Option 2 -** The first scenario is the 'baseline scenario' which captures the maximum savings that it was estimated could be obtained by implementing the Fuel regulation, prior to its implementation. It is based on Option 2 of the EASA's NPA 2016-06(A), using traffic and fuel price data from 2015 and specific assumptions regarding the fuel reductions that could be achieved.
- **Updated implementation scenario: NPA 2023 -** The second scenario updates the inputs of the baseline scenario with data from 2023, keeping the same assumptions, and following the same approach used in EFSA's NPA 2016-06(A). It provides a more up-to-date view of the maximum benefit of the full implementation of the proposed reductions, with results that better reflect current traffic levels, fleet and fuel price.
- **Current scenario / status -** Finally, the third scenario captures the current reality of adoption, i.e. the benefits achieved with the current levels of implementation of reductions. The assumptions made regarding the volume of flights at EU level that are benefiting from reductions have been modified, based on the information shared by operators and authorities through several stakeholder engagement initiatives. This scenario allows the comparison with respect to the maximum potential benefit (Updated implementation scenario), allowing to see the untapped savings still to be exploited.

For each of the scenarios, potential savings in tonnes of fuel, CO2 emissions and associated fuel costs such as one-off fuel costs and fuel burn have been calculated, as explained in the methodology section. With regard to the results obtained for each scenario, Figure 2-4 (see next page) allows to obtain an overview of the total savings for each of the above-mentioned categories, as well as to compare these results across the different scenarios. As mentioned, the objective of comparing the results obtained is to be able to quantify the possible gap between what it is estimated could be achieved in terms of fuel reduction through the adoption of fuel schemes and what it is estimated that operators are currently achieving under current levels of adoption.

Despite the uncertainties arising from the assumptions made, a clear conclusion can be drawn from the comparative analysis of the results in the figure: there is still room for achieving significant benefits through the implementation of variations through the fuel schemes. For a start, the environmental benefits are very significant, with great value in the current challenge of decarbonisation of the European aviation sector, as the number of tonnes of CO2 produced could be greatly reduced: Implementation of fuel reduction at scale can allow for a reduction of 1,172,520 tonnes of fuel consumed, which would consequently translate into a reduction of 3,705,160 tonnes of CO2 if applying the conversion factor provided by IATA Carbon Offset Program, which indicates that the combustion of 1 kilogram (kg) of jet fuel in an aircraft engine produces 3.16 kg of carbon dioxide (CO2).

In the economic sphere, there is also a great incentive yet to be exploited: comparing the estimated current situation of fuel reductions adoptions (current scenario) against the maximum savings estimated (updated implementation scenario), there exists a gap of approximately 919.26 M€ regarding fuel burn savings at EU level. On top of that, the savings that would be achieved in the first year due to the one-off fuel load savings should be added, thus increasing this gap by an additional 4.96 M€ in savings.

Figure 2-4 Comparison of the results from the three defined scenarios



As can be seen, the untapped potential for savings has increased in the updated NPA data, due to the increased levels of traffic, fuel prices and fleet involved. Of course, considering the current adoption levels and the benefits estimated by the EASA NPA 2016-06(A) with 2015 data, the untapped savings would be lower. However, the trend of increasing fuel traffic and fuel price inflation lends some strength to the conclusions derived from the comparison with the updated implementation scenario.

For these reasons, it is considered that there are still untapped benefits that can be unlocked through the implementation of variations in the context of the fuel schemes. An increasing number of operators are applying these variations, therefore it is expected that progressively further reductions would be approved and applied, while always having the priority of maintaining the highest levels of safety. In that regard, it is of utmost importance to keep pushing and fostering the adoption of the EASA fuel schemes across operators, providing them with increased flexibility potentially resulting in the consecution of fuel reductions. These benefits could serve as a counterpoint to justify the investment of resources in the continued development of solutions to support such adoption, as well as the development of digital capabilities and monitoring by operators. Finally, it should be underlined that once there is a considerable volume of operators with approved individual fuel schemes, whose flexibility is maximised allowing for greater reductions across almost every flight phase, further savings beyond the conservative assumptions of this study could be achieved. These might include, as an example, specific fuel reductions as filing plans with no alternate, taking advantage of aircraft navigation equipment, as captured in Section 2.4.3.

2.4 Mechanisms to activate the reductions and reduce the existing gap

Seeing the untapped potential in the adoption of fuel reduction schemes, the fundamental question is how to achieve it, how to build bridges between the current situation and a scenario of widespread adoption. A first answer to this question, through the analysis of current limitations and potential solutions has been the core of the work carried out under the DATAPP project, the main conclusions of which can be found in document D2.1.

The latest EASA's regulatory package on fuel policy updated in 2022 offers operators a range of frameworks to manage their fuel with greater flexibility at expenses of adopting new digital and analytical capabilities. As stated in the regulation, the flexibility provided by the regulation in fuel management also comes with requirements on the operator, in terms of collection, processing of fuel and safety data, both in planning, in-flight and post-ops, for the implementation of fuel reduction schemes.

These soft rules are set to favour digitalisation, but despite the growing interest in its implementation they have also resulted in a lack of definition of certain aspects that hinder the seamless adoption, integration, and management of the most advanced schemes, as well as the digital solutions on which they should be leveraged. The analysis performed under the DATAPP project identified (62) digital-related limitations that hinder such adoption across the fuel management process, spanning from fuel-related data collection, to the assessment of its quality, the development of required analytical models to justify introduction of reductions and the validation of such models, including approval from the Authorities. It is these limitations that favor the existence of this gap and slow down the widespread adoption of fuel reduction schemes. In the context of the project, (56) solutions, of which (25) are regulatory-related, are discussed in order to overcome such constraints. The proposed solutions are of a progressive nature and involve mostly an accompaniment, at industry and agency level, for the generation of reference material, practices, standards and, to a lesser extent, technological solutions to support the adoption of fuel reduction schemes.

However, based on the work done under this paper, it appears that much of the potential benefit can still be exploited in the more widespread adoption of reduction schemes with variations. Adoption levels, while high, still fall short of the levels estimated in NPA 2016-06(A), which can be understood as EASA's expectation. In some cases, operators adopt simple practices without engaging in the implementation of somewhat more sophisticated reductions that could facilitate greater reductions (e.g. 3% contingency fuel vs. SCF). Additionally, the assumptions made for more advanced reductions, such as trip fuel or other fuel components to be managed under individual schemes, are very conservative making the quantified benefits for these types of schemes practically negligible, both in the 2015 and current work. In other words, much of the untapped benefit quantified in this paper comes from the increased adoption of basic fuel schemes with variations.

The quick-win in terms of savings is likely to boost the adoption of basic fuel schemes with variations, facilitating the development of manual fuel implementation and/or similar initiatives, which will serve as a guide for operators and authorities in the approval of contingency and cab fuel reductions, both in terms of analytical approach and data collection. Thus, the first steps towards reducing the existing gap in fuel consumption should focus on further implementing variations in contingency fuel and taxi fuel, which are the variations that most of the mature operators are currently introducing and applying. In that regard, the main variation levels of contingency and taxi fuel that can lead to significant fuel savings and which are being implemented by the operators are summarised below.

2.4.1 Contingency Fuel Variations

For contingency fuel, operators can reduce the loaded fuel to the highest of the following:

- An amount of fuel that should be either:
    - not less than 3 % of the planned trip fuel; or
    - an amount of fuel sufficient for 20-minute flying time based upon the planned trip fuel consumption; or

- an amount of fuel based on a statistical fuel method, named Statistic Contingency Fuel (SCF)

- An amount of fuel to fly for 5 minutes at holding speed at 1,500 ft. above the destination aerodrome in standard conditions.

As observed during the conducted interviews with stakeholders under the DATAPP project, operators mainly apply the 3% contingency fuel and, in less proportion, the Statistical Contingency Fuel (SCF) option.

2.4.1.1 3% Contingency Fuel:

The 3% contingency fuel rule mandates carrying an additional 3% of the planned trip fuel. This is a simpler, more conservative approach compared to SCF, but it still allows for some flexibility and potential reductions. By applying operational efficiency measures and precise flight planning, operators can ensure that the 3% buffer is adequate for most scenarios, potentially lowering the overall fuel load.

2.4.1.2 Statistical Contingency Fuel (SCF):

SCF allows operators to base their contingency fuel on statistical data rather than fixed percentages. By analysing historical flight data, operators can determine a more accurate and often lower contingency fuel requirement, potentially leading to direct fuel savings. This method ensures that sufficient fuel is carried to account for unforeseen circumstances, but it avoids overestimation, which typically results in carrying excess fuel.

2.4.2 Taxi Fuel Variations

The taxi fuel calculation can also be performance-based and the operator may also use statistical taxi fuel if requirements are met.

2.4.2.1 Statistical Taxi Fuel (STF):

Statistical Taxi Fuel involves calculating taxi fuel requirements based on statistical data from previous taxi operations at specific airports. This method allows operators to adjust their taxi fuel based on real-time and historical data, accounting for factors such as average taxi time, airport congestion, and expected delays. Implementing Statistical Taxi Fuel can significantly reduce the amount of excess fuel carried for taxiing, as it is tailored to actual conditions rather than conservative estimates.

2.4.3 Specific fuel reductions through the approval of individual fuel schemes

Additional fuel reductions can be achieved through the implementation of Individual Fuel Schemes given the greater flexibility that they provide to the operators. In the context of this document, the estimation is essentially based on Fuel schemes with variations, but it is highlighted that further reductions could be achieved by increasing the number of flights with no alternate or with no go-around at DA/MDA, if allowing diverting from the holding partner. These two proposals of Individual fuel scheme examples have been considered in the different tables reflecting the "Updated implementation scenario: NPA 2023" and the "Current situation" scenarios contained throughout this document. **[See the "Alternate" section in Table 2-2, Table 2-10, Annex A & Annex B].** It is worth noticing that the assumptions made for the estimation of such reductions are conservative, as considered in the original NPA document, although greater benefits could be achieved in case that a higher volume of flights adopt such deviations. Similarly, it should also be noted that equivalent and appropriate levels of safety must be ensured for the potential implementation of this type of initiatives.

2.4.3.1 Individual Fuel Scheme for filling a flight plan with no alternate

Based on the results of a specific safety risk assessment conducted by an experienced operator which demonstrates how an equivalent level of safety will be maintained, the State of the operator could approve an Individual Fuel Scheme requiring lower meteorological requirements for filing flight plans with no Alternate. In that regard, there are specific conditions under which a State could approve such schemes, which would depend on the aircraft navigation equipment, the airport facilities, the reliability of the weather forecasts and the assistance that the operator's Ops Control Center can provide to the aircraft. By way of example, the operator might need to hold an approval for low-visibility and RNP approach, have a suitable computerised flight-planning system, an established operational control including flight monitoring, provide relevant training and decide what safety indicators are representative setting realistic alert levels, among other conditions.

2.4.3.2 Individual Fuel Scheme for filing a flight plan back to the home base of the operator subtracting the fuel needed for go-around

Similarly, there are specific conditions under which experienced operators can receive individual approval to use a Reduced Destination Alternate Fuel/Energy amount for return flights to their home base, based on the results of a specific safety risk assessment.

Destination Alternate Fuel/ Energy could be calculated starting from a given altitude in the relevant IAF holding pattern. Destination Alternate Fuel would then be reduced by the fuel to go-around from DA/MDA of the approach to the holding altitude.

Decision to divert from the holding pattern or to commit to Destination would be based on an operational exchange between the OPS control centre and the local ATC, the result of which would be transmitted to the flight crew for their final decision.

The specific conditions for this approval could include flight monitoring or watch capabilities, fully operational low visibility capabilities of the aircraft, and adherence to specific planning minima for the destination airport.

2.4.4 Discretionary fuel reductions

Discretionary fuel is the additional fuel carried by pilots beyond the calculated requirements to account for unexpected situations. Pilots generally add fuel relying on their experience and on the information that they have available. While it provides an extra layer of safety, carrying excessive discretionary fuel can lead to increased operational costs and higher CO_2 emissions, thus becoming an additional potential source of potential reductions.

This fuel component is crucial and captures the knowledge of the pilot, as the expert and ultimately responsible for the safety of the flight. Therefore, the reductions favoured under this component should be focused on the search and sharing of best practices regarding flight management among pilots, as well as building trust regarding the introduction of systematized performance-based fuel reductions at operator level, giving assurances and understanding to pilots regarding the same to avoid potential trade-offs under the discretionary component.

In that regard, reducing discretionary fuel without compromising safety could be achieved through enhancing pilots' confidence and through the implementation of advanced Fuel Monitoring Systems.

2.4.4.1 Transparent Fuel Calculation Processes:

Clearly explaining the process and rationale behind fuel calculations could help building pilots' confidence. By understanding the data-driven methods used to determine fuel requirements, pilots would be more likely to trust and adhere to the calculated fuel loads.

2.4.4.2 Regular Training and Updates:

Providing regular training sessions and updates on the latest fuel management techniques and technologies could ensure that pilots are well-informed and confident in the fuel planning process.

2.4.4.3 Dedicated fuel consumption monitoring capabilities

Beyond promoting understanding in the context of training and dissemination activities, the participation of the pilots in the analytical flow of fuel data, especially in the debriefing, reinforces the confidence and understanding of the professionals about the factual decisions regarding fuel management, as well as possible reductions introduced by the operator. There are multiple solutions on the market that favour the sharing of such statistics in debriefing, providing pilots with de-identified statistics on fuel consumption, which support their decision making.

3. Conclusions

The Rule Making Task RMT.0573 initiated by EASA in 2015 aimed to align Europe with the new ICAO standards (ICAO Doc 9976 Flight Planning and Fuel Management). This resulted in a new European fuel policy effective from 30th October 2022. This policy includes flexible performance-based fuel schemes that ultimately allow operators to reduce fuel consumption based on data-driven, factual decisions and as a result, also reduce CO2 emissions and achieve cost savings. DATAPP project has analysed the key digital limitations in implementing these fuel schemes from the perspectives of operators and stakeholders with the objective of proposing a set of solutions to incentivise the implementation of fuel reductions towards the individual fuel scheme and consequently allowing digitalisation.

As part of the work under EASA's NPA-2016-06 (A) in 2016, an estimation was performed on the potential fuel reductions for each regulatory option under assessment, providing insights into potential achievable savings across different flight phases or segments as per the expected adoption rates. However, the inputs used in that study, such as traffic levels and fuel prices, have significantly changed, especially due to the impacts of COVID-19 on aviation and to the increase in traffic volume with respect to 2016. Additionally, the initial study made assumptions on the adoption of the proposed schemes at EU level, which differ from current reality. Since then, more operators have adopted various fuel-saving measures, as confirmed by interviews conducted during the DATAPP project.

Therefore, the present work carried out under the DATAPP project aims to update the view on the potential benefits of the regulation, based on the maximum potential according to current traffic drivers, as well as the current levels of adoption after the implementation of regulation. The main objective of this document is to provide such updated assessment of the potential fuel reductions achievable through the implementation of fuel reduction schemes and to estimate the current state of their adoption. By identifying the existing gap between potential and current fuel savings, the study aims to uncover untapped benefits and highlight ongoing opportunities, encouraging broader adoption of fuel-saving variations aligning with the ultimate goal of achieving economic and environmental benefits for the stakeholders. Thus, this document serves as a substantiated basis to encourage operators to adopt fuel-saving variations within their schemes.

The implementation of the study considers three main scenarios. The first scenario, taken as the baseline or starting point, considers Option 2 of the NPA developed by EASA, which studied the impact of introducing Performance-Based Rules (PBRs). This scenario introduces a series of assumptions about the fuel reductions that could be achieved through variations implemented in the context of operators' fuel schemes, using 2015 traffic data and fuel prices as inputs. The second scenario captures the ‘Updated implementation scenario’. It follows the same approach as the baseline scenario but updates the inputs to 2023 data. This scenario provides an updated view of the estimated reductions achievable through the adoption of fuel schemes, as per current drivers. The third scenario captures the current reality of adoption, i.e. the benefits achieved with the current levels of implementation of reductions. Therefore, a series of adjustments to the initial assumptions regarding the adoption of fuel reduction schemes have been made, resulting in a third and final scenario. This scenario presents a more realistic view based on current information shared by operators and authorities through the interviews and active participation in questionnaires. These stakeholders shared information on the variations applied in their fuel schemes and the percentage of flights to which they apply such variations to achieve fuel reductions. Based on this information, savings have been calculated in terms of fuel tonnes, and subsequently in terms of CO_2 emissions, applying a conversion factor indicated by IATA. Furthermore, it has also been possible to calculate the economic related savings in terms of fuel burn and one-off fuel load, considering the updated cost of fuel.

The comparison of results between the different scenarios provides an order of magnitude of the untapped savings potential, i.e. the gap between the maximum possible profits to be exploited and those currently achieved by the industry. The analysis highlights a significant opportunity for achieving further benefits. In terms of environmental impact, variations can substantially lower CO_2 emissions, and economically, they can significantly reduce fuel costs for operators. Comparison between the updated implementation scenario (2023) with the current situation reveals a potential savings gap of approximately 919.26 M€ regarding fuel burn, plus an additional 4.96 M€ from one-off fuel load savings. This results from a reduction of 1,172,520 tonnes of fuel and, thus, 3,705,160 tonnes of CO_2. Therefore, it is considered that there are still significant untapped benefits from implementing the fuel schemes. As more operators adopt these fuel-saving variations, further reductions could be expected, always ensuring that the highest safety standards and levels are maintained. With that objective, promoting EASA fuel schemes among operators remains essential to increase flexibility and achieve greater fuel reductions. Hence, with broader adoption and maximised flexibility, even more savings beyond the scope of this study could be accomplished.

In terms of potential future actions or next steps, further studies could be performed to analyse, for instance, which support could be given by EASA to encourage more use of individual fuel schemes or studying diversions of planned flights (e.g., departure delay, high speed flying, arrival delays requiring discretionary fuel), including an analysis of the discretionary fuel for getting a picture of the expected deviations from flight planning. Other examples could include assessing the potential impact of “ReFuelEU Aviation” initiative or simulate possible scenarios regarding the implementation of variations through different examples of fuel schemes to obtain the potential reductions that could be achieved (e.g., estimate the fuel reductions achieved by simulating that 50% of the flights reduces the carried trip fuel), as has been done in this study to estimate the current adoption situation. In summary, it would be beneficial to develop studies that substantiate the monetary savings and costs of the adoption of specific individual fuel schemes reductions (e.g. with actual data from fuel consumption and fuel savings), with the purpose of further proving the value of such performance-based variations to the industry and thus fostering their adoption.

In this same vein, following the work performed in the context of the DATAPP project, there exist specific areas related with the fuel management in which further developments could be pursued to boost the adoption of individual fuel schemes. Although not directly linked to this document, these improvement areas are derived from DATAPP “D-3.3.3 - Recommendations on assurance framework for analytical development and approval of fuel schemes“ document. Regarding the safety component, best practice material could be developed for the calculation of safety events using QAR data (e.g., pseudocodes as defined at the level of EOFDM guidance), as well as queries to derive metrics based on safety reports according to ECCAIRS taxonomy. Additionally, European-wide data analysis to derive objective levels of risk exposure (baseline), could be promoted through collaborative data programmes (e.g., EASA Data4Safety). Moreover, building on the guidance material developed and the standards defined in ICAO 9976, an example of a risk assessment on an individual fuel scheme case could be considered and potentially implemented and tested by an operator through a continuous accompaniment.

Likewise, in the context of the trustworthiness of the models used for fuel estimation, the practicality of proposed analytical methods could be evaluated in a practical case with real data from models that support individual schemes (e.g. evaluate PCA, evaluation metrics, definition of coverage functions…). Additionally, guidelines for enhancing data collection and identify sources of reliable operating conditions data could be developed. Furthermore, a follow-up of the development of the work performed under the RMT.0742 could be performed, particularly in its Step 2, which focuses on the analysis, per domain, of those requirements that need to be complemented to provide an adequate regulatory basis for deploying the generic AI trustworthiness framework (e.g. Flight ops).

Hence, all these studies, and any other studies that may emerge, could be used to further promote and achieve improvements in the context of fuel management and fuel reduction schemes, thus contributing to achieving further fuel and CO_2 emissions reductions.

4. Reference material

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5. Annex A. Fuel consumption and fuel burn estimates for short/medium flights

	Reference		Updated implementation scenario: NPA 2023				Current situation		
		fuel (kg)		Fuel reduction	Flight share	Fuel (kg)	Fuel reduction	Flight share	Fuel (kg)
Total		**7,300**				**6,844**			**7,117**
Taxi	20-mn taxi	**250**				**200**			**232**
			Relative share of the flights with reduction (e.g., STF)		100%	200		36%	200
			Relative share of the flights with no reduction		0%	250		64%	250
Trip	**2**	**4,000**	**Average**			**3,960**			**4,000**
			Relative share of the flights to get 1-% reduction in fuel trip	1%	100%	3,960	1%	0%	3,960
			Relative share of the flights without a reduction in fuel trip	0%	0%	4,000	0%	100%	4,000
Contingency	**5%**	**200**	**Average**	Contingency %		**70**	Contingency %		**151.8**
			Relative share of the flights to get a 1-% reduction in fuel trip for short	1.00%	50%	40	1.00%	5%	40
			Relative share of the flights with reduction in fuel	2.50%	50%	100	2.50%	41%	100
			Traditional contingency fuel	5.00%	0%	200	5.00%	55%	200
Alternate[5]		**1,550**				**1,473.75**			**1,473.75**

[5] Further considerations on the reductions for the "Alternate" component are detailed in section "2.4.3 - Specific fuel reductions through the approval of individual fuel schemes".

Go-around		500	**Average**			**451.25**			**451.25**
			5 % without a go-around due to no alternate	100%	5%	0	100%	5%	0
			95 % without reduced fuel for a go-around	0%	95%	475	0%	95%	475
Alternate airport		1,050	**Average**			**1,022.5**			**1,022.5**
			95 % of the flights will need a selection of an alternate	0%	95%	1,050	0%	95%	1,050
			5 % of the flights will not need to select an alternate aerodrome; in this case, additional fuel for 15-mn holding will be needed, corresponding to 50%[6] of the final reserve fuel	50%	5%	500	50%	5%	500
Discretionary fuel		**300**	Reduction due to further confidence in the calculations and continuous monitoring by the OCC			**140**			**260**
			Relative share of the flights with a reduction of the discretionary fuel		80%	100		20%	100
			Relative share of the flights without a reduction of the discretionary fuel		20%	300		80%	300
Final reserve	For 30-min ISA 1500 ft above the	**1,000**				**1,000**			**1,000**

[6] The reference NPA value has been changed from 25% to 50% because a typo was found on the original material which slightly affected the required amount of fuel. The corrected figure is: 15 minutes of additional fuel correspond to 50% of the Final Reserve Fuel.

	alternate.								
Primary outcome				**Updated implementation scenario: NPA 2023**			**Current situation**		
Fuel change (kg)				**456.25**			**182.68**		
Benefit valuation - Approach with fuel burn savings				**Updated implementation scenario: NPA 2023**			**Current situation**		
Fuel burn savings (kg) per h			**3% reduction**	**13.688**			**5.480**		
Fuel burn savings (kg) for the flight				**27.375**			**10.961**		
Fuel burn savings in kg per min				**0.228**			**0.091**		

6. Annex B. Fuel consumption and fuel burn estimates for long-haul flights

	Reference		Updated implementation scenario: NPA 2023				Current situation		
		fuel (kg)		Fuel reduction	Flight share	Fuel (kg)	Fuel reduction	Flight share	Fuel (kg)
Total		**112,846**				**108,129**			**111,637**
Taxi	20-mn taxi	**600**				**500**			**582**
			Relative share of the flights with reduction (e.g., STF)		100%	500		18%	500
			Relative share of the flights with no reduction		0%	600		82%	600
Trip	**13**	**99,854**	**Average**			**99,554**			**99,854**
			Relative share of the flights to get 1-% reduction in fuel trip	1%	30%	98,855.46	1%	0%	98,558.89
			Relative share of the flights without a reduction in fuel trip	0%	70%	99,854	0%	100%	99,854
Contingency	**5%**	**4,993**	**Average**	Contingency %		**1427.95**	Contingency %		**4135.28**
			Relative share of the flights to get a 1-% reduction in fuel trip for short	0.1%	30%	100	0.1%	3%	100
			Relative share of the flights with reduction in fuel	2.00%	70%	1,997.08	2.00%	24%	1,997.08
			Traditional contingency fuel	5.00%	0%	4,993	5.00%	73%	4,992.7

Alternate[7]		**3,438**				**3,245.12**			**3,245.12**
Go-around		800	**Average**			**665**			**665**
			5 % without a go-around due to no alternate	100%	5%	0	100%	5%	0
			95 % without reduced fuel for a go-around	0%	95%	665	0%	95%	665
Alternate airport		2,638	**Average**			**2,580.12**			**2,580.12**
			95 % of the flights will need a selection of an alternate	0%	95%	2,638	0%	95%	2,638
			5 % of the flights will not need to select an alternate aerodrome; in this case, additional fuel for 15-mn holding will be needed, corresponding to 50%[8] of the final reserve fuel	50%	5%	1480.5	50%	5%	1480.5
Discretionary fuel		**1,000**	Reduction due to further confidence in the calculations and continuous monitoring by the OCC			**440**			**860**
			Relative share of the flights with a reduction of the discretionary fuel		80%	300		20%	300
			Relative share of the flights without a reduction of the discretionary fuel		20%	1,000		80%	1,000
Final reserve	For 30-min ISA 1500 ft	**2,961**				**2,961**			**2,961**

[7] Further considerations on the reductions for the “Alternate” component are detailed in section “2.4.3 - Specific fuel reductions through the approval of individual fuel schemes”.
[8] The reference NPA value has been changed from 25% to 50% because a typo was found on the original material which slightly affected the required amount of fuel. The corrected figure is: 15 minutes of additional fuel correspond to 50% of the Final Reserve Fuel.

	above the alternat e.								

Primary outcome		Updated implementation scenario: NPA 2023	Current situation
Fuel change (kg)		4717.48	1208.65
Benefit valuation - Approach with fuel burn savings		**Updated implementation scenario: NPA 2023**	**Current situation**
Fuel burn savings (kg) per h	3% reduction	141.524	36.26
Fuel burn savings (kg) for the flight		1836.763	470.589
Fuel burn savings in kg per min		2.359	0.604

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