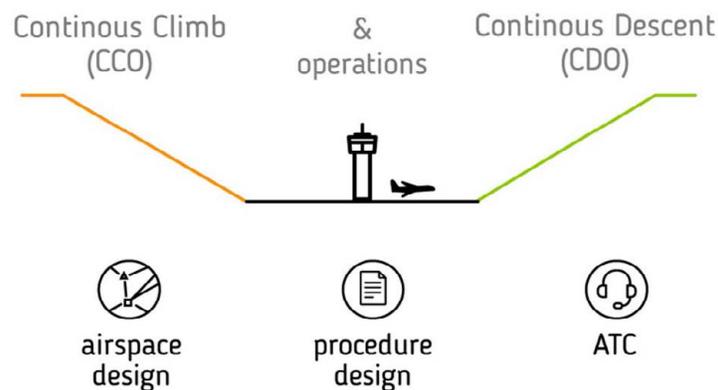


The Benefits Of CCO / CDO Operations – European Task Force Findings

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The European CCO / CDO Task Force



In 2019, ICAO's Committee on Aviation Environment Protection (CAEP) estimated that the planned implementation of the operational improvements detailed in the Aviation System Block Upgrade (ASBU) framework should provide an annual fuel savings of approximately 5.4 – 10.7Mt in 2025 (compared with 2015). In global fuel costs, these figures correspond to yearly fuel savings of up to €5.6 billion or \$6.4 billion. In that study, CAEP also estimated that four ASBU modules (CDO, ASUR, TBO and CCO¹) provide close to 60% of the higher range of fuel/CO₂ savings at the global level in 2025 compared with 2015. These findings are detailed elsewhere in this chapter in the article on *Global ASBU Environmental Benefits Assessment*.

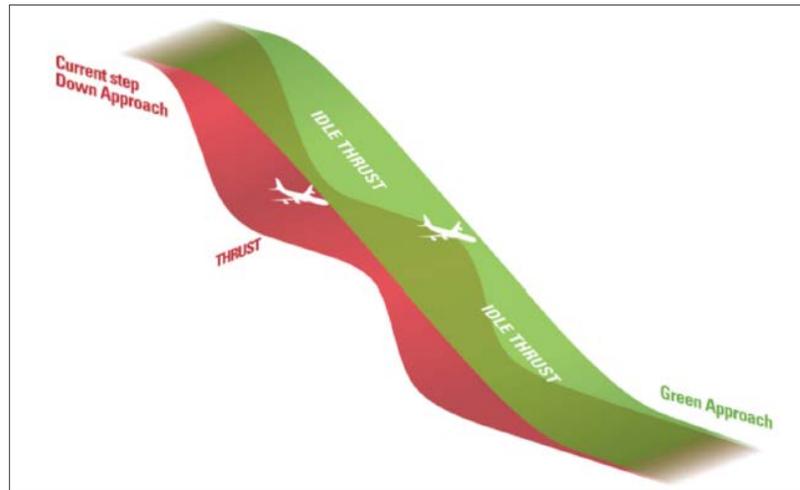
CCO AND CDO DEFINED

Continuous Climb Operations (CCO) and Continuous Descent Operations (CDO) are aircraft operating techniques that are enabled by airspace design and procedure design, and are facilitated by Air Traffic Control (ATC).

CCO and CDO are not new, they are essentially airplane pilot lessons numbers 1 and 2 – how to take-off and how to land. They are, in fact, the optimal climb and descent procedures to be followed in unrestricted airspace for all aircraft, from a 500 ton Airbus A380 to the smallest single seater light aircraft.

¹ CDO – Continuous Descent Operations, ASUR – Alternative Surveillance, TBO – Trajectory-Based Operations, CCO – Continuous Climb Operations. ASBU Modules CCO and CDO also contain elements relating to PBN SID / STAR implementation in addition to continuous climb / descent operations

FIGURE 1: Optimal CDO approach (green) versus a non-optimal approach (red)



Not only do CCO and CDO allow aircraft to follow a flexible, optimum flight profile but, as they are flown with optimal fuel flow and in low drag configuration, they minimize fuel burn and fuel costs, while simultaneously cutting gaseous emissions and reducing noise. In addition, this can be done without any adverse effect on safety (see ICAO Doc 9993 and ICAO Doc 9931 respectively).

CDO and CCO operations, respectively, allow arriving or departing aircraft to descend or climb continuously, to the greatest extent possible. Aircraft applying CCO employ optimum climb engine thrust and climb speeds until reaching their cruising levels. With CDO, aircraft apply minimum engine thrust, ideally in a low drag configuration and from top of descent, prior to the final approach fix. With the removal of time flown level at inefficient intermediate altitudes, these techniques result in more time being spent at more fuel-efficient higher cruising levels, hence significantly reducing fuel burn and associated costs, and thus lowering emissions.

BENEFITS OF CCO AND CDO

Stakeholders have long recognized the environmental benefits associated with optimized CCO and CDO. All ATM stakeholder organizations (e.g., ICAO, CANSO, ACI, IATA, etc.) strongly support CCO-CDO and readily promote the benefits of such operational procedures. Across the industry, CCO and CDO have been described as: ‘deployment baseline essentials’, one of four ‘global air

navigation priority operational improvements’, ‘capabilities within our grasp’, and ‘ASBU Block 0 initiatives that are agreed priorities for States to act upon in both the short- and medium-term timeframe’.

EUROCONTROL, along with industry stakeholders, has championed CDO implementation publications over the years, including:

1. Flight efficiency plan, 2008.
2. CDA implementation guidance, 2009.
3. European Joint industry Action Plan, 2009.
4. A guide to implementing continuous descent, 2011.

FREQUENCY OF CCO AND CDO FLIGHTS

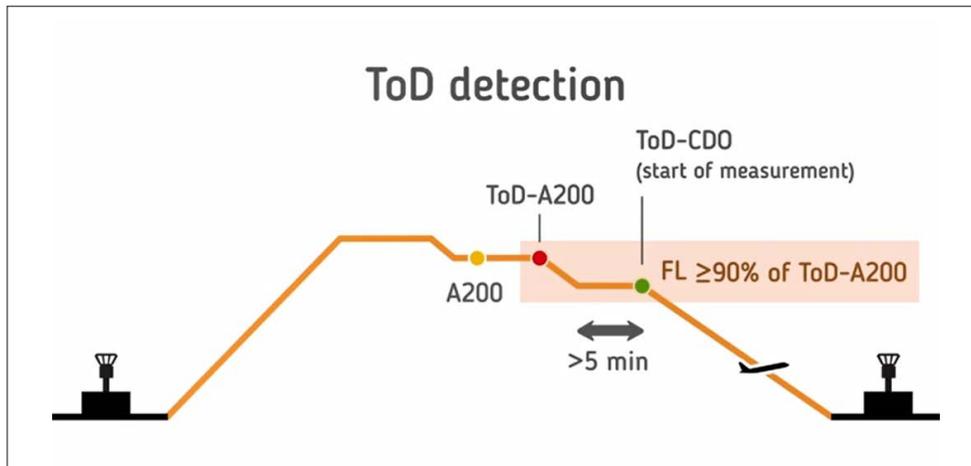
Despite all of that industry support, in 2015, four years after the publication of the last of these reports (2011), it was still not possible to know how many CCO and CDO operations are actually flown worldwide.

This was because CCO and CDO have traditionally been measured at the local level based on definitions, hours of operation, and ways of measurement etc. which differ according to local stakeholder needs. However, the benefits of CCO and CDO implementation have never been addressed at the network level so the overall performance benefit was unknown.

FIGURE 2: Previous European support to CDO implementation



FIGURE 3: Screenshot from the European CCO-CDO Task Force animation on the harmonized definitions, metrics and parameters for measurement of CCO-CDO



In 2015, EUROCONTROL set up the European CCO-CDO Task Force to solve this issue and developed a set of harmonized CCO-CDO definitions, metrics, and parameters for measuring CCO-CDO, as agreed by stakeholders. These include harmonized definitions of both a fuel CCO-CDO (to top of climb or from top of descent, respectively), and a noise CCO-CDO (from FL75 or to FL105, respectively) lower levels where noise is the primary environmental impact.

The Task Force developed a webpage and animation² that details the outcomes of these stakeholder agreed definitions.

All Stakeholders are being encouraged to use the harmonized definitions and parameters of the Task Force when measuring CCO-CDO, especially when measurements are presented at the international level in order to allow for a harmonized comparison of performance.

Based on these standardized definitions and parameters for measurement, an ECAC³-wide CCO-CDO study was undertaken by EUROCONTROL in 2018 (see Figure 4 and Figure 5).

² <https://www.youtube.com/watch?v=mUkMPb5eVJI>

³ ECAC – European Civil Aviation Conference: Albania, Armenia, Austria, Azerbaijan, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Moldova, Monaco, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, the Republic of North Macedonia, Turkey, Ukraine and United Kingdom.

FIGURE 4: Average time in level flight for low level CCO-CDO (noise CCO-CDO) for European airports in 2017

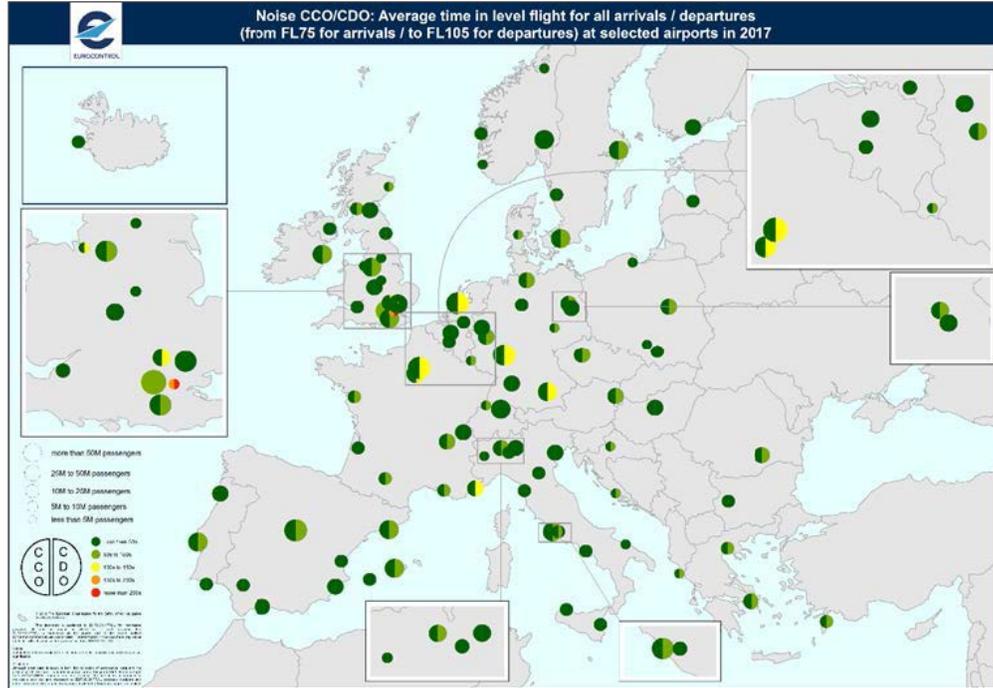
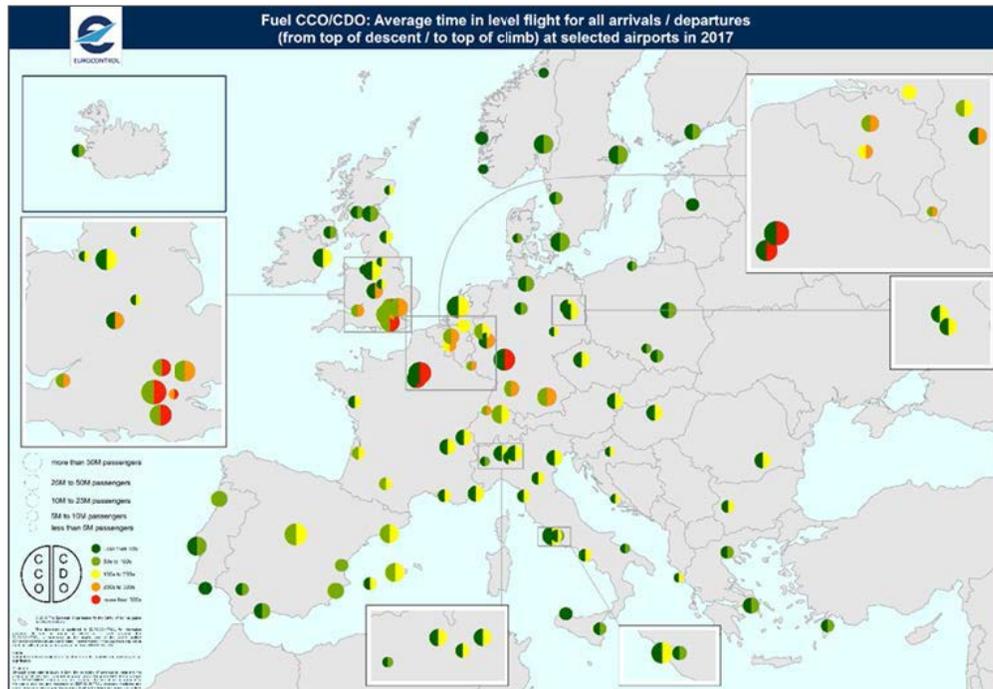


FIGURE 5: Average time in level flight for CCO to top of climb and CDO from top of descent (fuel CCO-CDO) for European airports in 2017



The results of this study revealed that the benefit pool of optimizing CCO-CDO in Europe could result in fuel savings of up to 340,000 tons of fuel per year for the airlines (>1m tons of CO₂) or about 150 million €⁴ in monetary savings (see Figure 6).

The main conclusions were:

- There are significant environmental savings that optimized CCO-CDO can provide.
- The amount of time flown level (a proxy for inefficiency) and consequently the amount of fuel savings available from optimizing the descent phase (CDO) is significantly larger (about x10) than the time flown level in the climb phase (CCO); therefore the greatest fuel saving benefits should be realized by optimizing CDO.
- The pool of potential performance improvements is much larger for the fuel CDO (CDO from top of descent) compared with low level (noise) CDO, with the majority of airports having only minor performance benefits available; therefore the focus of performance improvement should be to optimize CDO from top of descent or higher levels wherever possible.

EUROPEAN RESPONSE

The European CCO / CDO Task Force is looking for a step change in the implementation of CCO and CDO in Europe and is developing a CCO / CDO tool kit to support stakeholders in implementation. This tool kit consists of three main elements:

1. An *updated* CCO / CDO Action Plan.
2. A *new* CCO / CDO 'State of Play' Report.
3. Resources (e.g., training material, best practices, guidance material, implementation support, etc.) to enable stakeholders to implement and optimize CCO / CDO procedures – these will all be available in the Task Force webpages.

FIGURE 6: Total benefit pool from optimizing CCO-CDO in ECAC

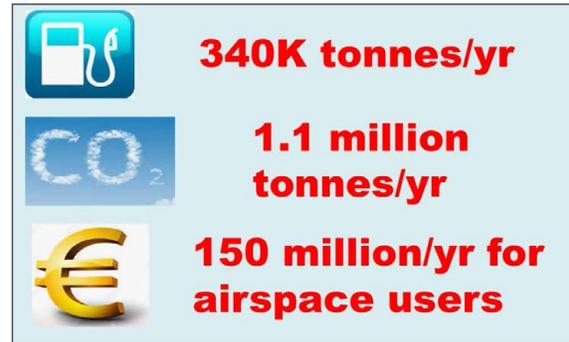


FIGURE 7: The 2019 Joint Industry CCO / CDO Action Plan



FIGURE 8: The NEW CCO / CDO State of Play Report

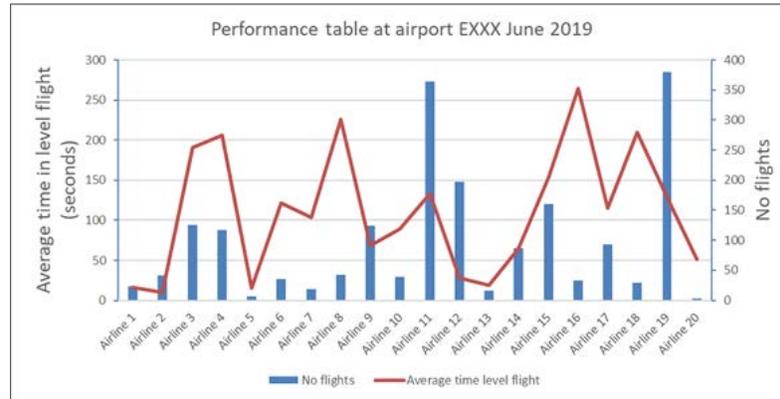


The updated 2019 CCO / CDO Action Plan is being developed by the European CCO / CDO Task Force and calls for a step change in the facilitation, promotion, and implementation of CCO / CDO so that the significant noise, emission, and fuel cost benefits of these procedures can be realized by stakeholders. The Action Plan introduces and promotes a set of actions that support CCO / CDO implementation across Europe.

The new CCO / CDO 'State of Play' Report is a supporting document to the CCO / CDO Action Plan. The report addresses interdependencies and the sharing of responsibilities, and also provides case studies of, and mitigations for, the contributory factors that limit optimized CCO / CDO in European Airspace. The 'State

⁴ Not all of the benefit pool is recoverable as the need to maintain safety and take into account capacity, cost efficiency and environmental impacts will result in non-optimal profiles for some flights and to a certain level of inherent inefficiency. The key is to minimise these inefficiencies to the extent possible.

FIGURE 9: Example of a monthly airport performance table with basic functionality



of Play’ report has been described as an enabler to better understand, evaluate and optimize CCO / CDO performance.

The tool kit resources will support stakeholders to implement and optimize CCO / CDO procedures and will include the following:

✂ As the ‘Hawthorne effect’⁵ has been demonstrated by NATS to improve CDO performance, EUROCONTROL will deliver monthly performance tables on CCO and CDO for all airports and airlines operating in Europe, together with support for analyzing data. The tables will be based on the harmonized European definitions of CCO / CDO and will allow performance comparisons for an airline at different airports or across all airlines at a single airport. The basic information in the performance tables will be monthly CDO figures from top of descent for the airport/airline selected. Enhanced data sets and functionalities will include the option to slice/aggregate data by aircraft type, country, alliance, type of flight, CCO / CDO, level band, time of analysis, etc. with multiple charting possibilities.

✂ ATCO (Air Traffic Control Officer) refresher training. The European ATCO Common Core Content (CCC) training material has been updated by:

- Updating the content to include mandatory content on CCO.
- Updating CDO Objectives to ensure more ATCO training simulation exercises are spent on CDO.
- Introducing a specific new objective for ATCO training on aircraft energy management.

In addition, the EUROCONTROL training institute, will create a refresher training module for ATCOs on aircraft energy management in collaboration with the Task Force, based on best practice training material. This will be available to all European ANSPs, and aims to provide feedback to ATCOs on the impact of the provision of ATCO instructions on aircraft and pilot behavior. Sharing specific scenarios and encouraging ATCO/pilot interactions will support the optimization of CCO and CDO.

- ✂ The Task Force is currently reviewing the European Route Network Improvement Plan (ERNIP) with the aim of ensuring that:
- CCO / CDOs are integrated into the airspace design process.
 - The main principles of airspace and procedure design that enable CCO / CDO are detailed.
 - There are links to resources in the plan that can provide support to airspace designers from the CCO / CDO point of view.

The proposals will reinforce the message that CDO should be optimized from the highest levels where possible,

⁵ The Hawthorne effect is a type of reactivity in which individuals modify an aspect of their behaviour in response to their awareness of being observed.

FIGURE 10: Example of ATCO training material on energy management

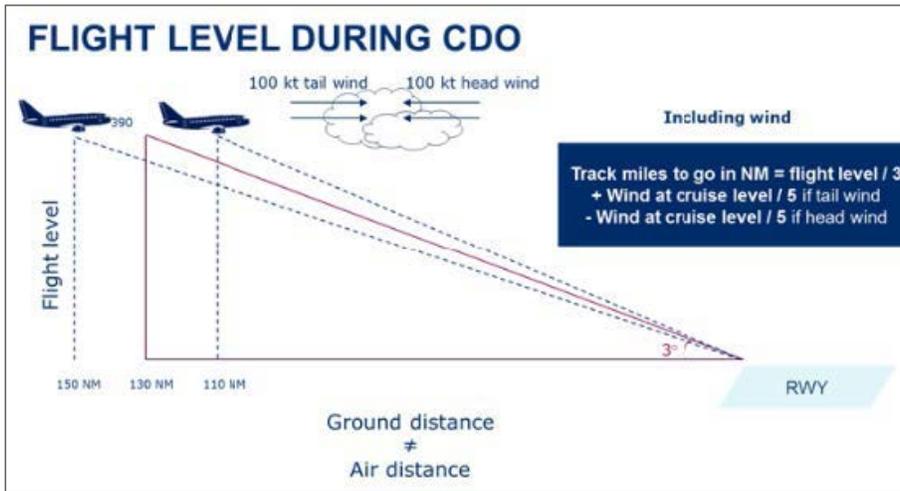


FIGURE 11: ERNIP Plan



together with the requirement to regularly review the individual transfer of control rules between airspace sectors and the consideration of flexible LoAs⁶. The Task Force is also collaborating with stakeholders on airspace change proposals to identify where airspace and procedure design best practices could be incorporated into the airspace change process to develop some fully optimized CDO-enabled airspace changes.

✘ **Harmonized AIP content on CDO** – The Task Force has reviewed the AIPs of the top 100 European airports, identifying good practices that promote CDO implementation. AIP information supporting CDO implementation is currently very fragmented. The Task Force, through collaboration with airlines, airports, ANSPs and Computer Flight Plan Software Providers (CFSPs), will develop some harmonized generic structure and content proposals for AIP CDO supporting information. These will be based on best practices identified by the Task Force. The objective is to ensure that airspace users know exactly where to find CDO supporting documentation, thereby eliminating the fragmentation of information.

✘ **Promoting airline best practices** - The Task Force recently undertook an airline questionnaire on CCO / CDO. More than 120 responses from 59 different

airlines including: 25 European national carriers, 18 of the 20 top European airlines in terms of passengers flown, and the top 5 Low Cost Carriers. The Task Force will be promoting the following best practices:

- Airline Standard Operating Practices (SOPs) on CDO – only one third of the respondent airlines have SOPs on CDO. The Task Force aims to work with and encourage industry to adopt such best practice SOPs as they reinforce the noise and fuel efficiency benefits and provide support to the pilots in flying optimized CDO techniques.
- CCO / CDO training for pilots - less than 50% of the airlines surveyed have refresher training in the simulator that includes CCO / CDO operations and techniques. Even fewer airlines use similar material for ab-initio, base and type-rating training. Considering it is the airlines (through pilots flying technique) that may be rewarded with the potential huge performance and fuel-saving benefits, it is a matter for concern just how low this figure is. The Task Force aims to support the airline industry and pilot associations to ensure that, not only is training on CCO / CDO techniques kept high on the airlines agenda, but in addition, that the best practices of existing pilot training material are shared and incorporated into airline

6 Letters of Agreement - negotiated handover conditions between sectors /ATC centres

FIGURE 12: Airlines responding to the Task Force questionnaire 2019



training plans. The European CCO / CDO Task Force promotes the inclusion of CDO as a best practice in both airline initial line-training and conversion-training. This will ensure that a ‘CDO mentality’ is engrained in the pilot from day one.

- Airline and pilot CDO performance measurement and performance feedback – The Task Force believes that measuring CCO/CDO performance is an enabler to improve performance at airline or pilot level. In such conditions: optimized techniques can be shared, pilots uncertain of CDO techniques can receive extra training, and a healthy performance ‘competition’ helps to improve overall performance.
- **Better understanding of the benefits of CCO and CDO.** The airline survey found that less than 30% of airlines measure their CCO / CDO performance let alone individual aircraft/

pilot performance. Many airlines leave it up to individual airports (e.g., London Heathrow) where such performance is measured, to inform them of their performance. There needs to be a step change in the understanding and promulgation of what benefits CCO and CDO can provide to the airline.

- ✘ Future concepts - The Task Force is also following emerging concepts that could enable more CDO or optimize current performance levels. This includes identifying parameters for 4D trajectory downlink data to optimize CDO such as the transmission of accurate top of descent position data from aircraft to ATC. The Task Force is also working with stakeholders to identify future sources of data such as Quick Access Recorder (QAR) data that could be used to provide actual fuel burn data for the measurement for CCO / CDO performance.

The Task Force ensures that active collaboration with industry stakeholders is maintained. ; Without the support of these stakeholders, a step change in CDO implementation will not be possible. Given the challenges ahead with traffic growth and short term capacity constraints, the improvements in CCO / CDO performance will not be possible without stakeholder support. It is an ongoing and long term objective.

For more information contact cdo@eurocontrol.int or visit <https://www.eurocontrol.int/concept/continuous-climb-and-descent-operations>

FIGURE 13: An example of best practice airline CDO performance measurement and feedback to pilots (Wizzair)

