KEO

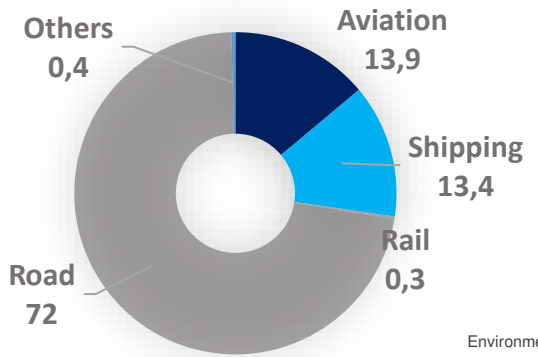
Optimal Trajectory KPIs

They didn't know it was impossible, so they got it

The blue marble. 1972

1 We have a huge challenge ahead: Aviation is one of the most difficult sectors to de-carbonise...

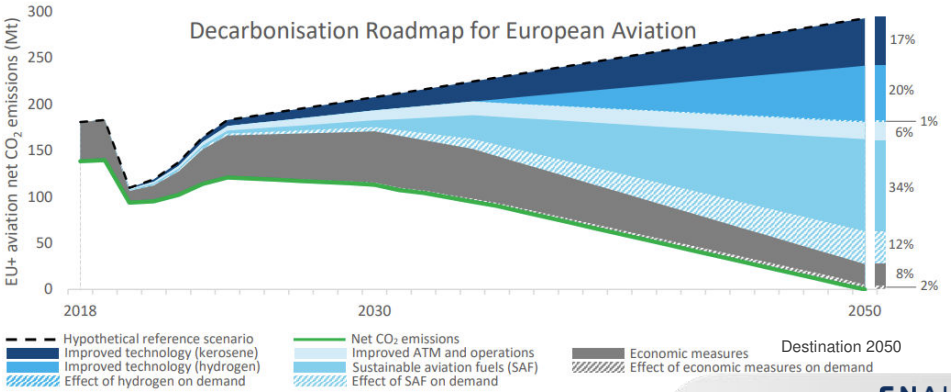
Despite Aviation isn't the most contaminant transport mode, is suffering a huge pressure and it's been reviled



Environmental European Agency

2 ...but we have a plan

The aviation industry is the 1st Industry worldwide that has agreed to reach net zero in 2050. This will be achieved by implementing different actions that depend on different actors, mainly improving technology



Current Environmental KPIs have limitations to face the CO2 emissions problem

KEA

Currently used to measure **FLOWN** efficiency vs **Great Circle Distance**

Problem, Does not include:

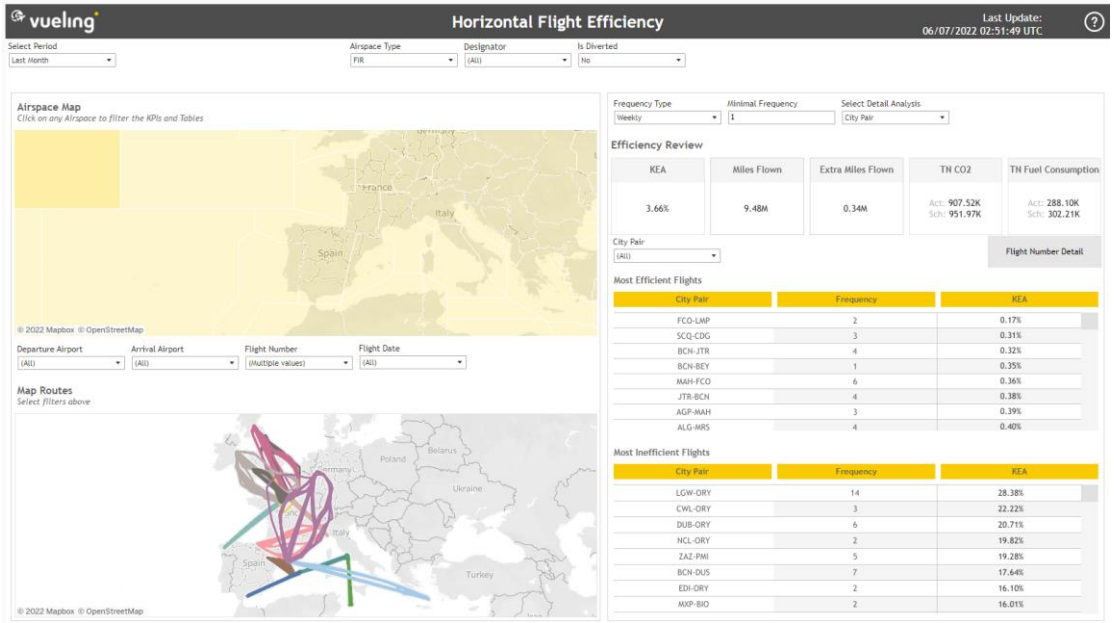
- First and last 40NM
- Vertical efficiency
- Real Fuel Consumption (CO2)

KEP

Currently used to measure **PLANNED** efficiency vs **Great Circle Distance**

Problem, Does not include:

- First and last 40NM
- Vertical efficiency
- Real Fuel Consumption considering Planned Winds (CO2)

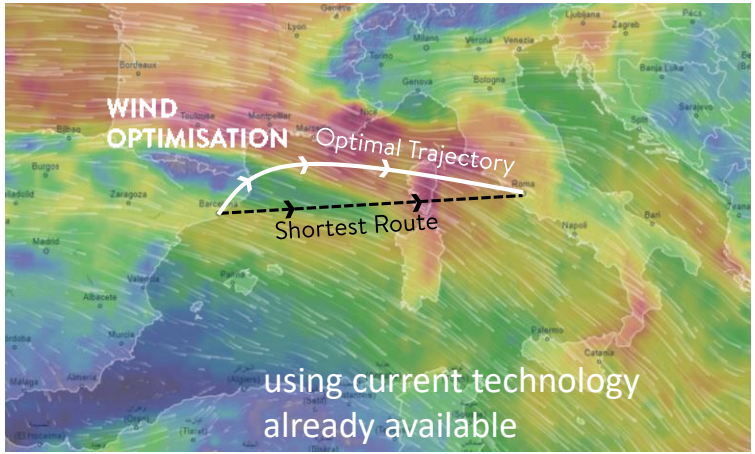


Proposed Solution: Start measuring Optimum Trajectory (KEO,...)

(CO2 emissions-based vs Distance)

1 Data of Optimal Trajectory in real time

Today we are presenting here a mock-up of the airspace efficiency Dashboard including the Optimal Trajectory



Eg: the Optimal Route is not always the shortest taking into account the winds

2 Sharing CO2 emissions

VUELING is already sharing CO2 emissions with ENAIRE and are working in a real-time sharing process

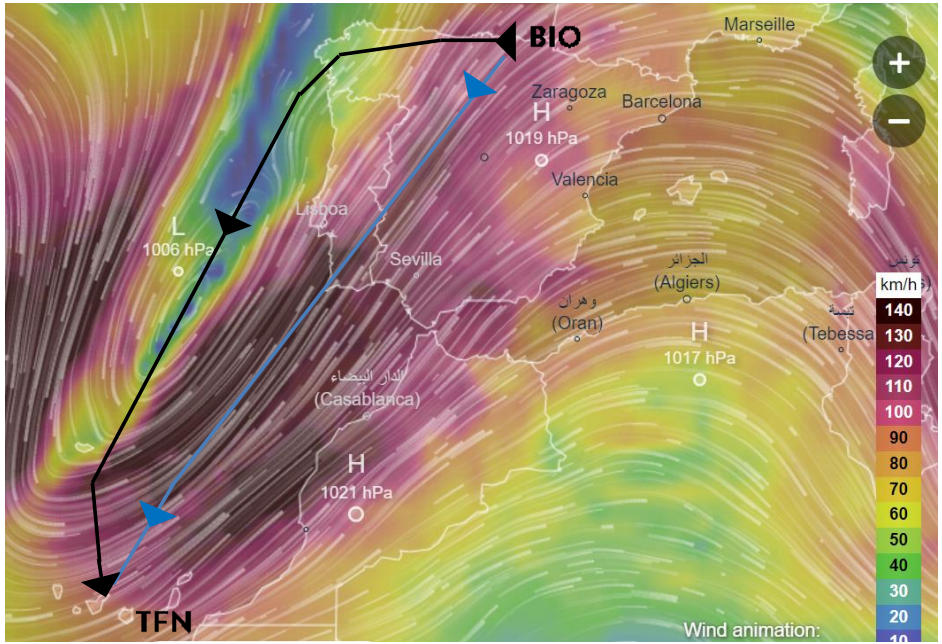
Eg:
- Continuous Descents
- Direct routings
- Optimal Flight Levels

ENAIRE vueling

BIOTFN flight on 13 Sept 2021 would have had extreme head-winds if it had flown the standard trajectory:

Standard trajectory

Optimum constrained trajectory ≈ Optimum trajectory



KEA

Achieved Trajectory / Great Circle Distance
excluding first and last 40NM

Standard Trajectory	1021NM / 1019 NM	**+0.2%**
Optimum trajectory	1153 NM / 1019 NM	**+11.6%**

Apparently inefficient

KEO

Achieved Trajectory / Optimum Trajectory.
Actual fuel burn vs ideal

Standard Trajectory	7425 Kg of Fuel / 6844 Kg of Fuel	**+8.5%**
Optimum trajectory	6849 Kg of Fuel / 6844 Kg of Fuel	**+0.1%**

Really inefficient

Proposed Solution: Start measuring Optimal route based on real CO2 (KEO and others…)

(Fuel Burn/CO2 emissions-based vs Distance)

The deployment of these indicators have several hurdles to overcome…and benefits

- Confidentiality
- Single source of truth
- To involve Airlines, ANSP's and Organisation
- Change of mind / paradigm
- Translate results into actions (bottle necks)

\- +

- Real emissions considering the entire flight
- Actions as a result of real measures
- Work together for the same purpose
- Horizontal and Vertical Efficiency concept

Proposed Solution: Start measuring Optimal route based on real CO2 (KEO and other…)

(Fuel Burn/CO2 emissions-based vs Distance)

Validated by A4E AIRLINES FOR EUROPE

Fuel burn (3D) **Optimum Trajectory** *(replacing great circle distance)*	• Including: actual environmental conditions (Wind/Temperature/Relief etc.) and actual a/c capabilities (influence of weight). • Excluding: any other constraints (RAD, airspace closures, adverse weather)
Fuel burn (3D) **Constrained Optimum Trajectory** *(equivalent of optimum available flight plan)*	• Including: Optimum Trajectory plus and all known constraints (RAD, airspace closures, etc.) • Excluding: Air navigation fees
Fuel burn (3D) **Achieved Trajectory**	• Including: all experienced constraints like adverse weather etc.

Optimum Trajectory

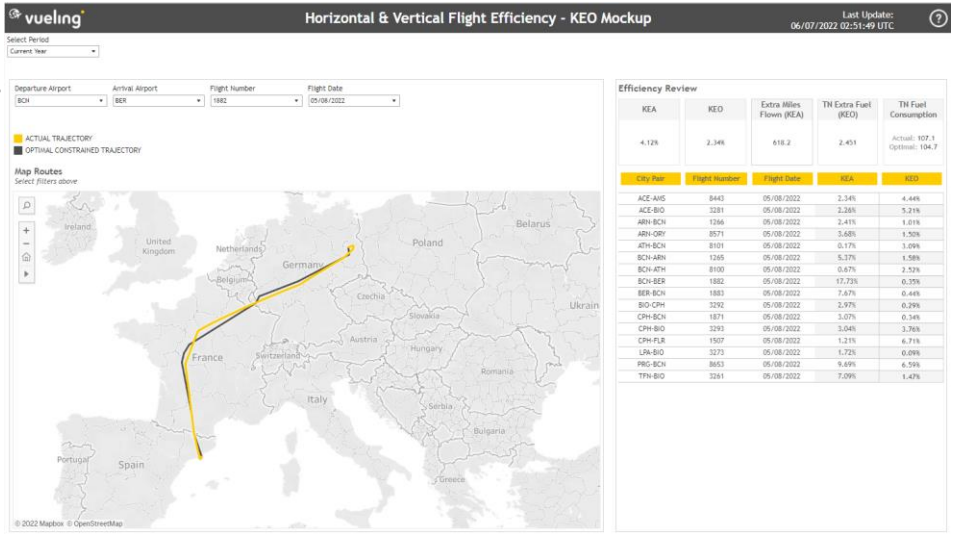
Ideal fuel burn	Benchmark fuel burn and emissions	Baseline

Proposed KPIs (in Fuel Burn)

KEO (formerly KEA, always >0%)	(Achieved Trajectory / Optimum Trajectory) - 1	Actual fuel burn vs ideal
Redefined KEP or KES (always >0%)	(Flight Plan or Constrained Optimum Trajectory / Optimum Trajectory)-1	Theoretical impact of planned/best available flight plan vs ideal
Tactical KEO	Achieved Trajectory / Constrained Optimum Trajectory (new)	Saved/added fuel burn and emissions due to tactical performance of ANSPs, NM, military…

Next Steps:

1 Evolve the KEO mock-up to calculate in real time the Optimum Trajectory



Example flight: VY1882 BCN-BER

Optimum trajectory

KEA

Actual Trajectory / Great Circle Distance (excluding first and last 40NM)	874 NM / 742 NM	+17.7%

Apparently inefficient

KEO

Actual Trajectory / Optimum Trajectory. Actual fuel burn vs ideal	5715 KG / 5695 KG	+0.3%

Really efficient

Note: The Optimal Constrained trajectory does not use ATC charges for its calculation a) because it is VLG policy and b) to compensate for the non-appropriate charges calculation

2 Use the collected data to introduce airspace design improvements (eg: dominant winds...)

3 Accelerate its introduction in the regulatory framework. How?

THANK YOU!

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