

# KEO

Optimal  
Trajectory  
KPIs

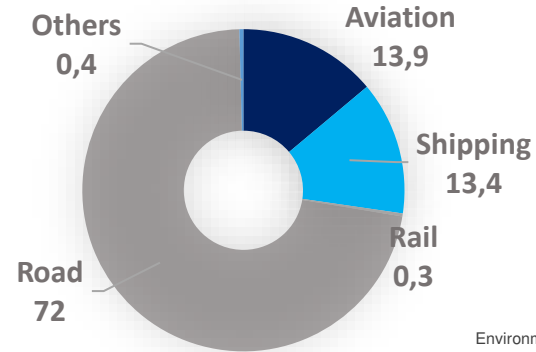




They didn't  
know it was  
impossible, so  
they got it

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

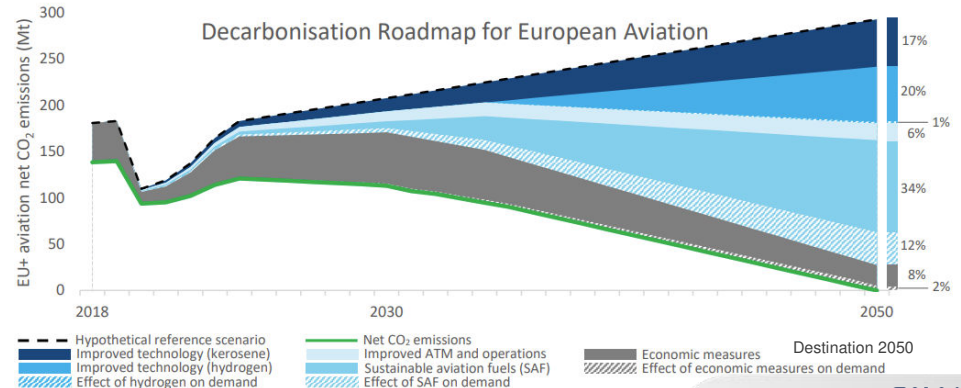
Despite Aviation isn't the most contaminant transport mode, is suffering a huge pressure and it's been reviled



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



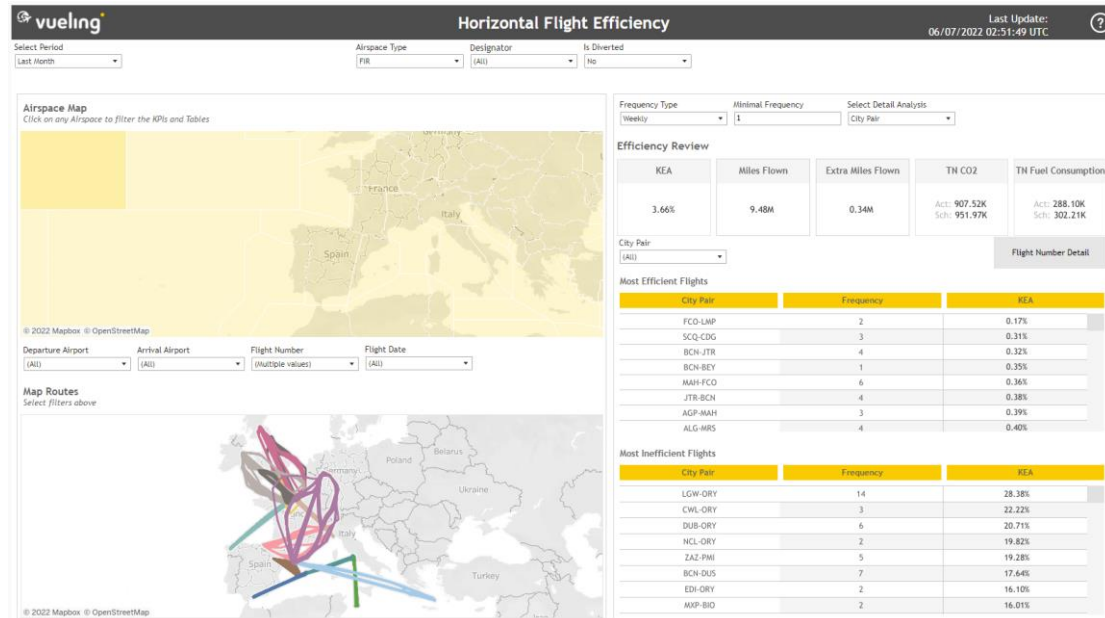
## Current Environmental KPIs have limitations to face the CO2 emissions problem

### 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

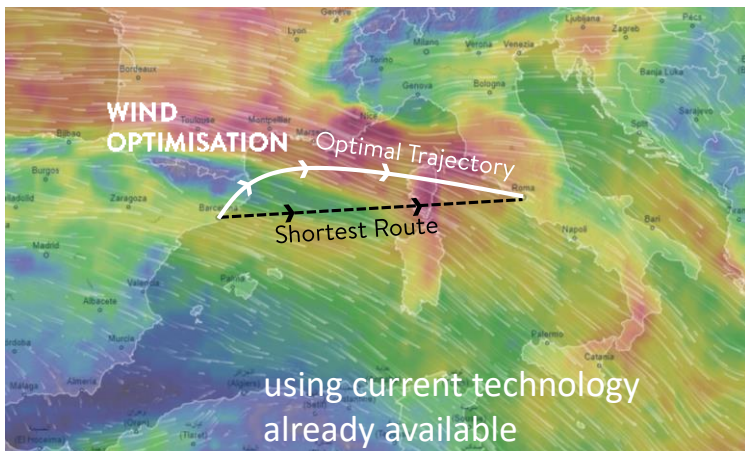
- Currently used to measure **PLANNED** efficiency vs **Great Circle Distance** Problem, Does not include:
- First and last 40NM
  - Vertical efficiency
  - Real Fuel Consumption considering Planned Winds (CO2)



## 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

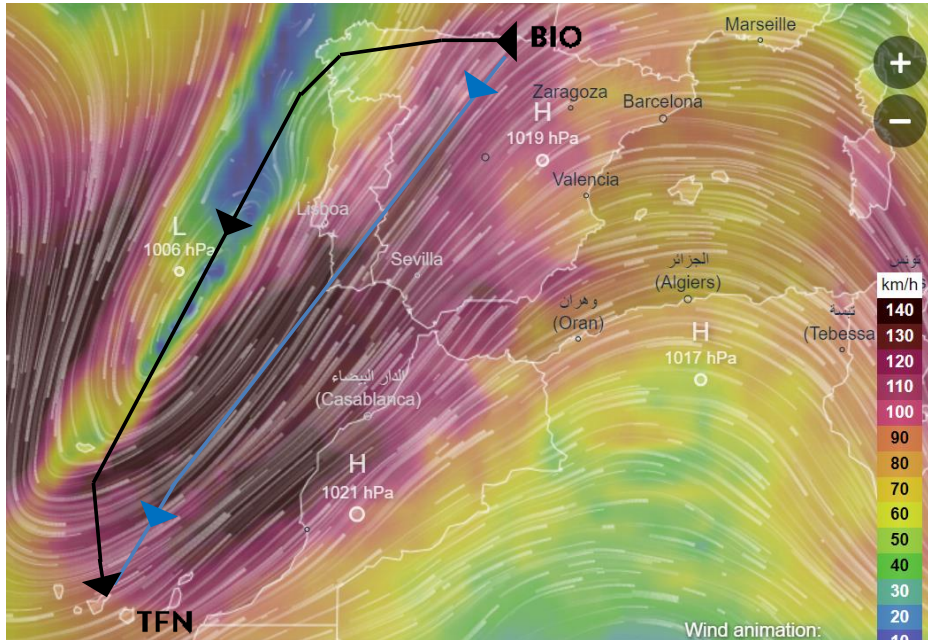


Eg:

- Continuous Descents
- Direct routings
- Optimal Flight Levels

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

-  Standard trajectory
-  Optimum constrained trajectory  $\approx$  Optimum trajectory



| KEA  |                   |               |
|--|-------------------|---------------|
| Achieved Trajectory / Great Circle Distance<br>excluding first and last 40NM |                   |               |
| <b>Standard Trajectory</b>   | 1021NM / 1019 NM  | <b>+0.2%</b>  |
| <b>Optimum trajectory</b>  | 1153 NM / 1019 NM | <b>+11.6%</b> |

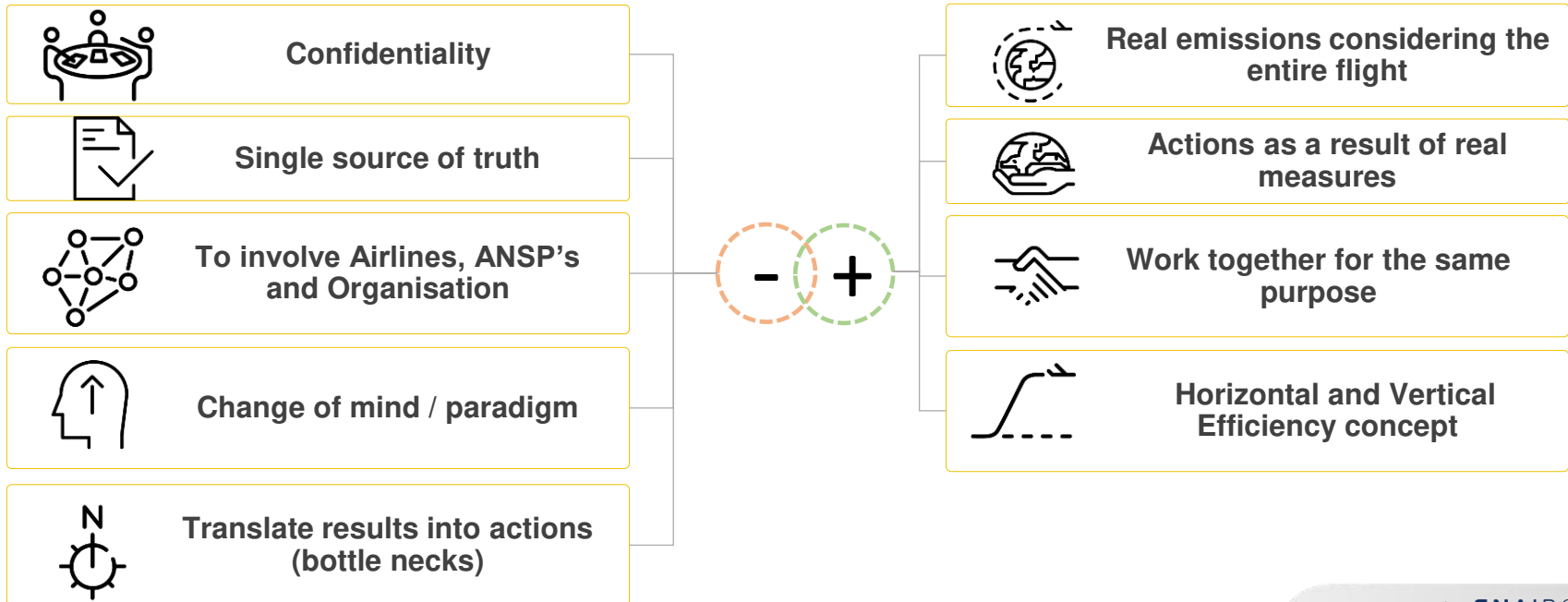
**Apparently inefficient**

| KEO  |                                   |              |
|--|-----------------------------------|--------------|
| Achieved Trajectory / Optimum Trajectory.<br>Actual fuel burn vs ideal |                                   |              |
| <b>Standard Trajectory</b>   | 7425 Kg of Fuel / 6844 Kg of Fuel | <b>+8.5%</b> |
| <b>Optimum trajectory</b>  | 6849 Kg of Fuel / 6844 Kg of Fuel | <b>+0.1%</b> |

**Really inefficient**

Proposed Solution: Start measuring Optimal route based on real CO<sub>2</sub> (KEO and others...)  
(Fuel Burn/CO<sub>2</sub> emissions-based vs Distance)

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



Proposed Solution: Start measuring Optimal route based on real CO<sub>2</sub> (KEO and other...)  
(Fuel Burn/CO<sub>2</sub> emissions-based vs Distance)

Validated by

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

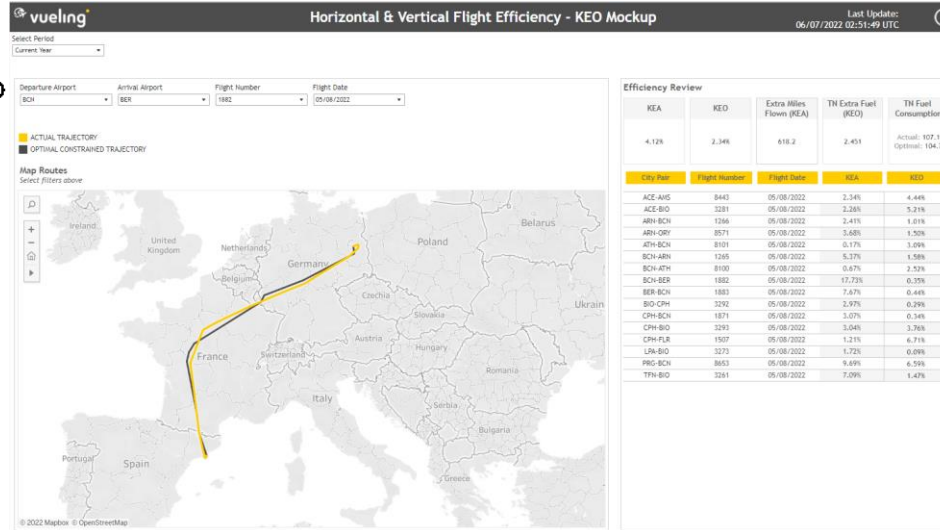
### Proposed KPIs (in Fuel Burn)

|   |  |   |
|---|--|---|
| <b>KEO</b><br>(formerly KEA, always >0%)    | (Achieved Trajectory / Optimum Trajectory) - 1                         | Actual fuel burn vs ideal   |
| <b>Redefined KEP or KES</b><br>(always >0%) | (Flight Plan or Constrained Optimum Trajectory / Optimum Trajectory)-1 | Theoretical impact of planned/best available flight plan vs ideal                         |
| <b>Tactical KEO</b>                         | 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

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

3 Accelerate its introduction in the regulatory framework. How?

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

# THANK YOU!



Gema Haro  
Head of Environment at ENAIRE  
gharo@enaire.es



Franc Sanmartí  
Director Sustainability & Government Affairs  
franc.sanmarti@vueling.com