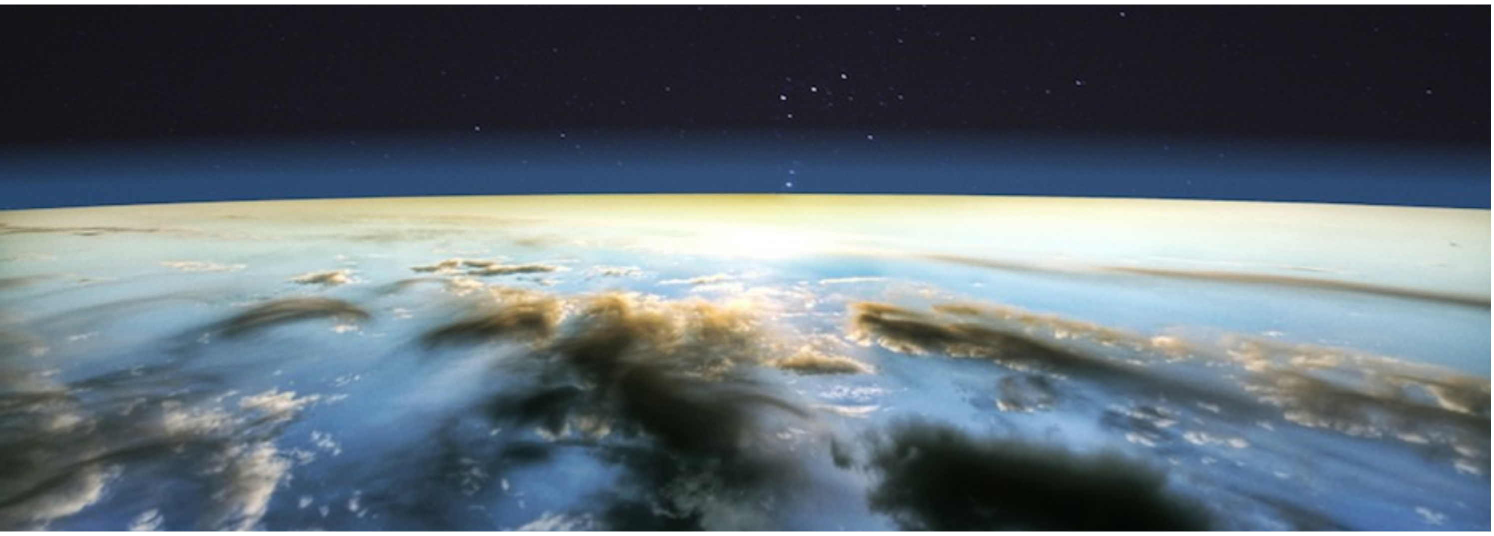

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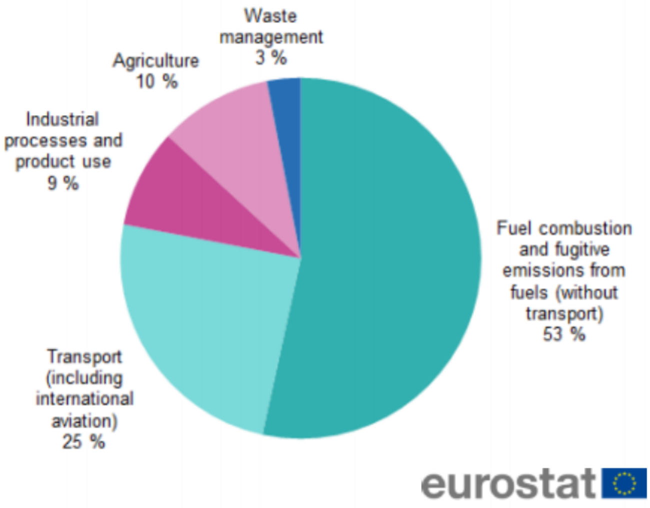
# Space-based Navigation to support 2050 carbon neutrality

Back in January 2016, the 2030 Agenda for Sustainable Development from the United Nations came into effect. The Agenda sets out 17 objectives, the so-called Sustainable Development Goals (SDGs), which establish 169 targets covering economic, social, and environmental spheres that must be achieved by all governments by 2030. Space-based services support the commitment with the 2030 Agenda and the importance of moving towards the SDGs. This specific article concerns the targets corresponding the SDG13 (Climate Action) and how EGNOS contributes to these goals.

Europe bids to reach carbon neutrality by 2050. In particular, its objective is to achieve a 50-55% cut in greenhouse gasemissions[1] by 2030 and zero-pollution (whether in air, soil, or water) by 2050.

In a recent article dated June 2020[2], Eurostat shows that the EU-27 generated 3893.1 million tons of $CO_2$ equivalents (the figure includes emissions from international aviation and excludes emissions or removals from land use, land-use change, and forestry (so called LULUCF) distributed by source sectors as follows:

**Greenhouse gas emissions, analysis by source sector, EU-27, 2018**

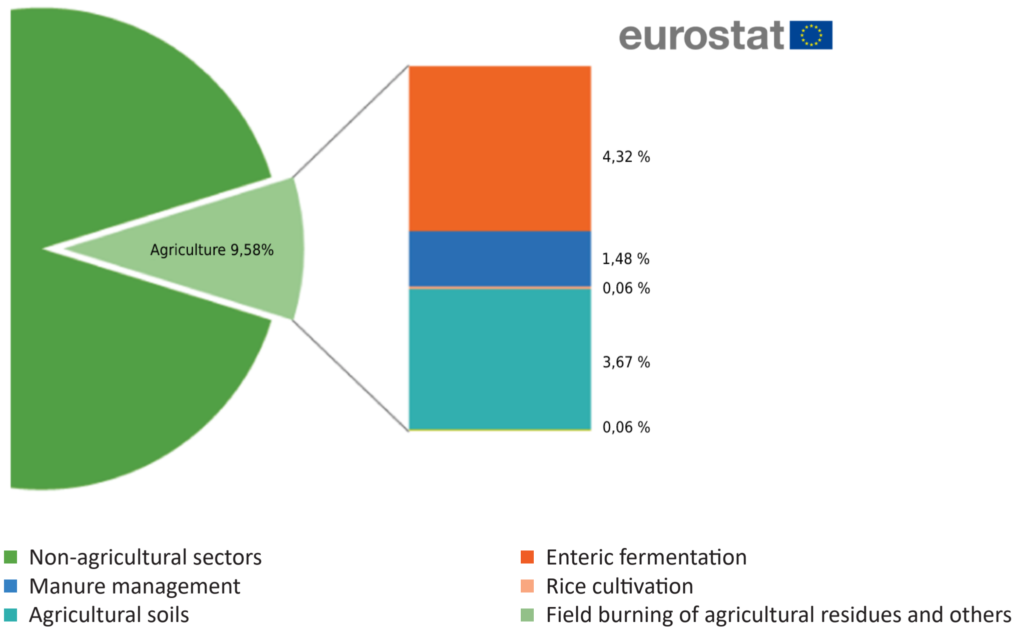



[1]GHG, greenhouse gas emissions: water vapor $H_2O$, carbon dioxide ($CO_2$), methane ($CH_4$)

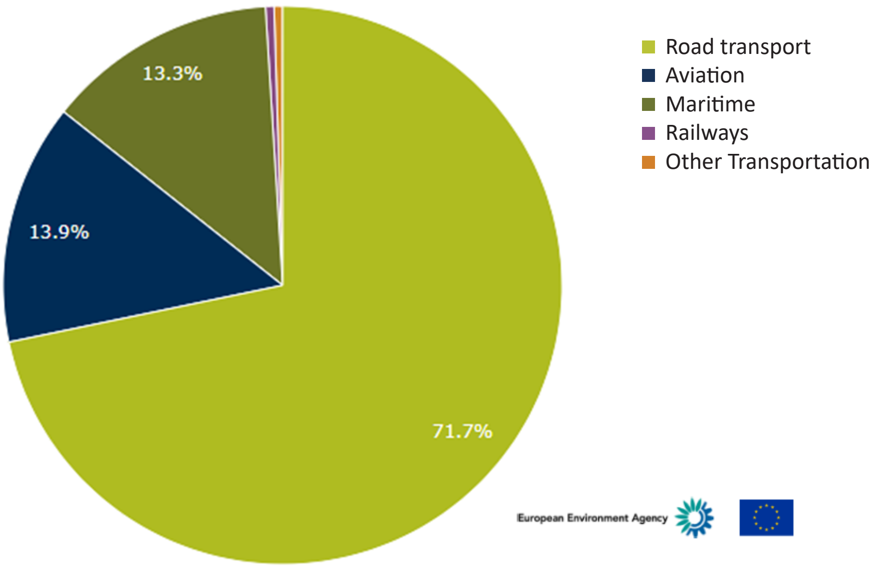
[2]Greenhouse gas emission statistics - emission inventories https://ec.europa.eu/eurostat/statistics-explained/pdfscache/1180.pdf

According to these figures, transport and agriculture add up to 35% of the emissions generated by the EU-27.

In particular, according to Eurostat, the contribution of farming is distributed as follows:




And the contribution of aviation within transport is explained as follows[3]:




What is the link between $CO_2$ emissions and a free public service that augments GPS signal allowing users to obtain a more precise PVT solution (Position, Velocity, Time)? Is there any relation between those source sectors and EGNOS? EGNOS is a fundamental pillar in the European Space Policy, which recently adopted resolutions to support a sustainable economy: thanks to EGNOS, sectors such as farming or aviation can reduce the amount of gas emitted. Every amount counts.

Satellite navigation systems, in general, and EGNOS, in particular, are used in farming for many applications, but tractor guidance is by far the most common one. Tractors use fuel and generate $CO_2$ to accomplish different tasks such as soil preparation, ploughing, spraying, harvesting, etc., carried out several times in each cropping season, with usually two or three seasons per year. Farmers labour following patterns known as the "pass-to-pass" mode, optimise their work, reducing the risk of overlap and ensuring that the whole field is treated.

[3]https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-12

GNSS guidance in tractors to be a vital tool. In particular, EGNOS provides the pass-to-pass accuracy needed by European cereal farmers, and, by driving more accurately, farmers save fuel[4].

For example, for a 20ha field in which ploughing, sowing, spreading, spraying, and harvesting take place one time per season, 48l of fuel are saved thanks to the reduced overlapped area treated (visit free EASE tool to perform the calculations). If this fuel is diesel B, C, or E5 (which generate an average of 2.5kg per litre of fuel), the release in the atmosphere of CO2 will be decreased of 120kg. According to Eurostat, in 2015, cereal crops in the EU-28 occupied 57 million hectares. If EGNOS were used to carry out all cereal crops tasks, around 350.000 tonnes of CO2 per year would nolonger be emitted.

EGNOS is used in aviation as well, mainly during the final approach when an LPV (Localiser with Vertical guidance)[5] procedure is employed. The final approach takes place in the lowest part of the troposphere, the area in which ozone pollution is generated (as a consequence of the NO2 generated by fuel combustion). Consequently, if EGNOS contributes to fuel reduction, it also contributes to ozone pollution reduction.

EGNOS allows for continuous descents (which signify not having to add thrust, thus reducing fuel consumption) and designing more direct procedures (which mean having to cover less distance). In the video hereunder, you will find further testimonies from operators: ‘you can fly a continuous descent, so we don’t need to add thrust’ (minute 2:50 and 5:27). ‘EGNOS can reduce the impact of aviation in the environment by facilitating curved approaches and continuous descent paths, and therefore, reduce both noise and emissions.’ And on ANSPs (minute 3:16) ‘we can design more direct procedures reducing fuel consumption and therefore emissions.'

Last but not least, as the number of aerodromes with published LPV procedures is increasing, the possibility for a dense network of alternative aerodromes is becoming more plausible, which means the fuel loaded on an aircraft as “alternative fuel”[6] can be reduced. Reduced fuel on an aircraft implies less weight thus less fuel consumed and, ultimately, less CO2 emissions. As a rough estimation, if for a given destination aerodrome we assume a flight distance of 1,500km, a cruise airspeed of 450kts (833km/h), fuel consumption during cruising of 5,300lbs/h (2,400kg/h), and an aircraft weight of 73,000kgs, the amount of fuel saved during that single flight is approximately 7.41kg because a closer alternative for landing is available. Usually, CO2 emissions from aviation fuel are estimated at 3,15 kg of CO2 per Kg of fuel burnt[7]. Assuming the previous scenario, for every 1000 flights an aerodrome receives, 23.3 tons of CO2 would not be released into the atmosphere if those 7.4kg of fuel per flight were saved.

Continuous descents, more direct-procedure designs, and less alternative fuel in the tank at take-offs are just three simple scenarios, but others must be explored. There is still a long road ahead to quantify the CO2 emissions saved in today’s European aviation, as well as in the near future, thanks to EGNOS.

Through the Green Deal, Europe has triggered an immense challenge: to become carbon neutral in 30 years. Every single kilogram of CO2 not released into the atmosphere counts. EGNOS, currently an essential enabler in European PBN air navigation and a fundamental pillar in precision farming (which represents greener and sustainable agriculture), is part of the challenge. Considering EGNOS plays a role in maritime, road, rail, and even fully automated vehicle transportation, shortly, once EGNOS augments not only GPS but also Galileo, more scenarios will become available to analyse from this perspective.

[4]This saving is calculated as Fuel savings (l) =Number of times a task is carried out x (Saved Area (ha) x Fuel consumption (l/ha)).
[5]Performance-Based Navigation (PBN) Manual (Doc 9613). - 4th edition, 2013
[6]The alternate fuel is the amount of fuel that is required from the missed approach point at the destination aerodrome until landing at the alternate aerodrome.
[7]https://www.iata.org/contentassets/922ebc4cbcd24c4d9fd55933e7070947/icop20faq20general20for20airline20participants20jan202016.pdf