The place-based multilevel dimension of the transition to sustainability in the European aerospace industrial ecosystem: a systematic review

Carmen Sillero Illanes, JRC-Seville (P)
Rosa Gallardo Cobos, University of Córdoba (Spain)
Pietro Moncada Paternò Castello, JRC-Seville
Karel Haegeman, JRC-Seville

ERSA 2023 Alicante 29 August 2023

European Commission

Index

Introduction to the Aerospace and Defense European Ecosystem

Research Question

Systematic Literature Review

Results

Discussion

Conclusions

Questions for the future

Aerospace and Defence ecosystem

EUR 247 billion turnover in 2021 (EUR 125 billion for aeronautics, EUR 12 billion for space and EUR 110 billion for defence)**(*)**

Manufacturing companies in aeronautics, space and defence, space operator and data and services provider and research institutes	Vanguard of technology on Aircraft, helicopters, satellites, launchers, UAVs, UAM	Essential for European sovereignty and Security	Globally competitive European OEMs,Tiers1, Tiers2 and their supply chain Airbus, Safran, Thales, Dassault Leonardo…
High-tech nature European technology institutes and academia knowledge transfer channels	Competing industry on other continents benefit from a massive, stable and predictable home markets of public procurement, and sponsoring of their national industry	Rebound after crisis COVID-19, Uncertain due to the aftermath of Ukraine crisis (fuel prices, disruption supply chain, geopolitical risk)	EU Member States define the needs and act as the primary client. Fragmented home market. Defence budget increase due to Ukraine crisis.

Aviation generated 2.5% of the global anthropogenic CO2 emissions in 2019. Additionally, aviation emits nitrogen oxides, sulphate aerosols, compounds, particulates, and water vapour leading to the formation of contrails, which contribute to radiative forcing and global warming

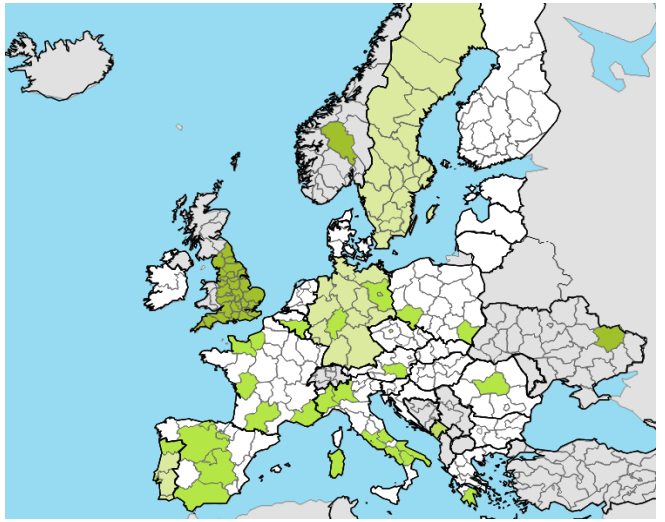
European Green Deal, Fit for 55, EU Climate Target Plan for 2030 and Repower EU Plan
2050 EU will be a climate neutral society as well as a carbon neutral economy

(*) SWD(2023) 280 final. COMMISSION STAFF WORKING DOCUMENT For a resilient, sustainable and digital aerospace and defence industrial ecosystem: Scenarios for a transition pathway

European Aerospace Ecosystem, how it lands in the European regions

- National aerospace sectors, mainly France, Germany, Italy and Spain
- Extended supply chain and a fabric of dynamic small- and medium- sized enterprises throughout the EU, some of them world leaders in their domain.

29 Aerospace clusters
EACP 2021



39 European Regions/countries mentioned Aerospace at RiS3 2014-2020(Eye-RIS3)

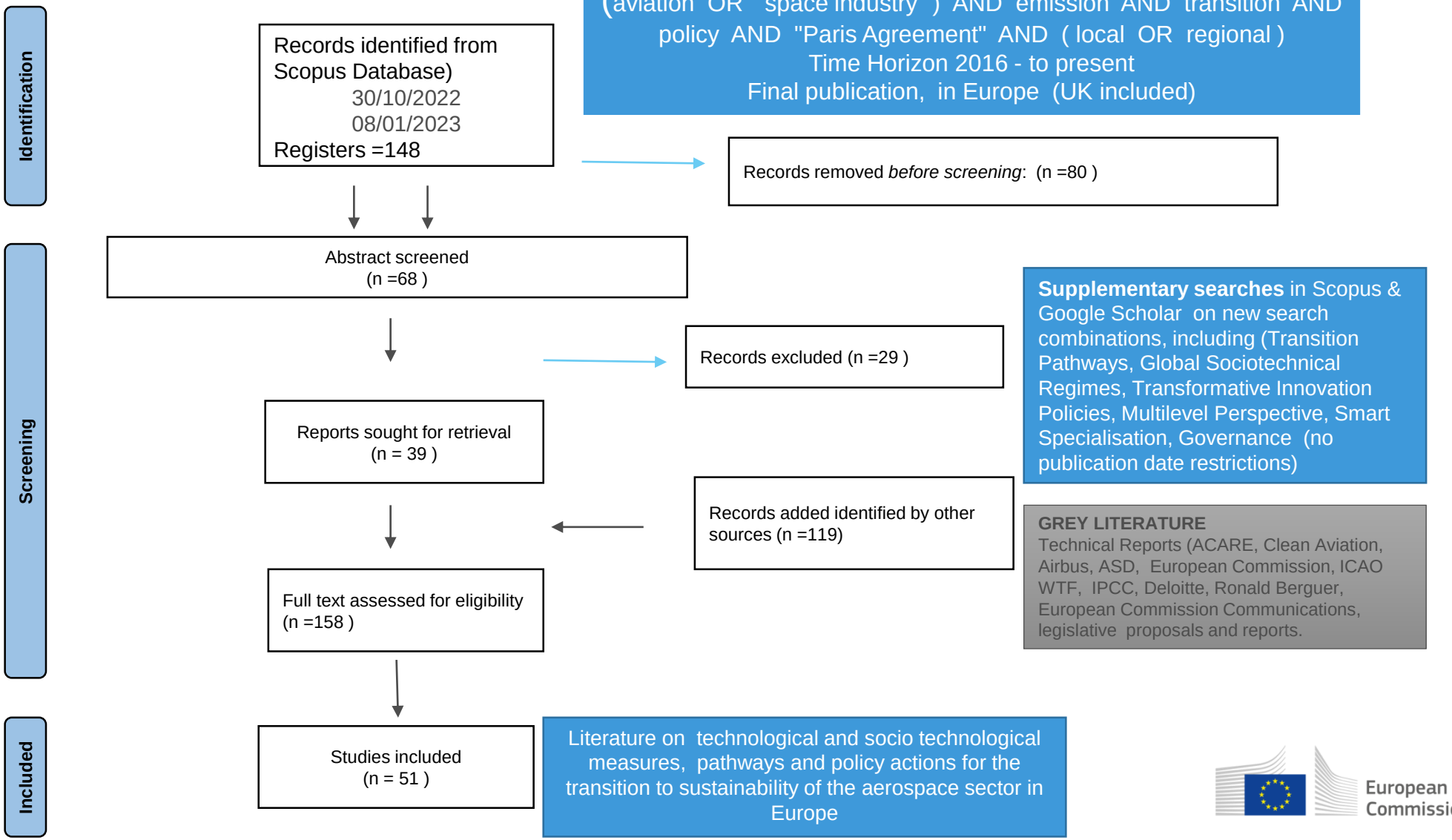
European Commission

Research Question

What does the literature reveal about the territorial dimension of the policy intervention for the transition to the sustainability of the European aerospace industrial ecosystem?

Systematic Review

Systematic Review-Steps



European Commission

Climate impact Migitation technology pathways

Analysing the demand

MLP in the Socio-Technical Transition. Sustainability Transition in Aviation

Industrial Policies after Green Deal and Covid-19

Transition to Sustainability Industrial Policy mix

Climate impact Migitation technology pathways

Systematic Review Results

Net –Zero Aviation

Demand

- EU Emission Trading System
- Behavioral changes, information of emission in tickets
- Air passenger duties (Low carrier duty or Progressive frequent flier tax) emission levies and carbon taxes
- Banning air travel advertisement
- Phasing out short-haul flights
- Alternatives to flying. The use of lower-carbon travel modes
- Staying airport expansion

Energy Intensity

- Improvement in Aircraft design
- Faster replacement of inefficient aircrafts
- Increase occupancy, denser premier class seats
- More efficient Traffic Management

Carbon Intensity

- Fossil Fuel Switching
- **NEW PROPULSION TECHNOLOGIES**
  - Electricity
  - Green Hydrogen
  - Short-haul aviation only
- **SAF**
  - Biofuels
  - Synthetic Fuels
  - Short, Medium and long-haul Aviation

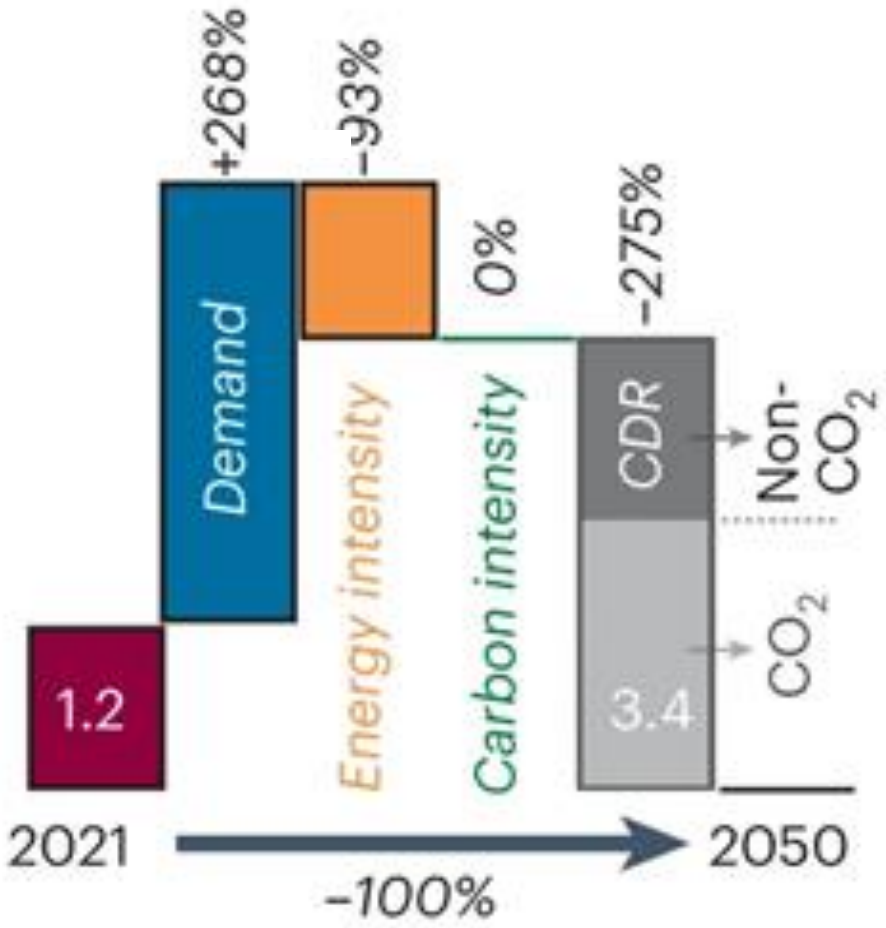
Carbon Off setting

Carbon Dioxide Removal

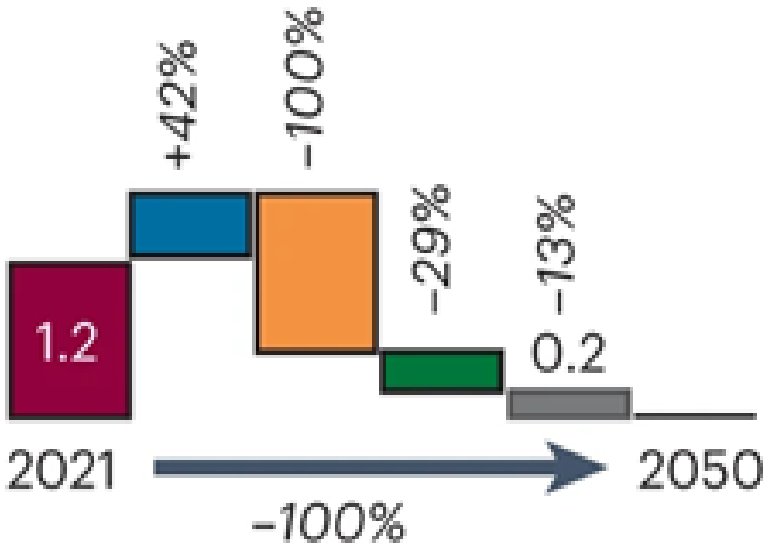
Adapted from Bergero et al. (2023), Gössling & Lyle (2021), Dray et al (2021)

Business as Usual Scenario

Ambitious scenario



Bergero et al. (2023) . Pathways to net-zero emissions from aviation



“European climate-neutral aviation will fly if traffic is reduced to limit the scale of the climate impacts to mitigate” Sacci et al (2023)

Analysing the demand

- The evolution of demand will play a crucial role, with expectations of a consistent annual growth rate of 4%. In a Business-As-Usual scenario, CO2 equivalent emissions could reach 2.71 times the 2021 level by 2050 (Bergero et al. 2023).

- Emerging trends in citizen behaviour due to the increased awareness of climate responsibilities are noteworthy. (Åkerman et al. 2021; Gössling and Humpe 2023; Wamsler, Mundaca, and Osberg 2022)

- Our SLR has delved into literature analyzing the political agency and social drivers of individual air travellers, primarily in Sweden and Germany. "individual transition pathways" (Olson, Svane, and Gullström 2021)

- Communication and business model of the Airlines (Gössling S. & Humpe A. 2023)

MLP in the Socio-Technical Transition. Sustainability Transition in Aviation

- Low-carbon transition will not be achieved by technology innovation or carbon pricing alone (Gössling and Lyle 2021)
- Authors advocating the Multi-Level Perspective (MLP) within Socio-Technical Transition and Transformative Change are calling for open to new actors to define a agenda for aviation. (Frank W Geels et al. 2017; Frank W. Geels et al. 2017; Geels 2006; Gössling and Higham 2021; Kanger, Sovacool, and Noorkõiv 2020; Pickard and Pasqualino 2022)
- This agenda seeks to surpass incremental improvements and instead analyze radical and disruptive innovations, new niches capable of replacing fossil-based jet fuels, breaking the industry's carbon lock-in and pave the way for a fossil-free future.

Systematic Review Results

Vector	EU Policies examples	Barriers	Example Territorial approach	Authors
CARBON OFSETTING	CORSIA.	Relates only to neutral growth beyond 2020. Carbon-capturing double-counted	Airport Carbon Accreditation (ACA) program.	(Gössling and Lyle 2021a; Lai et al. 2022a; Larsson et al. 2019; Pickard and Pasqualino 2022)
EMISSION TRADING SYSTEM	EU Emission Trading Systems	Carbon price within the system has not been high enough to generate substantial changes in airlines' behavior.	The local approach can complement the EU ETS for aviation	(Gössling and Humpe 2020; Gössling and Lyle 2021a; Larsson et al. 2019; Oesingmann 2022)
LEVIES & TAXES.	Carbon tax reflecting on the cost of emissions	An agreement (ICAO) from 1944 limits taxes on international aviation, and international flights are exempted from value added taxes or kerosene taxes	Local restrictions, as taxation and carbon pricing should also encourage and incentivise innovation and long-lasting feasible solutions that enablethe broadest possible global adoption.	(Gössling and Lyle 2021a; Lai et al. 2022a; Oesingmann 2022) Pickard and Pasqualino 2022)
SAF BIOFUELS	Renewable and Low-Carbon Fuels Value Chain Industrial Alliance	Limited availability and restricted by competing uses.	Biofuels production based on urban waste. Oslo, Gothenburg, and Hamburg have launched initiatives to use organic waste to produce biofuels for transportation, including aviation.Cities Mission	((ACARE) 2022; Åkerman et al. 2021; Bergero et al. 2023; Chiaramonti et al. 2021; Dray et al. 2022; Gössling and Humpe 2023)
SAF POWER TO LIQUIDS	Fit for 55' package. Refuel EU Aviation Renewable and Low-Carbon Fuels Value Chain Industrial Alliance INNOVATION FUND: HORIZONT EUROPE	More than three times higher than the global 2022 average cost of fossil jet fuel (as of 31 May 2022)	Smart Specialisation Strategies S3 ERDF, RRF	((ACARE) 2022; Åkerman et al. 2021; Barbosa 2022; Bergero et al. 2023; Dray et al. 2022; Lai et al. 2022a; Sacchi et al. 2023)
HYDROGEN AND ACCESS TO INFRASTRUCTURE FOR ALTERNATIVE PROPULSION TECHNOLOGIES	Clean Aviation JU Zero Aviation Alliance Refuel EU Aviation EU: INNOVATION FUND	Switching to hydrogen would require completely new aircraft designs as well as production facilities and distribution networks for hydrogen. LIMITED TO SHORT HAULS	RRM (Airbus Zero e. France & Spain) MoU Clean Aviation Hydrogen Valleys Regional S3 (S3 Partnership). H2 Hub Airport in France. ERDF	((ACARE) 2022; Åkerman et al. 2021; Delbecq S., Fontane J., Guardain N., Mugnier H., Planès T 2022; Lai et al. 2022b; World Economic Forum 2023),
ELECTRIFICATION	Clean Aviation JU: Zero Aviation Alliance	Energy density would have to increase three times the current energy density LIMITED TO SHORT HAULS	MoU Clean Aviation Vinnova, funded the project Electric Aviation in Sweden (ELISE) . INTERTERRITORIAL INITIATIVE NORDIC NETWORK FOR ELECTRI AVIATION (NEA) (Lai, 2022)	((ACARE) 2022; ACARE and The Mission Possible Partnership 2022; Åkerman et al. 2021; Barbosa 2022; Bergero et al. 2023; Delbecq S., Fontane J., Guardain N., Mugnier H., Planès T 2022; Dray et al. 2022; Gössling and Lyle 2021a; Lai et al. 2022b, 2022a; Larsson et al. 2019; Sacchi et al. 2023; World Economic Forum 2023)
REDUCED SPECIFIC ENERGY USE FOR MORE EFFICIENT VEHICLES	Clean Aviation JU		Support Innovation for the emergence of new niches of disruptive Innovation. Public Procurements.	(Åkerman et al. 2021; Delbecq S., Fontane J., Guardain N., Mugnier H., Planès T 2022; Dray et al. 2022; Gössling and Lyle 2021; Lai et al. 2022a; Larsson et al. 2019)(Bergero et al. 2023)
OPTIMIZED AIR TRAFFIC MANAGEMENT FOR MINIMIZING AVIATION'S CO2 AND NON-CO2-EFFECTS.,	Single Sky European Initiative Sesar JU			((ACARE) 2022; Åkerman et al. 2021; Barbosa 2022; Bergero et al. 2023; Delbecq S., Fontane J., Guardain N., Mugnier H., Planès T 2022; Dray et al. 2022; Gössling and Lyle 2021a; Lai et al. 2022b, 2022a; Larsson et al. 2019; Sacchi et al. 2023; World Economic Forum 2023)
CO2 REMOVAL BY DIRECT AIR CAPTURE (DAC) (AKA DACCS) AND BECCS	Demonstrators funded by Innovation Fund and Horizon Europe		Demonstrators Map	(European Commission 2023; Sacchi et al. 2023)
INCREASE OCCUPACY	14 European countries have implemented distance based air passenger taxes			Gössling and Lyle 2021; Lai et al. 2022a; Larsson et al. 2019; Pickard and Pasqualino 2022)
PHASING OUT SHORT-HAUL FLIGHTS			France decided to ban flights between cities that are linked by a train journey	(Gössling and Lyle 2021b)
STAYING AIRPORT EXPANSION				(Gössling and Lyle 2021a; World Economic Forum 2023)
INTERNATIONAL COLLABORATIVE PROJECTS SUPPORTED BY THE GOVERMENTS	Horizon Europe		Recovery and Resilience Mechanism, Connected Regional Innovation Valleys, Interreg , I3	(Pickard and Pasqualino 2022; World Economic Forum 2023)
REAL TIME & EXPERIEMENTATION ROOM				Malanowski et al 2022
MARKET BASED POLICIES FOR REDUCING DEMAND	VAT for all air travel, Removing subsidies Progressive frequent Flyer tax. Creating demand for green flights through transparency on emissions	Potential for traveller leakage		Gössling and Lyle 2021; Lai et al. 2022a; Larsson et al. 2019; Pickard and Pasqualino 2022)(World Economic Forum 2023)
INVOLVEMENT OF STAKEHOLDERS, CITIZENS, LOCAL GOVERMENTS	PUBLIC PRIVATE PARTNERSHIPS, ZERO AVIATION ALLIANCE EU Missions,	Sociotechnical Regimen Resistant	OPEN DISCOVERY PROCESS	Gössling and Lyle 2021; Lai et al. 2022a; Larsson et al. 2019; Pickard and Pasqualino 2022)(World Economic Forum 2023) Pontikakis et al 2022
COORDINATE HORIZONTAL AND MULTILEVEL POLICIES	IPCEIS, RIS3; Competition policy; Environmental standards; Climate policy Energy	Cultural factors Lack of capacities Governance mechanism	Alignment of local, regional policies with national and EU policies	Tagliapietra, S., & Veugelers, R. (2020)).
MODAL SHIFT FROM AIR TO MODES OF TRANSPORT WITH LOWER EMISSIONS, EUROPEAN MOBILITY AS A SERVICE (MAAS);	Information to consumer about emissions and mobility alternatives		Sweden scenarios	(Åkerman et al. 2021; Arnz 2022; Full et al. 2021; Gössling and Lyle 2021a)
REGULATIONS	FIT FOR 55- Refuel Aviation, New Regulation for encouraging climate optimised routing, Transparency of emissions and green flights		Sand boxes (interregional) Mobility as a service	(ACARE) 2022; ACARE and The Mission Possible Partnership 2022; Åkerman et al. 2021; Barbosa 2022; Bergero et al. 2023; Delbecq S., Fontane J., Guardain N., Mugnier H., Planès T 2022; Dray et al. 2022; Gössling and Lyle 2021a; Lai et al. 2022b, 2022a; Larsson et al. 2019; Sacchi et al. 2023; World Economic Forum 2023)Forum
CERTIFICATIONS AND STANDARDS	The EU has to establish a world-wide recognised SAF and hydrogen standards and certification processes for aviation		Interterritorial cooperation and collaboration with OEM, SMEs and innovators to define European Standards	(ACARE) 2022; ACARE and The Mission Possible Partnership 2022; Åkerman et al. 2021; Barbosa 2022; Bergero et al. 2023; Delbecq S., Fontane J., Guardain N., Mugnier H., Planès T 2022; Dray et al. 2022; Gössling and Lyle 2021a; Lai et al. 2022b, 2022a; Larsson et al. 2019; Sacchi et al. 2023; World Economic Forum 2023) Malanowsk et al 2022
ANTICIPATION BASED POLICY INSTRUMETNS			Regional Foresight	Malanowski et al 2022
ADRESSING SKILL SHORTAGES			Identification of local skills needs	Pickard and Pasqualino 2022

How could it be translated at the territorial level?

Expand the focus from ecosystem specific analysis to challenge oriented approach crossing sociotechnical systems (energy, mobility, industry, digital, tourism, infrastructures…)

Engage new constellations of actors (consumers/users included, cities), broad co-creation, open discovery process, open agenda setting, particularly involving new approaches to air mobility, space and defense.

ODP

Aerospace Value Chain, OEMs, tiers one and local cluster

Connect the local/regional/national initiatives with the EU initiatives Net Zero objective) (Clean Aviation, AZEA, Mobility Strategy, Green Deal Industrial Plan, Net Zero Industrial Act, Drone Strategy, Space Strategy..)

Multiple instruments, much more than **innovation projects projects**: Tax and Regulation, PPP, skills, infrastructures, anticipation and foresight, mobility platforms, information to citizens, local offsetting

Address funding fragmentation RRM (National Level)- Regional mart Specialisation Strategies and local missions

Address horizontal fragmentation of funding instruments and policies in the territory (Hydrogen Valleys, SAF development and aerospace cluster initiatives)

Multilevel governance

Interregional cooperation

Conclusions and future threads for research

- Our SLR confirms that the role of the territory remains a neglected topic in the literature about the transition to sustainability of the aerospace ecosystem in Europe.

- It's evident that achieving the low-carbon transition to the aerospace ecosystem extends beyond technology innovation or carbon pricing alone. Nevertheless, technological innovation and the connection with the aerospace global value chain is essential for maintaining or upgrading the positioning of the territories,

- Exploring the synergies among policies and instruments and developing new ways of multilevel governance layers are essential for policy directionality and for optimising the resources available.

- European Regional aerospace hubs, their actors and their interconnection as European Aerospace (and Defense) ecosystem could play a differentiated role in Place-Based Transformative Innovation Policies (Transition-oriented or mission-oriented).

The pilot project "Partnership for Regional Innovation," led by JRC in collaboration with 74 European territories, networks, and European, National and Regional institutions, is actively exploring TIP. This initiative is the most suitable arena for reflecting, experimenting and mutual learning and may provide strong evidence for the best future decision policy making.

Future threads for research

- How are the policy-blind innovation policies in place for the Aerospace transition impacting the European regions?
- Study cases of place-based transition/mission based-policies effectively contributing to benefit from the bottom-up to the top-down industrial (and sectorial) transition pathways in global value chains. Analyse of policy mix and multilevel governance structures.
- How is emerging sustainable air mobility as a system in the European territories?
- How could place-based TIPs, stimulate and accelerate new niches, sustain variety and provide, alternative approaches to the incremental OEMs' path-driven innovation in European Mobility?
- Space and Defence

Thank you
and keep in touch

Carmen.Sillero-Illanes@europa.eu

EU Science Hub
joint-research-centre.ec.europa.eu

@EU_ScienceHub
EU Science Hub – Joint Research Centre
EU Science, Research and Innovation
EU Science Hub
@eu_science

European Commission