Feedback opportunity for the work programme 2025

Cluster 5 - Climate, Energy and Mobility

Destination 1: Climate sciences and responses for the transformation towards climate neutrality

Draft expected impacts:

Advancing climate science and the knowledge base necessary to underpin actionable solutions is essential for catalysing the global transition to a climate-neutral and climate-resilient society.

Research should contribute to closing major knowledge gaps on the changing climate together with their associated impacts and risks, on both society and nature, and to developing tools to support decision-makers in designing and implementing effective mitigation and adaptation actions at various time and spatial scales while properly accounting for synergies and trade-offs with other policy objectives, such as just transition and leaving no one behind. Tailored scientific approaches that take into account disparities between regions, countries, communities and diverse groups within society, are needed, to understand how they are affected by global warming and what array of response options is available to them.

The first objective is to support and accelerate climate action (both mitigation and adaptation) globally by:

- Improved knowledge of the Earth system, its recent evolution and future responses under different global emissions pathways and socio-economic scenarios.
- Increased understanding of the interrelated impacts between climate change, human and natural systems, including from compound, cascading and tail risks, improving the attribution to anthropogenic factors, and leveraging the role of climate services for effective adaptation and response strategies.
- Well-ddesigned and evaluated solutions and pathways for climate-resilient, low-GHG-emission development enabling just societal transformation while promoting citizen and stakeholder involvement, climate literacy and integration of natural and social sciences.
- Increased synergies with the EU Mission on Adaptation to Climate Change generating actionable knowledge in support of transformative adaptation.

The second objective is contribute substantially to key international assessments by closing key knowledge gaps related to climate change. Such assessments include the ones by IPCC, IPBES, the Scientific Assessment of Ozone Depletion and other initiatives such as the Coupled Model Intercomparison Project under the World Climate Research Programme.

The third objective is a strengthened European Research Area on climate change by boosting scientific excellence and capacity in an inclusive manner across the participating countries.

The fourth objective is the maximisation of synergies with other policy priorities such as biodiversity and ecosystem preservation and restoration, just transition, just resilience, pollution reduction, health and well-being, resource conservation, circularity and the Sustainable Development Goals by exploring co-benefits, trade-offs and potential unintended consequences of climate strategies and policy interventions.

Main expected outcomes:

1. Advanced understanding and capability to analyse the recent past and predict the future evolution of the coupled Earth system, at global to local scales, and across timescales.
2. Fit-for-purpose capabilities for understanding, monitoring and attributing the causes and impacts of climate change.
3. Improved understanding of adaptation effectiveness and limits in the warming world, generating new and consistent scientific evidence to support decision-making.
4. To advance the understanding of the impacts of temperature overshoot and the attainability of bringing temperatures down using feasible and sustainable levels of Carbon Dioxide Removals (CDR) to complement reductions of GHG emissions.
5. Increased acceptance of climate policies by political and social stakeholders representing diverse socio-economic and development backgrounds, building on new scientific approaches that foster more balanced and inclusive policies by prioritising equity and justice.
6. Improved coherence and consistency among the different scientific communities and initiatives, and across derived policies.
7. Enabling science-based implementation of the Paris Agreement in 3rd countries, with particular emphasis on Africa and supporting the EU-AU R&I Partnership.
8. The expansion of the scientific knowledge base concerning pathways that decrease emissions of fluorinated greenhouse gasses to enable an improved implementation by Parties of the Montreal Protocol and its Kigali Agreement.

Overall, a significant contribution to the IPCC and other scientific assessments, as well as the UNFCCC and the global stocktake under the Paris Agreement.

Feedback opportunity for the work programme 2025

Cluster 5 - Climate, Energy and Mobility

Destination 2: Cross-sectoral solutions for the climate transition.

Draft expected impacts:

Batteries

- Increased competitiveness and strategic autonomy of EU Battery sector while maximizing sustainability.
- Enhanced local and circular supply chains by reducing dependency on critical raw materials and upscaling processing capacity, also for recycled materials.
- An integrated European battery sector for high performance batteries, from design to manufacturing and all the way to end of life, reducing environmental impact.
- Improved resilience of EU energy system and facilitated integration of renewable energy sources through application of energy storage.
- Affordable and reliable batteries to boost the market penetration of Electric Vehicles and storage systems.

Cities and Communities

- Support European cities in engaging in sustainability and climate-neutrality transitions, thereby enabling the EU to achieve targets set out by the European Green Deal and fulfil its commitments related to the UN Agenda 2030, the Urban Agenda for the EU, the Habitat III New Urban Agenda and the Paris Agreement.

Main expected outcomes:

Batteries

- Development of sustainable low-cost battery systems based on Li-ion, Na-ion or other chemistries, addressing both the mobility and stationary sectors.
- Development of battery systems for longer-term stationary storage (>12h or more) with low self-discharge, high cycle efficiency and low cost, using non-critical raw materials.
- Increasing the flexibility of processing technologies to deal with a variety of primary and secondary material streams, reducing dependence on single sources.
- Develop an integrated approach for advanced material, cell design and manufacturability for high-performance batteries aimed at mobility.
- Accelerating battery testing, reducing time-to-market while increasing battery reliability, predictability, and safety.

Communities and Cities

- Support the Driving Urban Transition (DUT) co-funded partnership to roll out its full strategy and action plan

Feedback opportunity for the work programme 2025

Cluster 5 - Climate, Energy and Mobility

Destination 3: Sustainable, secure and competitive energy supply.

Draft expected impacts:

Renewable energy

- Energy producers have access to competitive European renewable energy and renewable fuel technologies and deploy them to enhance the EU's energy security. This will contribute to the 2030 "Fit for 55" targets (in particular, at least 42.5% renewable energy share and aiming for 45% in the EU energy consumption, 5.5% advanced biofuels and renewable fuels of non-biological origin share in EU fuel consumption). It will also contribute to the indicative target of at least 5% innovative renewable energy technology for the newly installed renewable energy capacity. By 2050, climate neutrality in the energy sector will be achieved in a sustainable way in environmental (e.g., biodiversity, multiple uses of land and water, natural resources, pollution) and socioeconomic terms, and in line with the Sustainable Development Goals.
- Technology providers have access to European, reliable, sustainable, and affordable value chains of renewable energy and renewable fuel technologies.
- Economic sectors benefit from better integration of renewable energy and renewable fuel-based solutions that are among others cost-effective, efficient, flexible, reliable, and sustainable. Such integration is facilitated by digital technologies and by renewable energy technologies that provide network stability and reliability.
- European researchers benefit from a stronger community and from a reinforced scientific basis on renewable energy and renewable fuel technologies, also through international collaborations.
- European industries benefit from a reinforced export potential of renewable energy and renewable fuel technologies, also through international collaborations.
- European industries become frontrunners and maintain technological leadership in innovative renewable energy technologies in line with the energy union strategy.
- European citizens have access to an energy market that is fair and equitable, more resilient, uses all different types of local renewable energy resources, and is less dependent on fossil fuels imports. Local communities benefit from a more decentralized and secure energy system and from multiple uses of land and water. Less citizens experience fuel and energy poverty.
- The Strategic Energy Technology Plan (SET Plan) implementation working groups on solar photovoltaics, solar thermal technologies, renewable fuels and bioenergy, wind energy, geothermal energy, and ocean energy benefit from a reinforced scientific

basis and collaboration on renewableenergy and renewable fuel technologies towards meeting the ambitious targets of the European Green Deal.

Energy systems, grids & storage

R&I actions will support the just digital and green transformation of the energy system through advanced solutions for accelerating the energy systems integration and decarbonisation. The developed clean, sustainable solutions will contribute to making the energy system and supply more reliable, resilient, and secure. The solutions will contribute to increase flexibility and grid hosting capacity for renewables through optimizing cross sector integration and grid scale storage. They will enhance the competitiveness of the European value chain, reduce pressure on resources (also by making technologies 'circular by design') and decrease dependencies.

Carbon capture, use and storage (CCUS) and carbon dioxide removal (CDR)

- Accelerated development of carbon capture, use and storage (CCUS) as a CO2 emission mitigation option in electricity generation, in industry applications and carbon dioxide removal technologies (including conversion of CO2 to products).
- Reduced EU's dependency on imported fossil fuels and increased energy security, reduced energy system's vulnerability to the impacts of the changing climate.

Main expected outcomes:

Renewable energy

- Energy producers and consumers benefit from improved efficiency and flexibility, reduced cost, improved reliability, robustness, and security of a portfolio of renewable energy and renewable fuel technologies, compared to existing ones.
- Technology providers profit from successful demonstration and de-risking of a portfolio of renewable energy and renewable fuel technologies with a view to their commercial exploitation.
- Technology providers have improved access to financing through better understanding of the bankability of a portfolio of renewable energy and renewable fuel technologies, and achieve more effective market uptake, business models, and commercialization avenues.
- Technology providers are better placed to request support from other funding schemes closer to market, exploiting synergies across such schemes.
- Researchers, industry, public authorities, and citizens have access to increased knowledge, assessment methods and tools on the environmental (both positive and negative) impacts of the different renewable energy and renewable fuel technologies along their lifecycle and value chains.
- The implementation of the Strategic Energy Technology Plan (SET Plan) is supported and facilitated by science-based evidence.

- The implementation of the African Union – European Union Climate Change and Sustainable Energy partnership is supported and facilitated by joint research activities with African partners.
- The implementation of the missions and innovation communities of Mission Innovation is supported and facilitated by joint research activities with international partners.
- Policy makers and regulators are provided with evidence to accelerate permitting procedures, harvest benefits from multiple uses of land and water, and increase the public acceptance of innovative and sustainable renewable energy projects, minimizing negative environmental impacts and improving the regulatory framework.
- National authorities are provided with evidence of innovative renewable energy and renewable fuel technologies that can contribute to the target of at least 5% of newly installed renewable energy capacity by 2030 in line with the Renewable Energy Directive.

To generate these expected outcomes, R&I activities will focus, among others, on the long-term and short-term needs of renewable energy technologies in solar, wind, geothermal, ocean, hydropower, bioenergy, advanced biofuels, renewable synthetic fuels, biomethane, and heat pumps, to have competitive solutions for our 2030, 2040 and 2050 policy targets.

Priority will be given to those areas where R&I projects: 1) can contribute the most to the competitiveness of the EU when commercialised; 2) can contribute the most to the long-term EU targets related to the deployment of renewable energy technologies; 3) can address important R&I needs; 4) require EU public funding to address these needs; and 5) can contribute to the flexibility and reliability of the electricity grid.

Energy systems, grids & storage

- R&I activities will improve the knowledge base needed for the modernisation of energy networks and their operation, markets, and services. This will support system integration and accelerate the integration of renewables, electrification, and digitalisation, backed by an interoperable, flexible data ecosystem, generative and traditional AI, digital twins, and a common European energy data space.
- Developed digital solutions enhance the observability, real-time situational awareness, controllability, resilience, cost effectiveness and flexibility of energy grids.
- Innovative and cost-effective energy storage (integration) solutions are developed, that provide flexibility to the energy system, reduce total cost of grid operation and enhancement and that minimise the use of critical raw materials and ensure, to the best extent possible, their reuse and recycling, are key elements of the energy system.
- R&I actions will address forward looking aspects of energy security and value chain competitiveness of energy grids and storage applications and advance the

preparedness of the AC and DC grids (including HVDC and LVDC systems) for the massive increase of RES integration.

- Developed solutions contribute to the knowledgebase on secure operation and integration of power electronics at all systems levels, advancing the development of smart and flexible grids, increased resilience (including AI-powered solutions and cybersecurity), flexibility and decentralization.

Carbon capture, use and storage (CCUS) and carbon dioxide removal (CDR)

- European fossil-fuel power producers and carbon-intensive industries will gain access to improved technologies to capture CO2 from industrial installations at higher energy efficiency and CO2 purity.
- Operators and regulators for CO2 transport and storage have access to increased knowledge on the physical and chemical behav
- Improved technologies to remove carbon from the atmosphere (e.g., improving the feasibility, efficiency, and cost performance of Direct Air Capture).
- Process industries will have access to improved technologies for the conversion of captured CO2 from the atmosphere or industrial installations into valuable resources.
- Researchers, industry, public authorities, and citizens have access to knowledge and lessons learned from industrial-scale CCUS projects between stakeholders and Member States across the entire industrial carbon management value chain.
- The implementation of the Carbon Dioxide Removal Mission of Mission Innovation is supported and facilitated by joint research activities with international partners.
- The implementation of the Strategic Energy Technology Plan (SET Plan) is supported and facilitated by science-based evidence.

Feedback opportunity for the work programme 2025

Cluster 5 - Climate, Energy and Mobility

Destination 4: Efficient, sustainable and inclusive energy use.

Draft expected impacts:

This Destination targets the energy demand side, notably a more efficient use of energy in buildings and industry. It contributes to the activities of the Strategic Energy Technology Plan (SET Plan) and its implementation working groups.

Highly energy-efficient and climate neutral European building stock

- The life-cycle energy performance and resource efficiency of the European building stock is improved at an accelerated pace and contributes to the EU's energy security.
- The renovation and construction are cost-efficient, affordable, and less disruptive, have reduced climate and environmental impact through circularity, and use of low-carbon materials.
- The buildings in Europe are increasingly interacting with the users, energy system and their environment contributing to an integrated, resilient, secure, and flexible operation.
- The buildings and built environment in Europe mitigate climate change and are more resilient.
- The built environment is inclusive and delivers a better quality of life for all users.

Industry

The energy efficiency of EU energy intensive industries is improved, their consumption of fossil fuel and their GHG and other pollutants emissions are drastically reduced, while preserving / enhancing their global competitiveness.

Main expected outcomes:

Highly energy-efficient and climate neutral European building stock

Specific target groups will be identified in the Work Programme, so as not to limit the scope and expected outcomes to be defined at topic level.

- Measurable reduction in waste materials, costs, and time on site for construction and renovation.
- Measurable reduction in buildings' energy demand together with reduced energy performance gap between as-designed and as-built.
- Measurable increase in the number of building typologies with SMART grid connected RES and energy storage together with increased flexibility in grid/network management and operations.

- Quantifiable increase in the number of replicable and scalable planning approaches and building solutions for construction and renovation value chain actors to holistically tackle energy performance, sustainability, resilience, safety, health, comfort and durability of buildings and the built environment.
- Quantifiable increase in awareness of relevant construction and renovation value chain value actors on replicable and scalable holistic planning approaches and building solutions.
- Increased number of approaches and solutions for public authorities, operators and users enabling a positive energy balance at district level, with demonstrated replicability on a larger scale in different contexts.
- Quantifiable number of positive energy districts (PEDs) with a measurably higher level of social acceptance and inclusiveness of citizens and users.
- Measurable reduction in whole life-cycle carbon content in buildings, building materials and products.
- Quantifiable increase in the number of [emerging market] construction and renovation value chain business models with integrated circularity principles.

Industry

Efficient and cost-effective use of renewable energy is optimised in energy intensive industries, with a focus on the integration of renewable electrical and/or thermal energy sources with low or no emissions of greenhouse gases and other pollutants, together with process flexibility and energy storage, as well as waste heat reuse.

Feedback opportunity for the work programme 2025

Cluster 5 - Climate, Energy and Mobility

Destination 5: Clean and competitive solutions for all transport modes.

Draft expected impacts:

Zero-emission road transport

- Clean solutions for zero tailpipe emission and environmentally friendly mobility for a climate neutral and zero pollution mobility with a higher level of circularity.
- Affordable, user-friendly, inclusive, safe, and secure concepts and technologies that are easy to deploy, considering needs, behaviors, and socio-economic status of end-users.
- Increased global competitiveness of the EU transport sector.
- Increased user acceptance of zero tailpipe emission vehicles and systems.
- Use cases and concepts for zero-emission road mobility of people and goods are successfully and innovatively demonstrated.

Aviation

- New and updated Aviation Research and Technology Infrastructures, where the new research and technologies will be developed and tested.
- Increased understanding and analysis of mitigation options of aviation's non-CO2 climate impacts. New technologies for significantly lower local air-pollution and noise.
- Accelerated uptake of sustainable aviation fuels in aviation, including the coordination with Member States and private initiatives.

Waterborne transport

- The shipping industry (shipowners, equipment manufacturers, port authorities, terminal operators, and shipbuilders) will have access to high-power low and zero emission fuel solutions by 2030, leading to lower costs, enhanced energy efficiency, risk mitigation, standardised implementation, and improved operational efficiency through data science.
- Port operators and ship owners will benefit from increased safety and technical standards on ammonia and hydrogen bunkering, including failure scenarios and risk mitigation.
- The shipping industry will benefit from lower-cost and flexible battery-based solutions as primary sources of energy, higher safety standards and broader electrification solutions.
- Shipowners, ship operators and port authorities will have access to OPS (Onshore Power Supply) solutions that will enable them to comply with the current and incoming legislative framework.
- Policy makers and shipowners will benefit from access to accurate information and assessment methods on the direct energy savings resulting from the use of wind-assisted propulsion (WAP) systems under current legislative frameworks like FuelEU Maritime,

contributing to the assessment of GHG intensity of energy used on-board. Shipowners, shipbuilders, and European shipyards will have access to commercially viable, cost-efficient, and easy-to-retrofit WAP solutions deployed at commercial scale, particularly for long-distance shipping.

- Shipyards will have innovative holistic intelligent design tools for various retrofit solutions, enhancing the competitiveness of European shipyards and marine equipment providers.
- Governments, port authorities, and shipping companies will benefit from access to standardized systems and tools for monitoring air pollutants and fuel consumption of ships, enabling compliance with current and incoming regulations on ship emissions.
- Policymakers and enforcement bodies will benefit from innovative tools to fulfil the requirements of the Ship Sourced Pollution Directive resulting in an increased environmental protection of sea waters.

Transport related environment and health

Better monitoring of the environmental performance and enforcement of emissions regulation and biodiversity protection in order to reduce the overall environmental impact of transport (e.g.: as regards biodiversity, noise, pollution and waste) on human health and ecosystems.

Main expected outcomes:

Zero-emission road transport

Activities shall help develop and further accelerate the uptake and innovation of zero-tailpipe emission ecosystem, with technological solutions at system level (vehicles, infrastructure, user and grid) – with specific focus on energy efficiency, affordability (and extended lifetime), safety and security, user-friendliness, interoperability of solutions:

- User-friendly, efficient charging infrastructure wireless concepts and technologies that are easy to deploy.
- Accelerated uptake of affordable, accessible, user-centric solutions for optimised energy efficiency (vehicles, infrastructure, and services) in a safe and resilient e-mobility ecosystem.
- Effective design and development of innovative zero-emission system's technological solutions for the clean road transport challenge, for more efficient and extended lifetime of Zero-emission vehicles.

Aviation

- Aircraft energy storage and power distribution, conversion and generation technologies for hydrogen and electrified-propulsion that exceed the state-of-the-art. Low weight and low energy aircraft systems, including flight-control applications and novel heat

dissipation technologies. Advanced joining composite technologies, with emphasis on new designs, high-volume manufacturing with integrated inspection.

- Advancements in Model Based Enterprise (MBE) for an efficient, digital, and robust systems/equipment development and manufacturing process. Innovative aviation manufacturing and Maintenance, Repair and Overhaul (MRO) procedures in line with circular economy practices.
- Minimisation of non-CO2 emissions, with emphasis on validated climate models, AI methodologies, trajectory optimisation and aircraft drop-in fuel research in collaboration with Member States and EASA.
- Coordination and alignment of the European aviation research policy with Member States, with emphasis on advancements in physical and digital research and technology infrastructures, and operational infrastructures.

Waterborne transport

- Integration of energy conversion systems using low and zero emission fuels with power ranges exceeding 5 MW for fuel cells and 15 MW for internal combustion engines, enabling adoption of these fuels at a large scale for shipping distances of 4500 nm or more. There will be risk identification related to these fuels, and protocols for safe response operations in case of accidental releases.
- Validation of dispersion scenarios through modelling the dispersion of ammonia cloud after spillage, evaluation of risks related to port SIMOPS operations, Identification of different hazardous scenarios for ammonia and hydrogen and impact in ports and formal Safety Assessments and risk assessment, including setting recommendations on protocols for safe response and safety distances for bunkering hydrogen and ammonia.
- Demonstration of battery-electric vessel operation for at least 2 vessels in the 400-5000 GWT range, aiming for at least a 50% increase in operating range compared to baseline using battery propulsion, along with showcasing innovative onboard energy efficiency measures such as thermal management, high voltage components, and energy modeling. Integration of renewable energy solutions such as photovoltaic panels and wind assistance are encouraged.
- Demonstration of a wide range of Onshore Power Supply (OPS) solutions for ships at anchorage (excluding barges), with a particular focus on the connectivity in hazardous zones.
- Development of a methodology for real-time assessment of energy savings related to Wind-Assisted Propulsion (WAP) systems. The topic includes the integration of WAP solutions into vessels, aiming for at least 50% energy savings and 35% efficiency gains.
- Development of digital tools for shipyards to facilitate cost-efficient ship retrofit concepts integrating various decarbonisation technologies.
- Development of a temper-proof standardised system to monitor air pollutants and fuel consumption on ships, alongside Real-Time Decision Support Systems (RT DSS) enabling

data-driven decision-making for ship operators and maritime authorities, establishing an automatic reporting and verification system.

- Development of a standardised system to monitor and detect illegal discharges of the substances falling under the scope of the Ship Sourced Pollution amended Directive.

Transport related environment and health

- Demonstrating on-board and remote measurement techniques for a wide range of pollutants (including pollutants from alternative fuels) from vessel emissions, under dynamic engine loads, used during normal operation of all ship types (including port service vessels).
- Developing harmonized coastal- and open sea monitoring methods with the potential to be used for future compliance monitoring and -if possible- prosecution, further to fuel sulphur content and including low or zero carbon fuels or aftertreatment technologies.
- Identify in the field releases of harmful species which are currently not controlled by regulations and excessive releases of species already controlled in open seas and in-port activities and assess the health impact (both the nature, seriousness, and number of people at risk) of the measured pollutants from shipping at ports or at the nearby urban environment.

Feedback opportunity for the work programme 2025

Cluster 5 - Climate, Energy and Mobility

Destination 5: Clean and competitive solutions for all transport modes.

Draft expected impacts:

Zero-emission road transport

- Clean solutions for zero tailpipe emission and environmentally friendly mobility for a climate neutral and zero pollution mobility with a higher level of circularity.
- Affordable, user-friendly, inclusive, safe, and secure concepts and technologies that are easy to deploy, considering needs, behaviors, and socio-economic status of end-users.
- Increased global competitiveness of the EU transport sector.
- Increased user acceptance of zero tailpipe emission vehicles and systems.
- Use cases and concepts for zero-emission road mobility of people and goods are successfully and innovatively demonstrated.

Aviation

- New and updated Aviation Research and Technology Infrastructures, where the new research and technologies will be developed and tested.
- Increased understanding and analysis of mitigation options of aviation's non-CO2 climate impacts. New technologies for significantly lower local air-pollution and noise.
- Accelerated uptake of sustainable aviation fuels in aviation, including the coordination with Member States and private initiatives.

Waterborne transport

- The shipping industry (shipowners, equipment manufacturers, port authorities, terminal operators, and shipbuilders) will have access to high-power low and zero emission fuel solutions by 2030, leading to lower costs, enhanced energy efficiency, risk mitigation, standardised implementation, and improved operational efficiency through data science.
- Port operators and ship owners will benefit from increased safety and technical standards on ammonia and hydrogen bunkering, including failure scenarios and risk mitigation.
- The shipping industry will benefit from lower-cost and flexible battery-based solutions as primary sources of energy, higher safety standards and broader electrification solutions.
- Shipowners, ship operators and port authorities will have access to OPS (Onshore Power Supply) solutions that will enable them to comply with the current and incoming legislative framework.
- Policy makers and shipowners will benefit from access to accurate information and assessment methods on the direct energy savings resulting from the use of wind-assisted propulsion (WAP) systems under current legislative frameworks like FuelEU Maritime,

contributing to the assessment of GHG intensity of energy used on-board. Shipowners, shipbuilders, and European shipyards will have access to commercially viable, cost-efficient, and easy-to-retrofit WAP solutions deployed at commercial scale, particularly for long-distance shipping.

- Shipyards will have innovative holistic intelligent design tools for various retrofit solutions, enhancing the competitiveness of European shipyards and marine equipment providers.
- Governments, port authorities, and shipping companies will benefit from access to standardized systems and tools for monitoring air pollutants and fuel consumption of ships, enabling compliance with current and incoming regulations on ship emissions.
- Policymakers and enforcement bodies will benefit from innovative tools to fulfil the requirements of the Ship Sourced Pollution Directive resulting in an increased environmental protection of sea waters.

Transport related environment and health

Better monitoring of the environmental performance and enforcement of emissions regulation and biodiversity protection in order to reduce the overall environmental impact of transport (e.g.: as regards biodiversity, noise, pollution and waste) on human health and ecosystems.

Main expected outcomes:

Zero-emission road transport

Activities shall help develop and further accelerate the uptake and innovation of zero-tailpipe emission ecosystem, with technological solutions at system level (vehicles, infrastructure, user and grid) – with specific focus on energy efficiency, affordability (and extended lifetime), safety and security, user-friendliness, interoperability of solutions:

- User-friendly, efficient charging infrastructure wireless concepts and technologies that are easy to deploy.
- Accelerated uptake of affordable, accessible, user-centric solutions for optimised energy efficiency (vehicles, infrastructure, and services) in a safe and resilient e-mobility ecosystem.
- Effective design and development of innovative zero-emission system's technological solutions for the clean road transport challenge, for more efficient and extended lifetime of Zero-emission vehicles.

Aviation

- Aircraft energy storage and power distribution, conversion and generation technologies for hydrogen and electrified-propulsion that exceed the state-of-the-art. Low weight and low energy aircraft systems, including flight-control applications and novel heat

dissipation technologies. Advanced joining composite technologies, with emphasis on new designs, high-volume manufacturing with integrated inspection.

- Advancements in Model Based Enterprise (MBE) for an efficient, digital, and robust systems/equipment development and manufacturing process. Innovative aviation manufacturing and Maintenance, Repair and Overhaul (MRO) procedures in line with circular economy practices.
- Minimisation of non-CO2 emissions, with emphasis on validated climate models, AI methodologies, trajectory optimisation and aircraft drop-in fuel research in collaboration with Member States and EASA.
- Coordination and alignment of the European aviation research policy with Member States, with emphasis on advancements in physical and digital research and technology infrastructures, and operational infrastructures.

Waterborne transport

- Integration of energy conversion systems using low and zero emission fuels with power ranges exceeding 5 MW for fuel cells and 15 MW for internal combustion engines, enabling adoption of these fuels at a large scale for shipping distances of 4500 nm or more. There will be risk identification related to these fuels, and protocols for safe response operations in case of accidental releases.
- Validation of dispersion scenarios through modelling the dispersion of ammonia cloud after spillage, evaluation of risks related to port SIMOPS operations, Identification of different hazardous scenarios for ammonia and hydrogen and impact in ports and formal Safety Assessments and risk assessment, including setting recommendations on protocols for safe response and safety distances for bunkering hydrogen and ammonia.
- Demonstration of battery-electric vessel operation for at least 2 vessels in the 400-5000 GWT range, aiming for at least a 50% increase in operating range compared to baseline using battery propulsion, along with showcasing innovative onboard energy efficiency measures such as thermal management, high voltage components, and energy modeling. Integration of renewable energy solutions such as photovoltaic panels and wind assistance are encouraged.
- Demonstration of a wide range of Onshore Power Supply (OPS) solutions for ships at anchorage (excluding barges), with a particular focus on the connectivity in hazardous zones.
- Development of a methodology for real-time assessment of energy savings related to Wind-Assisted Propulsion (WAP) systems. The topic includes the integration of WAP solutions into vessels, aiming for at least 50% energy savings and 35% efficiency gains.
- Development of digital tools for shipyards to facilitate cost-efficient ship retrofit concepts integrating various decarbonisation technologies.
- Development of a temper-proof standardised system to monitor air pollutants and fuel consumption on ships, alongside Real-Time Decision Support Systems (RT DSS) enabling

data-driven decision-making for ship operators and maritime authorities, establishing an automatic reporting and verification system.

- Development of a standardised system to monitor and detect illegal discharges of the substances falling under the scope of the Ship Sourced Pollution amended Directive.

Transport related environment and health

- Demonstrating on-board and remote measurement techniques for a wide range of pollutants (including pollutants from alternative fuels) from vessel emissions, under dynamic engine loads, used during normal operation of all ship types (including port service vessels).
- Developing harmonized coastal- and open sea monitoring methods with the potential to be used for future compliance monitoring and -if possible- prosecution, further to fuel sulphur content and including low or zero carbon fuels or aftertreatment technologies.
- Identify in the field releases of harmful species which are currently not controlled by regulations and excessive releases of species already controlled in open seas and in-port activities and assess the health impact (both the nature, seriousness, and number of people at risk) of the measured pollutants from shipping at ports or at the nearby urban environment.

Feedback opportunity for the work programme 2025

Cluster 5 - Climate, Energy and Mobility

Destination 6: Clean and competitive solutions for all transport modes.

Draft expected impacts:

Connected, Cooperative and Automated Mobility (CCAM)

- Safe, shared, inclusive, affordable, attractive and accessible door-to-door mobility for people and goods, including freight services and last-mile deliveries, in all weather conditions, seamlessly integrated with various transportation modes to ensure interoperability and full integration of CCAM solutions into the existing transport ecosystem.
- Resilient, climate neutral, and sustainable mobility solutions with a reduced carbon footprint leading to greener, less congested, cost-effective and more demand-responsive transport everywhere.
- Smart mobility services based on user-centric and explainable technologies and services, including digital technologies, advanced satellite navigation services, and smart traffic management (Ai enabled when appropriate), considering the diverse needs and behaviors of categories of end-users.
- Improvement of road safety thanks to the progressive transition of road traffic towards automation

Multimodal and sustainable transport systems for passengers and goods

- Advanced knowledge base and solutions for climate neutral and resilient infrastructure.
- More efficient, sustainable, safe, and competitive infrastructure construction, maintenance, inspection and monitoring in a “whole life cycle” approach.
- Existing and new transport infrastructure is designed/adapted to support deployment of new technologies and fuels in view of improving its performance, user experience and safety, support seamless and efficient multimodality and limit transport related emissions.
- Reduced emissions and increased efficiency and competitiveness of long-haul and regional freight transport and logistics, including the supply chain optimisation.

Safety and resilience

- Drastic reduction in serious injuries and fatalities in road crashes involving cyclists, pedestrians, and users of micro-mobility devices.
- Predictive framework is established using AI and big data for transport safety.
- Optimised Human-technology interaction that minimises confusion, distraction and thus collision risks.
- Enhanced aviation safety under adverse weather condition

Main expected outcomes:

Connected, Cooperative and Automated Mobility (CCAM)

- Seamless and affordable CCAM based solutions for mobility users and goods deliveries, in all weather conditions, reaching high public acceptability for both users and non-users.
- Validated safety and security, improved robustness, and resilience of CCAM technologies and systems, where appropriate and applicable, based on a software-defined vehicle approach and digital technologies like explainable and trustworthy AI, notably generative AI, high-performance electronic hardware, Big Data, and cybersecurity. Vehicle technologies and solutions that optimise the on-board and off-board experience in terms of well-being, security, and privacy.
- Advanced technologies and solutions for remote vehicle operations, providing guidance for operators, local authorities, and developers. This includes technical, governance, and policy recommendations aimed at facilitating large-scale demonstrations.
- Comprehensive sets of verification, validation, and assessment procedures for CCAM performances and systems to ensure safe and reliable solutions, moving towards deployment and market uptake.
- Secure and trustworthy interactions of CCAM solutions for all road users (including vulnerable road users), with specific focus on CCAM and "conventional" vehicles, infrastructure, and other services to achieve safer and more efficient transport flows (of people and goods) and a better use of infrastructure capacity.
- CCAM solutions that align with societal needs, answering to mobility challenges faced by authorities, users, and citizens with a clear understanding of its broader societal aspects, particularly in terms of ethics, environmental impact, as well as employment and skills development, paying attention to the gender dimension and other relevant, and intersecting social variables.
- A European framework (including, among other, standards and repositories) for the collection and exchange of CCAM data and best practices in line with the wider European approach to data-space development to support the entire CCAM stakeholder community (i.e.: research, public bodies, industry, implementers, operators…).

Multimodal and sustainable transport systems for passengers and goods

- Resilient to extreme weather and human caused events infrastructure assuring at least 80% capacity at network level during the disruptions, for passengers and freight transport.
- Resilient and smooth functioning of passenger mobility as well as freight transport and logistics networks operating on these infrastructures.
- Increased circularity of construction materials by at least 30%.
- Reduced environmental impact (emissions, soil/water pollution, degradation of ecosystems and fragmentation of habitats) and land use, during construction, maintenance, operation and decommissioning of transport infrastructure.

- Public authorities and freight transport stakeholders are provided with increased digital interconnectivity of logistics systems in both the B2A and the B2B perspectives, including the related transport infrastructure, with minimal integration effort and considering SMEs needs and capabilities.
- More sustainable transport modes are increasingly used and integrated into logistics networks.
- A framework for reliable data and effective practices to measure and monitor emissions from multimodal transport chains, building on the development of common European data spaces, is available for policy makers, transport operators and users.
- The uptake of innovative solutions in freight transport and logistics and synergies with other programmes is supported and accelerated.

Safety and resilience

- Increased road safety by an increased understanding of the synergies between driver and assistance systems capabilities and by implementing tailored, “self-learning” Human Technology Interaction (HTI) strategies.
- Advanced standardisable assessment tools and methods for improved HTI.
- Improved road safety (actual and perceived) for cyclists (including e-cyclists), pedestrians, and users of other micro-mobility devices.
- Increasing use of active modes of transport in all age groups.
- Development of mitigating solutions for the adverse impact of the changing car fleet towards bigger and heavier vehicles to the safety of cyclists, pedestrians, and other users.
- Predictive identification of safety-critical situations based on data from multiple sources and AI and enabling real-time interventions to avoid crashes, enabling road authorities to deploy appropriate countermeasures pro-actively.
- Enhanced monitoring of traffic flows and particularly on critical situations enabling more effective traffic management by foreseeing unexpected or disruptive events.
- Scientific expertise to develop new prototypes for ice detection and protection by the aviation industry.

Feedback opportunity for the work programme 2025

Cluster 5 - Climate, Energy and Mobility

Destination 6: Clean and competitive solutions for all transport modes.

Draft expected impacts:

Connected, Cooperative and Automated Mobility (CCAM)

- Safe, shared, inclusive, affordable, attractive and accessible door-to-door mobility for people and goods, including freight services and last-mile deliveries, in all weather conditions, seamlessly integrated with various transportation modes to ensure interoperability and full integration of CCAM solutions into the existing transport ecosystem.
- Resilient, climate neutral, and sustainable mobility solutions with a reduced carbon footprint leading to greener, less congested, cost-effective and more demand-responsive transport everywhere.
- Smart mobility services based on user-centric and explainable technologies and services, including digital technologies, advanced satellite navigation services, and smart traffic management (Ai enabled when appropriate), considering the diverse needs and behaviors of categories of end-users.
- Improvement of road safety thanks to the progressive transition of road traffic towards automation

Multimodal and sustainable transport systems for passengers and goods

- Advanced knowledge base and solutions for climate neutral and resilient infrastructure.
- More efficient, sustainable, safe, and competitive infrastructure construction, maintenance, inspection and monitoring in a “whole life cycle” approach.
- Existing and new transport infrastructure is designed/adapted to support deployment of new technologies and fuels in view of improving its performance, user experience and safety, support seamless and efficient multimodality and limit transport related emissions.
- Reduced emissions and increased efficiency and competitiveness of long-haul and regional freight transport and logistics, including the supply chain optimisation.

Safety and resilience

- Drastic reduction in serious injuries and fatalities in road crashes involving cyclists, pedestrians, and users of micro-mobility devices.
- Predictive framework is established using AI and big data for transport safety.
- Optimised Human-technology interaction that minimises confusion, distraction and thus collision risks.
- Enhanced aviation safety under adverse weather condition

Main expected outcomes:

Connected, Cooperative and Automated Mobility (CCAM)

- Seamless and affordable CCAM based solutions for mobility users and goods deliveries, in all weather conditions, reaching high public acceptability for both users and non-users.
- Validated safety and security, improved robustness, and resilience of CCAM technologies and systems, where appropriate and applicable, based on a software-defined vehicle approach and digital technologies like explainable and trustworthy AI, notably generative AI, high-performance electronic hardware, Big Data, and cybersecurity. Vehicle technologies and solutions that optimise the on-board and off-board experience in terms of well-being, security, and privacy.
- Advanced technologies and solutions for remote vehicle operations, providing guidance for operators, local authorities, and developers. This includes technical, governance, and policy recommendations aimed at facilitating large-scale demonstrations.
- Comprehensive sets of verification, validation, and assessment procedures for CCAM performances and systems to ensure safe and reliable solutions, moving towards deployment and market uptake.
- Secure and trustworthy interactions of CCAM solutions for all road users (including vulnerable road users), with specific focus on CCAM and "conventional" vehicles, infrastructure, and other services to achieve safer and more efficient transport flows (of people and goods) and a better use of infrastructure capacity.
- CCAM solutions that align with societal needs, answering to mobility challenges faced by authorities, users, and citizens with a clear understanding of its broader societal aspects, particularly in terms of ethics, environmental impact, as well as employment and skills development, paying attention to the gender dimension and other relevant, and intersecting social variables.
- A European framework (including, among other, standards and repositories) for the collection and exchange of CCAM data and best practices in line with the wider European approach to data-space development to support the entire CCAM stakeholder community (i.e.: research, public bodies, industry, implementers, operators…).

Multimodal and sustainable transport systems for passengers and goods

- Resilient to extreme weather and human caused events infrastructure assuring at least 80% capacity at network level during the disruptions, for passengers and freight transport.
- Resilient and smooth functioning of passenger mobility as well as freight transport and logistics networks operating on these infrastructures.
- Increased circularity of construction materials by at least 30%.
- Reduced environmental impact (emissions, soil/water pollution, degradation of ecosystems and fragmentation of habitats) and land use, during construction, maintenance, operation and decommissioning of transport infrastructure.

- Public authorities and freight transport stakeholders are provided with increased digital interconnectivity of logistics systems in both the B2A and the B2B perspectives, including the related transport infrastructure, with minimal integration effort and considering SMEs needs and capabilities.
- More sustainable transport modes are increasingly used and integrated into logistics networks.
- A framework for reliable data and effective practices to measure and monitor emissions from multimodal transport chains, building on the development of common European data spaces, is available for policy makers, transport operators and users.
- The uptake of innovative solutions in freight transport and logistics and synergies with other programmes is supported and accelerated.

Safety and resilience

- Increased road safety by an increased understanding of the synergies between driver and assistance systems capabilities and by implementing tailored, “self-learning” Human Technology Interaction (HTI) strategies.
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