Draft orientations towards the 'main' work programme 2025

Cluster 5 ('Climate, Energy and Mobility)

Please note that:

- **All elements included in this document are preliminary and only serve the purpose of discussing possible priorities for WP 2025.**
- **Not all elements may be included in WP 2025 and new elements may be included at a later stage.**
- **The number of expected outcomes and impacts contained in this document is not an indicator for the number of topics to be included in the first draft WP, nor for the budget allocation to the different areas.**
- **Proposed impacts/outcomes will be further simplified and streamlined based on strategic priorities for energy, transport/mobility and climate policy.**

1. Introduction

The priorities of the cluster 5 work programme (WP) 2025 will be guided by the key strategic orientations (KSO) of the Strategic Plan 2025-2027: fostering the green and digital transition in Europe, making Europe more resilient, competitive, inclusive and democratic, and promoting open strategic autonomy.

The Cluster 5 WP 2025 will put a special emphasis on:

- R&I for **accelerating EU policy's implementation and underpinning its longer-term policy targets**: The EU has put in place a comprehensive policy and legislative framework in the areas of climate, energy and mobility that include ambitious targets (more details are provided in the relevant Destinations below). R&I actions need to support the implementation of the policy framework and enable sectors to reach those targets.

1. R&I for **increasing European competitiveness**: Efficient and low-cost energy and transport solutions are crucial for the competitiveness of all European industry. At the same time, the energy and mobility are key sectors for the EU economy with strong European actors that face increasing competition from other parts of the world. To support European industry, the EU has recently launched the Net-Zero Industry Act and the Strategic Technologies for Europe Platform. Cluster 5 WP 2025 will contribute by supporting relevant R&I actions, fostering the uptake of R&I results, creating synergies between sectors and programmes, and increasing circularity.
2. R&I for **addressing the human, societal, and social aspects** of the green and digital transition, helping to identify and address societal needs and concerns, improve the evidence base for policy making and maximising societal, environmental, climate and economic benefits.

2. Implementation issues with relevance for all cluster 5 Destinations

- Ensure a strong contribution to the spending targets on climate action and biodiversity.
- Ensure balance between research (RIA) and innovation-focused (IA) actions and coverage of relevant TRL range (TRL 2-8, with a main focus on TRL 4-7).
- Mix of various project sizes (in general: smaller projects for lower TRLs, more expensive projects for high-TRL projects) with an average grant size higher than for WP 2023-2024.
- Ensure a balanced level of granularity with topic descriptions that remain open enough to permit a range of different pathways to achieve the expected outcomes and impacts.
- Use lump sum funding for around a third of all topics across Destinations.
- Include topics that are particularly attractive to SMEs.
- Support targeted international cooperation across all Destinations.
- Integrate SSH-dimension and social innovation across topics of all Destinations. A pilot action will be launched targeting the integrating of societal readiness considerations into a limited number of topics.
- Foster synergies inside cluster 5, across clusters, with Horizon Missions, with other Horizon pillars, and between other EU programmes and initiatives.
- Continued support for the Co-funded European Partnership on Clean Energy Transition (CET) and Driving Urban Transition (DUT), as well as for the co-programmed European Partnerships BATT4EU, B4P, 2ZERO, CCAM and ZEWT.

- A new co-programmed European Partnership on photovoltaics will be set-up.

3. Expected impacts and outputs for cluster 5 Destinations

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

This Destination contributes to the Strategic Plan's 2025-2027 expected impact of 'advancing science for a fair transition to a climate-neutral and resilient society'.

Addressing main policy issues

Activities in this Destination contribute to EU climate policy objectives by **strengthening the evidence base**:

- Globally: Supporting the ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC) and the goals of the Paris Agreement, and contributing to the 2028 Global stock take.
- EU objective of achieving climate neutrality by 2050 and the intermediate targets (2030 and 2040).
- Strengthening resilience to climate change impacts in Europe (together with the Mission on Adaptation) and globally.
- Support early warning and disaster risk reduction systems and policies.
- Support international scientific co-operation related to climate, including CMIP7, assessments (IPCC, IPBES, IRP) and others.

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 and countries 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:

- Improving the knowledge of the Earth system, its recent evolution and future responses under different global emissions pathways and socio-economic scenarios.

- Increasing understanding of the impacts of climate change on 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.
- Designing and evaluating solutions and pathways for climate-resilient, low-emission development to enable social transformation while promoting citizen and stakeholder involvement, climate literacy and integration of natural and social sciences; and
- Fostering synergies with the EU Mission 'adaptation to climate change' by generating actionable knowledge in support of transformative adaptation.

The second objective is to **close key knowledge gaps related to climate change** by contributing substantially to key international assessments such as the Intergovernmental Panel on Climate Change (IPCC), the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), and other initiatives such as the Coupled Model Intercomparison Project under the World Climate Research Programme.

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

The fourth objective is to **maximise synergies with other policy priorities** such as biodiversity and ecosystem restoration, just transition, just resilience, pollution reduction, 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 CDR to complement reductions of GHG emissions.
5. Increased acceptance of climate policies by political and social partners, as well as other societal 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 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.

Destination 2: Cross-sectoral solutions for the climate transition

This Destination contributes to the Strategic Plan's 2025-2027 expected impact of 'facilitating the clean and sustainable transition of the energy and transport sectors towards climate neutrality through cross-cutting solutions'.

Under WP 2025, this Destination will support activities in the area of batteries as well as cities and communities. Activities on SSH will be mainstreamed across all Destinations; activities on breakthrough technologies will not be addressed in WP 2025.

Addressing main policy issues

Global demand for batteries is increasing rapidly and is set to increase 14 times by 2030. To minimise the environmental impact of this exponential growth, and to promote the development of a competitive sustainable battery industry, the EU adopted the new **Batteries Regulation** in 2023. R&I actions in WP 2025 will contribute to the targets and ambitions of the Batteries Regulation.

Increased circularity and recycling efforts for batteries are also imperative to ensure secure and sustainable supply of critical raw materials for Europe's industry and significantly lower the EU's dependency on imports from single country suppliers. The **European Critical Raw Materials Act**, adopted in 2023, sets recycling and dependencies targets to which also batteries must contribute and that WP 2025 will support.

The **Net-Zero Industry Act** finally provides incentives for faster scale-up of battery manufacturing in Europe and extraction of raw materials, as well as skills development.

Draft expected impacts

Batteries

1. Increased competitiveness and strategic autonomy of EU Battery sector.
2. Reducing dependency on critical raw materials and upscaling processing capacity, also for recycled materials.
3. Creating an integrated European battery sector for high performance batteries, from design to manufacturing.
4. Improving resilience of EU energy system, facilitating integration of renewable energy sources.
5. Affordable and reliable batteries to boost the market penetration of EVs and storage systems.

Cities and Communities

1. 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

1. Development of low-cost battery systems based on Li-ion, Na-ion or other chemistries, addressing both the mobility and stationary sectors.
2. 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.
3. Increasing the flexibility of processing technologies to deal with a variety of primary and secondary material streams, reducing dependence on single sources.
4. Develop an integrated approach for advanced material, cell design and manufacturability for high-performance batteries aimed at mobility.
5. Increasing battery reliability, predictability and safety.

Communities and Cities

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

Destination 3: Sustainable, secure and competitive energy supply

This Destination contributes to the Strategic Plan's 2025-2027 expected impact of 'ensuring more efficient, sustainable, secure, and competitive renewable and decarbonised energy supply'.

Addressing main policy issues

The EU has developed a comprehensive and ambitious legislative and policy framework for the energy transition, underpinning the EU's greenhouse gas emission reduction targets (55% for 2030; proposal of 90% for 2040). This transition is based on a smart, resilient and integrated energy system, which is capable of integrating unprecedented shares of renewables in the energy mix.

Key components of this framework are the:

- Renewable Energy Directive (collective binding target of renewables in the EU's energy mix of at least 42.5% by 2030; minimum target of advanced biofuels and biogas and renewable fuels of non-biological origin in energy supplied to transport of 5,5 % in 2030).
- Energy Performance of Buildings Directive (making zero-emission buildings the new standard for new buildings; buildings must be solar-ready; solar energy systems will become the norm and must be gradually installed starting from 2027).

- ReFuelEU Aviation Regulation (sustainable aviation fuels (SAF) must contribute at least 6% to the fuel supply in aviation by 2030).
- FuelEU Maritime Regulation (biofuels, biogas, renewable fuels of non-biological origin and recycled carbon fuels reduce the greenhouse gas content of energy in ships by 6% in 2030, and 80% in 2050).
- RePowerEU Plan (double the EU biomethane production to 35 billion m3/y by 2030; double the rate of deployment for heat pumps, and increase the integration of geothermal and solar thermal in district and communal heating).
- Electricity Market Design (States assess define an indicative national objective for non-fossil flexibility, i.e. principally demand response and storage).
- EU Action plan on grids (adopted by the European Commission in 2023; presents sweeping actions for expanding, enforcing and enhancing the European grids).
- Hydrogen and gas decarbonisation package (facilitate the integration of renewable and low-carbon gases into the existing gas network).
- EU Strategy on Offshore Renewable Energy and its delivery plan (100 MW of ocean energy capacity should be installed in the EU by 2027 and 1 GW by early 2030's).
- EU Wind Power Package (accelerate wind energy manufacturing and deployment in Europe).
- EU Solar Energy Strategy (target of 320 GW of solar photovoltaics installed by 2025 and almost 600 GW by 2030).
- EU Solar PV Industry Alliance (launched in 2022; alliance will promote investments in large-scale factories, aiming for 30 GW of manufacturing capacity of each key solar component, annually).
- Strategic Energy Technology Plan and the actions in renewables (offshore wind, photovoltaics, ocean energy, deep geothermal, solar thermal, bioenergy and renewable fuels) and carbon capture storage and use will be more focused technological targets.

This framework is complemented by the Green Deal Industrial Plan, the Critical Raw Materials Act, the Net-Zero Industry Act, the EU Biodiversity Strategy 2030, the EU Forest Strategy for 2030, and the Communication 'Towards and ambitious Industrial Carbon Management for the EU' and 'Sustainable Carbon Cycles'.

Draft expected impacts:

Renewable energy

1. 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, water, land use, natural resources, pollution) and socioeconomic terms, and in line with the Sustainable Development Goals.

2. Technology providers have access to European, reliable, sustainable, and affordable value chains of renewable energy and renewable fuel technologies.
3. Economic sectors benefit from better integration of renewable energy and renewable fuel-based solutions that are among others cost-effective, efficient, flexible, and sustainable. Such integration is facilitated by digital technologies.
4. European researchers benefit from a reinforced scientific basis on renewable energy and renewable fuel technologies through international collaborations.
5. European industries benefit from a reinforced export potential of renewable energy and renewable fuel technologies, also through international collaborations.
6. European industries become frontrunners in innovative renewable energy technologies in line with the energy union strategy.
7. European citizens have access to an energy market that is 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.
8. The Strategic Energy Technology Plan (SET Plan) Implementation Working groups of solar photovoltaics, solar thermal technologies, wind energy, geothermal energy, ocean energy, renewable fuels and bioenergy, and carbon capture storage and use benefit from a reinforced scientific basis and collaboration on renewable energy 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)

1. Accelerated development of carbon capture, use and storage (CCUS) as a CO_2 emission mitigation option in electricity generation, in industry applications and carbon dioxide removal technologies (including conversion of CO_2 to products).
2. 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

1. Energy producers and consumers benefit from reduced cost and improved efficiency and flexibility of a portfolio of renewable energy and renewable fuel technologies, compared to existing ones.

2. Technology developers profit from demonstration and de-risking of a portfolio of renewable energy and renewable fuel technologies with a view to their commercial exploitation.
3. Technology developers benefit from better understanding of the bankability of a portfolio of renewable energy and renewable fuel technologies and achieve more effective market uptake and commercialization avenues.
4. Technology developers are better placed to request support from other funding schemes closer to market.
5. Researchers, industry, public authorities, and citizens have access to increased knowledge and assessment methods on the environmental (both positive and negative) impacts of the different renewable energy and renewable fuel technologies along their lifecycle and value chains.
6. The implementation of the Strategic Energy Technology Plan (SET Plan) is supported and facilitated by science-based evidence.
7. The implementation of the AU-EU Climate Change and Sustainable Energy partnership is supported and facilitated by joint research activities with African partners.
8. The implementation of the missions and innovation communities of Mission Innovation is supported and facilitated by joint research activities with international partners.
9. Policy makers and regulators are provided with evidence to accelerate permitting procedures and increase the public acceptance of innovative and sustainable renewable energy projects, while minimizing negative environmental impacts.
10. 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 to short needs of renewable energy technologies in solar, wind, geothermal, ocean, hydropower, bioenergy, advanced biofuels, renewable synthetic fuels, biomethane, heat pumps, and in industrial carbon management technologies, in order 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; 2) can contribute the most to the long-term EU targets related to the deployment of renewable energy technologies; 3) with important R&I needs; and 4) which require EU public funding to address these needs.

Energy systems, grids & storage

1. 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 and a common European energy data space.
2. Developed solutions enhance the observability, real-time situational awareness, controllability, resilience, cost effectiveness and flexibility of energy grids.
3. 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.

4. 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 for the massive increase of RES integration.
5. 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)

1. Improved technologies to capture CO_2 from industrial installations at higher energy efficiency and CO_2 purity.
2. Contribution to standardisation work through improved understanding of the physical and chemical behaviour of impure CO_2.
3. Improved technologies to remove carbon from the atmosphere (e.g. improving the feasibility, efficiency and cost performance of Direct Air Capture).
4. Improved technologies for the conversion of captured CO_2 from the atmosphere or industrial installations into valuable resources.
5. Improved and structured knowledge-sharing from industrial-scale CCUS projects between stakeholders and Member States across the entire industrial carbon management value chain.
6. The implementation of the Carbon Dioxide Removal Mission of Mission Innovation is supported and facilitated by joint research activities with international partners.
7. The implementation of the Strategic Energy Technology Plan (SET Plan) is supported and facilitated by science-based evidence.

Destination 4: Efficient, sustainable and inclusive energy use

This Destination contributes to the Strategic Plan's 2025-2027 expected impact of 'using energy in buildings and industry in an efficient, affordable and sustainable way'.

Addressing main policy issues

By making the energy use in buildings and industries more efficient, affordable and sustainable, this Destination contributes to the achievement of the EU's climate and energy objectives including long-term carbon neutrality. This is in line with the outcome of COP28 and the initiative, co-led by the EU, of setting global goals on renewables and energy efficiency, including to double annual energy efficiency improvements from around 2% to over 4% globally by 2030.

The main political priority to which this destination contributes is the European Green Deal and the implementation of the Fit for 55 package, notably the revised Energy Efficiency Directive, Energy Performance of Buildings Directive and the Renewable Energy Directive. At the same time, by boosting

energy efficiency and reducing energy demand in buildings and the industry, it aims at reducing the EU energy dependencies, in line with the objectives of the REPowerEU communication, as well as contributing to higher EU competitiveness.

This Destination contributes as well to the EU digital agenda and biodiversity targets (given the multiple impacts of the built environment on biodiversity).

As regards buildings, this Destination will deliver the solutions that can help increase buildings renovation rates, in line with the objectives of the Renovation Wave, reduce energy consumptions of buildings, improve smart readiness, foster integration in the energy system and interaction with built environment, improve cost-effectiveness and life cycle resource-efficiency, circularity, health and comfort, while focusing on user-centricity, social innovation, inclusiveness and affordability.

It relies on the Built4People co-programmed partnership's broader action and is complementary to Driving Urban Transitions partnership and to the Mission on Climate-neutral and Smart Cities. Strengthening synergies between the Built4People Partnership and the New European Bauhaus facility will also be pursued.

To achieve the objectives of the European Green Deal / European Industrial strategy / RepowerEU plan / 2040 Climate target plan, the EU energy intensive industries must reduce their GHG emissions; notably by switching to low-carbon non-fossil energy sources and improving energy efficiency.

It should be noted that the bulk of R&I support related to energy-intensive industries is in Cluster 4 'Digital, Industry and Space', notably the Processes4Planet and Clean Steel partnerships, covering industry-related topics and complementing Cluster 5.

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

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

Industry

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

Main expected outcomes

Highly energy-efficient and climate neutral European building stock

1. Measurable reduction in waste materials, costs and time on site for construction and renovation.

2. Measurable reduction in buildings' energy demand together with reduced energy performance gap between as-designed and as-built.
3. 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.
4. Quantifiable increase in the number of replicable and scalable planning approaches and building solutions to holistically tackle energy performance, sustainability, resilience, safety and durability of buildings and the built environment.
5. Quantifiable increase in awareness of relevant construction and value chain value actors on replicable and scalable holistic planning approaches and building solutions.
6. Increased number of approaches and solutions enabling a positive energy balance at district level, with demonstrated replicability on a larger scale in different contexts.
7. Quantifiable number of positive energy districts (PEDs) with a measurably higher level of social acceptance and inclusiveness.
8. Measurable reduction in whole life-cycle carbon content in buildings, building materials and products.
9. 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.

Destination 5: Clean and competitive solutions for all transport modes

This Destination contributes to the Strategic Plan's 2025-2027 expected impact of 'achieving sustainable, inclusive, and competitive transport modes'.

Addressing main policy issues

Transport represents almost a quarter of the EU's greenhouse gas emissions and is the main cause of air pollution in cities. Consequently, EU's Sustainable and Smart Mobility Strategy calls for a drastic cut in emissions across all transport modes by 2030, leading to an overall 90% reduction in the transport sector's emissions by 2050. The European Climate Law further commits to at least -55% reduction in EU greenhouse gas emissions by 2030, leading to climate neutrality by 2050.

The 'Fit for 55' package translates these policy objectives into specific legislative measures, including the Alternative Fuel Infrastructure Regulation and stricter CO_2 emissions standards, to support an 'irreversible shift towards zero emission mobility', an historic opportunity to make European transport not only more sustainable but more competitive globally.

Draft expected impacts

Zero-emission road transport

1. Clean solutions for zero tailpipe emission and environmentally friendly mobility for a climate neutral and zero pollution mobility with a higher level of circularity.
2. Affordable, user-friendly, safe and secure concepts and technologies that are easy to deploy.
3. Increased global competitiveness of the EU transport sector.
4. Increased user acceptance of zero tailpipe emission vehicles.
5. Innovative demonstrations use cases and concepts for zero-emission road mobility of people and goods.

Aviation

1. New and updated Aviation Research and Technology Infrastructures, where the new research and technologies will be developed and tested.
2. Increased understanding and analysis of mitigation options of aviation's non-CO_2 climate impacts. New technologies for significantly lower local air-pollution and noise.
3. Accelerated uptake of sustainable aviation fuels in aviation, including the coordination with Member States and private initiatives.

Waterborne transport

1. 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.
2. Port operators and ship owners will benefit from increased safety and technical standards on ammonia and hydrogen bunkering, including failure scenarios and risk mitigation.
3. 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.
4. 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.
5. 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.
6. Shipyards will have innovative holistic intelligent design tools for various retrofit solutions, enhancing the competitiveness of European shipyards and marine equipment providers.

7. 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.
8. 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

The better monitoring of the environmental performance and enforcement of emissions regulation in coastal areas and open seas 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

2Zero 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:

1. User-friendly, efficient charging infrastructure wireless concepts and technologies that are easy to deploy.
2. Accelerated uptake of affordable, user-centric solutions for optimised energy efficiency (vehicles and services) in a safe and resilient e-mobility ecosystem.
3. 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

1. 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.
2. 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.
3. Minimisation of non-CO_2 emissions, with emphasis on validated climate models, AI methodologies, trajectory optimisation and aircraft drop-in fuel research in collaboration with Member States and EASA.
4. 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

1. 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.
2. 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.
3. 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.
4. 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.
5. 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.
6. Development of digital tools for shipyards to facilitate cost-efficient ship retrofit concepts integrating various decarbonisation technologies.
7. 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.
8. 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

1. 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).
2. 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.
3. 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.

Destination 6: Safe Resilient Transport and Smart Mobility services for passengers and goods

Addressing main policy issues

The Sustainable and Smart Mobility Strategy (SSMS), adopted in 2020, lays the foundation for a 90% cut in emissions by 2050 delivered by a smart, competitive, safe, accessible, affordable and resilient transport system. The Strategy states that infrastructure must be adapted to climate change and made resilient to disasters. This will be implemented via the revised TEN-T regulation and the Climate Adaptation Strategy, including guidance on the climate proofing. In line with the Strategy it is also important that the infrastructure put in place relies on clean and decarbonised energy sources.

Greening freight transport is a key flagship of the Strategy. Digitalisation, by facilitating the exchange of information between businesses and with national authorities, is a key enabler to improve operational efficiency and reduce administrative costs. Shifting to more sustainable and energy-efficient forms of transport, such as inland waterways, by integrating them in the European logistics networks and boosting their attractiveness is key to ensuring a more future-proof freight transport.

In addition, the integration of clean technologies to CCAM developments, combined with smart mobility, will further advance the greening of the transport ecosystem, together with electromobility, charging infrastructures, and smart traffic management. Under the SSMS, some key interim targets include the large-scale deployment of automated mobility across transport modes and at least 30 million zero-emission cars in operation on European roads by 2030. The ambition for 2050 builds upon these targets: nearly all cars, vans, buses, and new heavy-duty vehicles to become zero-emission, and a fully operational, multimodal Trans-European Transport Network (TEN-T) for sustainable and smart transport with high-speed connectivity.

Draft expected impacts

Connected, Cooperative and Automated Mobility (CCAM)

1. Safe, shared, and accessible door-to-door mobility for people and goods, including freight services and last-mile deliveries, seamlessly integrated with various transportation modes to ensure interoperability and full integration into the existing transport ecosystem.
2. 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.
3. Smart mobility services based on user-centric and explainable technologies and services, including digital technologies, advanced satellite navigation services, and smart traffic management.

Multimodal and sustainable transport systems for passengers and goods

1. Advance science and bring solutions for climate neutral and resilient infrastructure.

2. With “whole life cycle” approach, make infrastructure construction, maintenance and inspection, more efficient, sustainable, safe and competitive.
3. Adapt existing and design new transport infrastructure to support deployment of new technologies and fuels in view of improving its performance and limit transport related emissions.
4. Reduce emissions and increase efficiency and competitiveness of long-haul and regional freight transport and logistics.,

Safety and resilience

1. Drastic reduction in serious injuries and fatalities in road crashes involving cyclists, pedestrians and users of other micro-mobility devices.
2. Establishing a predictive framework using AI and big data for transport safety.
3. Optimised Human-technology interaction that minimises confusion, distraction and thus collision risks.
4. Enhanced aviation safety under adverse weather conditions.

Main expected outcomes

Connected, Cooperative and Automated Mobility (CCAM)

1. Seamless, affordable and user oriented CCAM based solutions for mobility and goods deliveries for all, with high public acceptability for these solutions.
2. Validated safety and security, improved robustness, and resilience of CCAM technologies and systems, based on explainable and trustworthy AI, Big Data, and cybersecurity.
3. Vehicle technologies and solutions that optimise the on-board and off-board experience in terms of well-being, security, and privacy.
4. Technologies and solutions for the advancement of remote vehicle operations.
5. Comprehensive sets of verification, validation, and rating procedures of CCAM performances and systems.
6. Secure and trustworthy interactions between road users, CCAM and “conventional” vehicles, infrastructure, and services to achieve safer and more efficient transport flows (people and goods) and a better use of infrastructure capacity.
7. Clear understanding of user needs and societal aspects of CCAM, particularly in terms of ethics, environmental impact, as well as employment and skills development.
8. 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

Multimodal and sustainable transport systems for passengers and goods

1. Enhance infrastructure resilience to extreme weather and human caused events by assuring at least 80% capacity at network level during the disruptions.

2. Ensure resilience and smooth functioning of passenger mobility as well as freight transport and logistics networks operating on these infrastructures.
3. Increase circularity of construction materials by at least 30%.
4. Reduce environmental impact (emissions, soil/water pollution, degradation of ecosystems and fragmentation of habitats) during construction, maintenance, operation and decommissioning.
5. Accelerate the digitalisation of the freight transport and logistics and achieve digital interconnectivity of logistics systems in both the B2A and the B2B perspectives, with minimal integration effort and considering SMEs needs and capabilities.
6. Increase use and integration of more sustainable modes, namely inland waterways transport, into logistics networks.
7. Establish a framework for reliable data and effective practices to measure and monitor emissions from multimodal transport chains.
8. Accelerate the uptake of innovative solutions in freight transport and logistics and synergies with other programmes.

Safety and resilience

1. 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.
2. Advanced standardisable assessment tools and methods for improved HTI.
3. Improved road safety (actual and perceived) for cyclists, pedestrians, and especially for e-cyclists and users of other micro-mobility devices.
4. Increasing use of active modes of transport in all age groups.
5. 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.
6. 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.
7. Enhanced monitoring of traffic flows and particularly on critical situations enabling more effective traffic management by foreseeing unexpected or disruptive events.
8. Scientific expertise to develop new prototypes for ice detection and protection and to certify de-icing systems for new air mobility products.