European Commission

EU Report of the Seventh EU-U.S. Transportation Research Symposium 2024

Global Pathways to Net-Zero: Behavioural, Social and Technological Research and Innovation (R&I) Strategies for Transportation Decarbonisation

Independent Expert Report

Research and Innovation

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Manuscript completed in December 2024

PDF ISBN 978-92-68-22192-1 doi: 10.2777/1032013 KI-01-24-085-EN-N

Luxembourg: Publications Office of the European Union, 2024

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EUROPEAN COMMISSION

EU Report of the Seventh EU-U.S. Transportation Research Symposium 2024

Global Pathways to Net-Zero: Behavioural, Social and Technological Research and Innovation (R&I) Strategies for Transportation Decarbonisation

Washington D.C., June 11-12, 2024

Prepared by Sophie Punte, 31 August 2024

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2024

Directorate-General for Research and Innovation
Horizon Europe: Climate, Energy and Mobility

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Abbreviations

Abbreviations included in the main sections of the report (excluding annexes)

2Zero	Towards Zero Emission Road Transport partnership
ABM	Agent Based Modelling
AFIR	Alternative Fuels Infrastructure Regulation
AI	Artificial Intelligence
AV	Automated vehicle
BEV	Battery electric vehicle
BRT	Bus rapid transit
CAFE	U.S. Corporate Average Fuel Economy standards
CEM	Clean Energy Ministerial
CMAQ	Community Multiscale Air Quality Model (of the USEPA)
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EC	European Commission
ESG	Environment, social, governance
EU	European Union
EV	Electric Vehicle
FCEV	Fuel cell electric vehicle
GHG	Greenhouse gas
GLEC	Global Logistics Emissions Council
HEV TCP	Hybrid and Electric Vehicle Technology Collaboration Programme
ICAO	International Civil Aviation Organization
IEA	International Energy Agency
IIJA	U.S. Infrastructure Investment and Jobs Act
IMO	International Maritime Organization
IRA	U.S. Inflation Reduction Act
ITF	International Transport Forum
KPI	Key performance indicator
LCA	Life cycle analysis
MaaS	Mobility as a service
MOU	Memorandum of Understanding

MPO	Metropolitan Planning Organization (in the U.S.)
NGO	Non-governmental organisation
PCF	Product Carbon Footprint
PHEV	Plug-in hybrid vehicle
PIARC	World Road Association
R&I	Research and innovation
RTO	Regional transmission organization (in the U.S.)
SAF	Sustainable Aviation Fuels
SDV	Software-defined vehicles
SoS	System of Systems
SRA	Strategic Research Agenda
STRIA	Strategic Transport Research and Innovation Agenda
SUMP	Sustainable Urban Mobility Plans
SYMPEUS Research	Support for the organisation of EU-US symposia in the field of Transport
TEN-T	Trans-European Transport Network
TRB	Transportation Research Board
TSO	Transmission System Operators (in the EU)
U.S.	United States
USEPA	U.S. Environmental Protection Agency
V2G	Vehicle-to-grid
VMT	Vehicle miles travelled
ZEWT	Zero-Emission Waterborne Transport Partnership

1. Introduction

The seventh EU-US Transportation Research Symposium on **"Global pathways to Net-Zero: Behavioural, Social, and Technological Research and Innovation Strategies for Transportation Decarbonisation"** was held at the National Academies of Sciences, Washington, DC, USA on 11 and 12 June, 2024.

This Symposium is a result of the joint efforts between the European Commission (EC) and the U.S. Department of Transportation (DOT), with support from the Transportation Research Board (TRB) and the EU-funded SYMPEUS project.

The Symposium brought together 25 selected experts from the EU and US respectively (see Annex C) to

- Identify innovative technical and societal strategies for decarbonising transportation
- Foster enhanced collaboration between the U.S. and the EU
- Address the crucial transition towards a sustainable and digitally integrated future.

It serves as a continuation of a series of symposia that bring together European and US experts to explore ongoing transportation research in various selected topic areas. The four topic areas of the 7th edition were:

1. Accelerating the Transition to Electrification and Alternative Fuels
2. Ensuring a Just Transition to Net-Zero Transport
3. Leveraging Digitalisation, Artificial Intelligence, and Other Integrated System-of-Systems Technologies to Decarbonise Transport
4. Implementing Sustainable and Resilient Land Use and Transportation System Design.

A bilateral planning committee was jointly assembled by the European Commission (EC) and the TRB to organize and develop the symposium program. Committee members provided expertise in the topic areas above. The planning committee was responsible for organizing the symposium, identifying speakers, commissioning a white paper and developing topic papers for the four exploratory to facilitate discussion at the symposium.

This report for the European Commission (EC) presents the main outcomes of the Symposium. The report is a public document which aims to inform key European and other interested stakeholders.

A U.S. report is prepared in parallel by the U.S. Department of Transportation and will be released separately.

With the aim to make the report actionable, the report starts with strategic recommendations for collaboration stemming from the Symposium in chapter 2, which are subsequently further detailed and supplemented with results from expert sessions with regards to recommended research questions for priority topics (chapter 3), and research collaborations at the programming level (chapter 4) and policy level (chapter 5).

The views expressed in the report are those of individual experts attending the symposium and do not necessarily represent those of all participants, the planning committee, TRB or the European Commission.

2. Strategic Recommendations for EU-U.S. Research Collaboration

This section presents strategic recommendations for EU-U.S. research collaboration, which are further substantiated in chapters 3, 4 and 5, and relevant Annexes. These recommendations are the result of discussions held between the Symposium's participants.

2.1. Research Questions across Four Topics

During the symposium, participants reflected on the research questions that could be addressed by researchers to advance research and innovation in the field of transport decarbonisation.

The results of these deliberations are presented in Table 1 below. Further details are provided in chapter 3.

1. Accelerating the Transition to Electrification and Alternative Fuels
a) Systemic solutions for decarbonising transport modes: What are holistic solutions for decarbonising transport modes that cover technologies, whole system energy sources, policy design and assessment, scaling possibilities, and sustainable business models?
b) Charging of electric vehicles: • Grid: What are common design principles, mechanisms and policy options for grid planning, considering future transport electrification alongside other needs? • Charging: What policies can stimulate charging infrastructure availability and financial viability? Demand: What policies can lower the purchase price of electric vehicles, costs of charging and overall affordability of electric vehicles?
c) System level improvements for electric vehicles and alternative fuels: How can life-cycle impacts of electric vehicles and alternative fuels be effectively integrated into policies and regulations? What are other system level improvements?
2. Ensuring a Just Transition to Net-Zero Transport
a) Governance and inclusive transport policies: What does a governance framework look like through an equity lens?
b) Narrative and discourses: What are social science approaches to examine the significance of cultural values, but applied to transportation?
c) Jobs and workforce development: What is needed to create new jobs and develop the workforce in the transport transformation?

d) Life cycle impacts of transportation: Who are the winners and losers along the life-cycle of new vehicles?
3. Leveraging Digitalisation, Artificial Intelligence, and Other Integrated System-of-Systems Technologies to Decarbonise Transport
a) Cross-cutting: What harmonisation is needed for policies and standards on data disclosure, data exchange and other related topics? For top 5 technologies, what problems can be solved and what is the expected decarbonisation impact?
b) Planning tools including adaptive traffic management: How can decarbonisation effects of different interventions and the link between data, evidence and policy be determined?
c) Digital twins / modelling tools: How can actionable knowledge be extracted to understand system-of-systems interdependencies and design future systems?
d) Tools / digitalisation for on-demand shared mobility: What minimum user data is required to optimise shared mobility services and utilisation?
e) Automation: What policies would induce changes in behaviour and business models for maximum decarbonisation? What is needed for automation to accelerate the transport system transformation?
f) Software-defined vehicles (SDVs): What functionalities are required to improve energy efficiency while retaining performance and comfort levels?
4. Implementing Sustainable and Resilient Land Use and Transportation System Design
a) Sustainable design: What would a future transport system look like in the context of a given city, region or country?
b) Policies and programmes: How to rapidly deploy and design regulations (and supporting programs) that respect local contexts and provide flexibility whilst moving towards a shared vision?
c) Stakeholder engagement: How can widespread stakeholder support for decarbonisation be realised, and what are the best models for effective stakeholder engagement?
d) New mobility: How can innovation and partnerships drive new mobility that also considers equity?

Table 1. Recommended research questions for four transportation decarbonisation topics.

2.2. EU-U.S. Research Collaboration: Programming Level

Table 2 below presents recommendations for EU-U.S. research collaboration at the programming level identified by Symposium participants. Further detail is provided in chapter 4.

Considerations for collaboration	Key recommendations / suggestions
Successful collaborations (section 4.1)	Successful collaboration exists in: EU-US bilateral and multilateral cooperation, North-South development cooperation, joint programming / government-funded programmes; government-industry programmes; initiatives led by NGOs, research / academic institutes, or industry; events; unilateral programs / projects; technology deployment; start-ups
Priority research topics (section 4.3)	• Cross-cutting: governance, vision, narratives, social sciences, regulations, data and modelling, standardisation at international level, and harmonisation • Electrification and alternative fuels: clean fuels; electric vehicles and associated infrastructure for road transport; alternative fuels for aviation; materials for EVs and circularity • Just transition: inequality / equity especially regarding workforce transition and considering the Global South • Digital technologies: system of system tools; traffic knowledge; software-defined vehicles and vehicles automation • Land-use and system design: supply chain innovation, resilience, green corridors and liveability
Short-term priorities (section 4.4)	• Technology for vehicles: electric road vehicles (passenger and freight) including the charging infrastructures, software-defined vehicles (SDV) and digitalisation; batteries including new technologies, critical materials, recyclability and circular economy; vehicle design including circularity, optimising efficiency, weight and aerodynamics in particular for the global market;, aviation / maritime / off-road including sustainable aviation fuels (SAF), sustainable marine fuels and electrification for off-road vehicles • People and social / behavioural sciences: engagement (including lower-income and underserved communities as well as their protection from adverse impacts) and behavioural change i.e. in terms of convincing people to change to zero-emission mobility forms (through nudging and adequate pricing mechanisms and taking into account their various mobility needs) and policy including subsidies for underserved communities and better consideration of freight demand next to mobility demand

	• Space and land-use: planning infrastructure including urban development needs and regional connectivity, collaboration with different stakeholders with the support of adequate resources for local authorities; transport infrastructure with a focus on reducing GHG emissions across the lifecycle, enhancing resilience to climate impacts, and expanding the focus beyond roads to include other transport modes and key transport nodes like train stations and warehouses.

Table 2. Recommendations for EU-U.S. research collaboration: Programming Level

2.3. EU-U.S. Research Collaboration: Policy Level

Table 3 below presents recommendations for EU-U.S. research collaboration at the programming level identified by Symposium participants. Further detail is provided in chapter 5.

Considerations for collaboration	Key recommendations / suggestions
Successful research collaborations (section 5.3)	• Joint programming: Consider bringing together more partners who contribute their own funding to joint proposals with shared goals, which can help mobilise efforts toward achieving common outcomes. • North-South collaborations: Explore further partnerships with organisations in the Global South, such as India or China, and leverage funding from charitable foundations to enhance collaboration on projects and facilitate government connections. • Multilateral collaborations: Consider collaborating with more multilateral centers and organisations, such as Johns Hopkins or the ITF, to address global challenges in clean energy, transport, and climate change through joint efforts. • Collaboration in government-funded programmes: Invite further experts or officials from other countries to participate in advisory councils for government-funded programmes, which can foster extended cross-border collaboration with minimal costs. • Government-city collaborations: Promote further cross-pollination between cities, like through the U.S. DOT Smart City Challenge, to share smart transportation ideas and develop innovative data standards and solutions. • Government-industry collaborations: Engage further with industry through platforms like ITF's Corporate Partnership Board or PIARC committees to bring business insights into policy discussions, particularly in the area of decarbonisation. • Multistakeholder collaboration: Set up additional multistakeholder boards, such as the EMT Madrid Mobility Board, to engage diverse sectors (public, private, civil society, and research) in shaping policies through consensus-building.

	• Collaboration with NGOs, research institutes, or industry: Encourage further government agencies to nominate experts to participate in NGO-led initiatives, such as the Smart Freight Centre's GLEC Framework, to overcome administrative hurdles and align with existing programs. • Collaboration on events and publications: Actively invite more stakeholders from various sectors to contribute to events and publications, facilitating international dialogue and knowledge exchange. • Collaboration in unilateral programmes / projects: Address challenges effectively like visa restrictions and funding hurdles by finding flexible solutions, such as collaborating on projects that can overcome these barriers. • Collaboration on technology deployment: Work with a more diverse range of partners, including transmission system operators and research hubs from both the EU and U.S., to co-develop technologies and inform policy on key infrastructure like charging stations. • Collaboration with start-ups: Strengthen further collaboration with start-ups by focusing on shared research goals, providing co-financing opportunities, and prioritizing fundamental research for mutual benefit.
Tools and instruments (section 5.4)	• Planning: focused on an EU-U.S. mission for 2050 and aligned R&I goals and plans • Programme collaboration: considering joint / bilateral calls and projects, with greater interaction and emphasis on practical implementation / pilot projects • Awareness, information and capacity: sharing information, data, best practices and research agendas; capacity building and educational programmes including through secondments and working with NGOs • Funding: including co-funding of programmes, joint R&I fund, technologies, universities
Actions beyond research (section 5.5)	• Policies and standards: aligned policies and joint commitments; harmonised standards; SUMP (sustainable urban mobility plans); and carbon pricing • Implementation: development, piloting, deployment and scaling of solutions • Data / information: a combination of data sharing and methods as well as combatting misinformation • Collaboration: collaboration agreements, joint research / exchange programmes, joint funds • Events: political fora, meetings / conferences, and dialogues like the Symposium • Stakeholder engagement: including other regions, industry, and along supply chains

Barriers (section 5.6)	• Barrier types include governance / policy, programmes, market and other. In addition to shared / common barriers, some barriers are caused by differences between the EU and the U.S. • Top three barriers for research collaboration identified were: • Common research calls that have different topics; timelines and scales of research • Funding: general funding; structured funding for research and collaboration; mismatch with programmes / topics that need funding. • Competitiveness that can drive innovation and scaling but also can keep industry / manufacturers from sharing developments • Collaboration is furthermore affected by barriers to decarbonisation itself. A key observation was that policies, standards, and investment schemes for decarbonisation are largely in place, but the challenge is implementation at speed and scale.

Table 3. Recommendations for EU-U.S. Research Collaboration: Policy Level

2.4. Ideas for future Joint EU-U.S. collaboration

Recommended ideas for future Joint EU-U.S. collaboration include

- Continued reflection on policy priorities and research programmes of both the EU and U.S. (see Annexes D and E).
- Continued international collaboration between the EU and U.S. on areas of mutual benefits – see Annex F for existing collaborations presented at the Symposium.
- Consider at the programming level the existing successful collaborations, priority research topics and short term priorities identified by experts (see chapter 4).
- Consider at the policy level the tools and instruments that work, the integration of actions beyond research, and barriers to research collaboration between the EU and U.S. (chapter 5).

3. Review of Four Explanatory Topics

This section presents more detailed results based on Breakout Sessions and Group Discussions, held on Tuesday 11 June as part of sessions 5-7 of the Symposium programme (see Annex B) for the four exploratory topics, and informed by Briefing Papers #1 to #4 (see Annex A).

1. Accelerating the Transition to Electrification and Alternative Fuels
2. Ensuring a Just Transition to Net-Zero Transport
3. Leveraging Digitalisation, Artificial Intelligence, and Other Integrated System-of-Systems Technologies to Decarbonise Transport
4. Implementing Sustainable and Resilient Land Use and Transportation System Design.

3.1. Accelerating the Transition to Electrification and Alternative Fuels

3.1.1. Topic Description

The transition to electrification and alternative fuels for transport requires a combination of a shift towards carbon-neutral energy production, reliable energy storage and transfer systems, and the widespread adoption of zero-emission modes of transportation – particularly for road vehicles, from e-bikes and scooters to passenger cars to heavy duty vehicles (trucks and buses).

While road vehicles are shifting to electric, aviation and marine transport will continue to rely on energy-dense liquid fuels in the foreseeable future. In parallel, ports, airports and logistics sites are increasingly being electrified.

Electrification of vehicles for on-road transportation includes battery electric vehicles (BEV) and to a lesser extent fuel cell electric vehicles (FCEVs) and plug-in hybrid vehicles (PHEVs). Hydrogen faces challenges and high costs associated with production, transportation and storage. Light-duty EVs (electric 2- and 3-wheelers, cars, vans) and electric buses uptake is accelerating, whereas medium- and heavy-duty trucks uptake is at an earlier stage. Charging infrastructure remains a challenge, especially public charging in part due to slowness is grid upgrades and expansions. A systemic and life-cycle assessment is crucial to understand the decarbonisation benefits of EVs. Future prospects exist in battery technology, light-weight and alternative (non-rare) materials, alongside smart design and circular economy solutions.

Alternative or clean fuels can be used as drop-in fuels in existing engines, or cleaner fuel in new combustion engines. These fuels can be derived from biomass sources, cellulosic waste, or combining hydrogen and carbon. Sustainable aviation fuels are produced with biofuels but increasingly from synthetic fuels. There are adverse impacts associated with alternative fuels. GHG emission savings and air pollution impacts depend on the feedstock (biomass), processing and end-use. Feedstocks that present deforestation risks, such as palm oil, are being phased out. Corn ethanol is associated with emissions resulting from changes in land-use, although bioenergy carbon capture sequestration could be a solution.

The exploration of research questions and EU-US collaboration focused on three research areas: Systemic solutions for decarbonising transport modes; Charging of electric vehicles; and System level improvements for electric vehicles and alternative fuels.

3.1.2. Research Questions

The following research questions are recommended based on Breakout Sessions and Group Discussions, and informed by Briefing Paper #1.

Research area	Recommended research questions	Key other comments / suggestions
Systemic solutions for decarbonising transport modes	• What are holistic solutions for decarbonising transport modes that cover technologies, whole system energy sources, policy design and assessment, scaling and transfer possibilities, and sustainable business models?	• Road is further developed, a special focus is needed for aviation, maritime and long-haul trucks for both electrification opportunities and alternative fuels • Determination of what technology to select but also when to deploy it • Solutions should be global because transport is a global sector, but be tailored / transferable to different regions • Scalability of solutions is an important consideration to ensure decarbonisation is impactful • Tools and models are essential to assess effectiveness of policies and track decarbonisation impacts
Charging of electric vehicles	• Grid: What are common design principles, mechanisms and policy options for grid planning, considering future transport electrification alongside other needs? • Charging: What policies can stimulate charging infrastructure availability and financial viability? • Demand: What policies can lower the purchase price of electric vehicles, costs of charging and overall affordability of electric vehicles?	• Grid: o Grid expansion / reinforcement o Stimulating microgrids / local renewable power generation o Managing optimising grid utilisation while ensuring grid reliability • Charging supply: o Smart charging, vehicle-to-grid (V2G) improvements o Data-sharing / interoperability o Interaction between energy and transport sectors o Sustainable / scalable business models to support charging

		• Demand: o Demand needs o Total cost of ownership and acceptance o Deployment of charging and other infrastructure o Sharing successful stories o Distinguishing between electric passenger and freight vehicles
System level improvements for electric vehicles and alternative fuels	• How can life-cycle impacts of electric vehicles and alternative fuels be effectively integrated into policies and regulations? • What are other system level improvements?	• Life-cycle: o Life cycle analysis (LCA) risks and boundaries o Barriers in obtaining upstream emissions data o Ability to track successful results and determine co-benefits o Full LCA of renewable fuels needed to determine what is sustainable and what is not • Other system considerations: o Access to critical minerals o Impact of automation, and of mode- and demand-shifting o Efficiency once scale is reached o Circularity opportunities o US and EU have different perspectives that should be further analysed.

Table 4. Research questions and suggestions: Electrification and Alternative Fuels

3.2. Ensuring a Just Transition to Net-Zero Transport

3.2.1. Topic Description

The transition to net-zero transport offers diverse socio-economic benefits, such as reduced GHG emissions, reduced tailpipe pollutants as well as improved public health and job creation. However, transport decarbonisation can also result in new inequalities or the perpetuation of existing ones. Examples of risks that affect people disproportionately are congestion, lack of accessible and affordable mobility options for underserved populations, and displacement of health impacts to areas providing energy and raw materials for electric vehicles.

A just transport transition entails transforming the transportation system by ensuring all communities, workers and social groups are included in the processes towards and outcomes of a net-zero future by incorporating the principles of justice. Briefing paper #2 explains underlying key terms: equity, justice, transport justice and transport transition.

To realise this, we need socio-institutional innovations along technological ones. This in turn requires user-tailored mobility options and entirely different transport ecosystems.

Finally, transportation decarbonisation policies must target equity at the local, national and international levels.

The White Paper raises several socio-economic and equity considerations for underserved communities, summarized in the table below.

	Causes	Consequences	Policy Solutions
Transport infrastructure	• Community segregation due to infrastructure • Community co-location with highways and industrial areas • Underfunding regional public transport	• Pollution exposure • Public health impacts • Mobility poverty and physical separation from economic areas • Lack of safe pedestrian, cycling and transit infrastructure • Social divide / isolation	• Increase access to transit, pedestrian and cycling infrastructure • New mobility infrastructure which are not constrained by traditional transit infrastructure
Electric vehicles	• Lack of home charging due to lack of parking space, funding, permits in multi-family housing • Lack of public charging which are more in wealthier neighbourhoods	• Inability to charge at or near home • Higher public charging costs	• Rebates for home chargers • Targeted investments along interstate corridors and disadvantaged neighbourhoods
Climate risk exposure	• More vulnerable infrastructure and areas • Lack of escape routes	• Loss of lives, livelihoods and infrastructure	• Investments in climate-resilient infrastructure

Table 5. Equity and affordability considerations for underserved communities

3.2.2. Research Questions

The following research questions are identified from the Breakout Sessions and Group Discussions, and informed by Briefing Paper #2.

Research area	Recommended research questions	Other comments / suggestions
Governance and inclusive transport policies	What does a governance framework look like through an equity lens?	Take into consideration: • Accesibility, affordability: urban planning, public transport, non-motorised transport. If people get displaced then this causes problems such as job losses due to inability to travel to work • Opportunities: benefits beyond climate, better jobs / quality of jobs, North-South transfer, health, women empowerment, deployment of low-tech low-cost solutions • Policy mixes and Sustainable Urban Mobility Plans (SUMPs): impact of alternative packages of measures on sustainability and equity, how to make sure measures are mutually reinforcing each other, and avoid unintended consequences, e.g. climate gentrification. • Systems-thinking and holistic integrated approach. For example, provide good infrastructure for rail / public transport before introducing congestion taxes, vehicle bans and road tolls. • Cooperation and public / private partnerships, especially for freight, exploring new business models, subsidies (private sector mobility services) to help reach equity goals, capitalising on Environment, Sustainability and Governance (ESG). • Government regulatory frameworks that ensure that private sector innovation is aligned with policy goals. E.g. make it legal to re-invest road taxes in public transport to improve equity. • Case studies and best practice sharing can support policy.
Narrative and discourses	What are social science approaches to examine the significance of cultural values, but applied to transportation?	• Examine your audience and understand their aspirations, problems, solutions, and how these can be used by policy makers in strategic behavioural and coalition-building efforts. • Social norms play a role, for example for a city, ‘close and slow’ travel is more inclusive that ‘far and fast’ travel

		• Analytic, descriptive, normative, positive (not fear), whereby framing can sometimes be more important than facts. • Air quality and public health means more than decarbonisation.
Jobs and workforce development	What is needed to create new jobs and develop the workforce in the transport transformation?	Take into consideration • Impact of new technologies and innovation on the workforce, both positive and negative. • Relationships between economy and ecology - often economic arguments are used to water down ecological arguments, have them reconciled. • Capacity-building, focused on people with a job who need to switch, provide people with a career trajectory. • Capitalising on the amount of data available, while addressing the strong digital divide between public and private sector. • Look at fit for purpose projects, can be overlooked (low-tech) in favour of flashier innovation.
Life cycle impacts of transportation	Who are the winners and losers along the life-cycle of new vehicles?	Take into consideration the life-cycle stages • Raw materials extraction • Production of vehicles, engines and batteries • Energy sources • Operation and supply of transportation • Waste management / circularity

Table 6. Research questions and suggestions: Just Transition to Net-Zero Transport

3.3. Leveraging Digitalisation, Artificial Intelligence, and Other Integrated System-of-Systems Technologies to Decarbonise Transport

3.3.1. Topic Description

System-of-systems technologies allow the connection of multiple smaller systems to create a new, more complex system. The purpose of an integrated system-of-systems (SoS) in this context is to support transportation decarbonisation in ways that previously were unthinkable.

Relevant strategies, technologies and infrastructures, as well as new and emerging technologies identified in the White Paper include:

- Digitisation of travel and big data analysis, and emerging technologies like artificial intelligence (AI), machine learning, and integrated electronic systems, system-of-systems, can help reduce emissions, improve efficiency and smooth traffic flows by reducing demand for on-road vehicles, improving the efficiency of transportation systems, and supporting investments in multi-modal systems in an optimised way.

- The transition from decentralised, vehicle-based control technologies to a systemic top-down control paradigm demands the preservation of safety, flexible coordination of data and energy flows, software updates and hardware allocation across the vehicle, infrastructure and cloud levels.
- Crucial is also the development of digital interfaces between different transport modes, standardised solutions for intelligent and bidirectional grid integration, and digital tools for user friendly, inclusive, and accessible mobility.

3.3.2. Research Questions

The following research questions are recommended based on Breakout Sessions and Group Discussions, and informed by Briefing Paper #3.

Research area	Recommended research questions	Other comments / suggestions
Cross-cutting for all technologies	• What harmonisation is needed for policies and standards on data disclosure, data exchange and other related topics? • What problems can be solved and what is the expected decarbonisation impact? (see top 5 technologies below)	• Digitalisation is a condition for decarbonisation and resilience which can only be brought about by harmonised policies / standards on data disclosure, data exchange and other topics • The lack of a common language for technologies and data is a challenge, e.g. system-of-systems • Data access and interoperability is essential for management of transport, including road freight • Data sharing and privacy rules are different between EU and U.S. • Policies must consider how to encourage data sharing in industry operational environments, which is currently not embedded in corporate culture
Top 5 technologies		
1. Planning tools including adaptive traffic management	• What problems can be solved and what is the expected decarbonisation impact? • How can decarbonisation effects of different interventions and the link between data, evidence and policy be determined?	• Problems solved: o Remove local barriers to information sharing o Reduce congestion and optimise benefits during transition period to new vehicles o Improve effectiveness clean air policies o Facilitate deployment of mobility as a service (MaaS) and other tools o Better understanding of passenger and freight transport needs o Reduce transport demand o Transparency of environmental / social costs o Transport mode integration / multimodality o Informed, evidence-based policies through better data (although decisions are not based on data alone)

		• Impact of interventions: o Marginal direct CO_2 impacts but can help to identify and optimise impactful interventions e.g. multimodal transport o Behaviour change and system design have greater influence on decarbonisation
2. Digital twins / modelling tools	• What problems can be solved and what is the expected decarbonisation impact? • How can actionable knowledge be extracted to understand system-of-systems (SoS) interdependencies and design future systems?	• Problems solved o Understand SoS critical interdependencies between systems e.g. transport-energy-telecommunication o Support system-wide redesign that integrates models and factors of influence o Improve modelling by co-simulation with agent-based modelling (ABMs) to compare policy options and desired / unintended consequences o Real-time scheduling of freight deliveries o Improve actionable knowledge to inform policy • Decarbonisation impact is more indirect through knowledge generationof new technologies and innovation on the workforce, both positive and negative.
3. Tools/ digitalisation for on-demand shared mobility	• What problems can we solve and what is the expected decarbonisation impact? • What minimum user data is required to optimise shared mobility services and utilisation?	• Problems solved o Reduce the number of vehicles and trips o Support behavioural change o Avoid rebound effects of shared mobility (more trips or longer distances) • Decarbonisation impact is marginal unless coupled with on-demand shared AVs, and rebound effect is managed (could double the VMT - vehicle miles travelled)
4. Automation	• What problems can be solved and what is the expected decarbonisation impact? • What policies would induce changes in behaviour and business models for maximum decarbonisation?	• Problems solved o Reduce VMT from passenger transport in urban areas (less evidence for freight) o Energy efficiency and improved road safety through speed and braking optimisation, which also considers developments in and platooning of trucks • Decarbonisation impact is unclear and more research is needed on how automation policies can be designed to optimise decarbonisation

	• What is needed for automation to accelerate the transport system transformation?	
5. Software-defined vehicles (SDVs)	• What problems can be solved and what is the expected decarbonisation impact? What functionalities are required to improve energy efficiency while retaining performance and comfort levels?	• Problems solved o Ability to upgrade a vehicle throughout its lifetime via a centralised architecture facility to enhance performance and improve energy efficiency • Decarbonisation impact o Extended vehicle life and energy efficiency reduce the carbon footprint and contribute to circular economy o Emission increase from IT needs to be considered

Table 7. Research questions and suggestions: Digitalisation, AI and other Technologies

3.4. Implementing Sustainable and Resilient Land Use and Transportation System Design

3.4.1. Topic Description

This topic is built around opportunities to rethink our built environment to reduce climate pollution, *and* promote efficient use of resources, minimise environmental impacts more broadly, and promote the social and equity benefits of climate smart community design. Importantly, it goes beyond a shift to zero emission vehicles, and covers four topics (see White Paper and Briefing Paper #4 for further detail):

- Integrated land-use and surface transportation system design. Land use optimisation can have tremendous effects on reducing emissions from transportation. Sustainable Urban Mobility Plans (SUMPs) help strategise more efficient, greener, and integrated transport systems and mobility options that reduce fossil fuels and GHG and air pollutant emissions
- Sustainable urban mobility planning, such as carbon-neutral cities, reallocation of space, and 15-minute cities, whereby daily necessities and services can be accessed within a 15-minute walk, bike ride or public transport ride from anywhere in the city.
- Region-specific challenges and opportunities to shift modes based on movement of people or goods, geography, weather, land use patterns and other variables. Mode shift from on-road cars to other modes such as transit, walking, biking and shared mobility, particularly in urban environments
- New mobility, land use and logistics options that consider smart land use and transportation system design. Ride hail continues to disrupt the transportation sector, but also face criticism of increasing congestion and emissions due to empty rides and people shifting from biking and public transport to ride hail services. Without regulation, the introduction of Automated vehicles (AVs) in rideshare could exacerbate impact.

3.4.2. Research Questions

The exploration of research questions and EU-US collaboration focused on four research areas: Sustainable design; Policies and programmes; Stakeholder engagement; and New mobility. The following research questions are recommended based on Breakout Sessions and Group Discussions, and informed by Briefing Paper #4.

Research area	Recommended research questions	Other comments / suggestions
Sustainable design	**What would a future transport system look like in the context of a given city, region or country?** • How can we establish the unique characteristics and needs of the city, region or country? • How do we ensure that transport serves the needs of its users and is integrated with other land-use requirements? • How can land uses be reallocated and how can we design in resilience to climate change and ensure equity of access? • What are the tools and data that policy makers and practitioners need to support individual strategies and decisions? • What systems can we develop to enable data and information sharing to enable collaborative approaches and shared learning?	• Vision for city design is critical for an effective and decarbonised transport system because choices are for decades. Considerations: people and companies as the main actors; changing demographics; increasing freight movement / delivery; changing work / living situations; suburban areas; connection with regions • Role of density and intersection with transport hubs – these are different between the EU and US and combine top-down and bottom-up planning • Land use combinations including co-benefits and trade-offs – how do we value space and how do we communicate that?

Policies and programs	**How to rapidly deploy and design regulations (and supporting programmes) that respect local contexts and provide flexibility whilst moving towards a shared vision?**
	• How to address the disconnect at different levels? In particular between
	  ○ EU/federal/state and local/regional
	  ○ Land-use and transportation planning
		• A research programme could compile examples of successes and failures, including the special ingredients that make an approach successful, and develop solutions.
		• Differences / disconnect related to speed, scale, and underlying capacity / skills, human resources, finance, different authorisations
		• Freight is given insufficient consideration in comparison to passenger transport
		• What are the right decision and leverage points at different regulatory levels, how to pull those levers, and how to make connections?

	○ Speed at which infrastructure is built versus policies and programmes, and ways in which regulations can limit flexibility • How do we identify and influence data and research from other fields that impact or are impacted by transportation (e.g., housing, health, schools, greenspace, business development, etc.)? • How to show these connections in a way that is broadly understood and actionable by policy makers? How can we quantify these non-transport specific data and use them to inform transportation decisions?	• Policies supporting the status quo need to be looked at • Shared vision on pieces / components of sustainable transport • Middle density neighbourhoods and cities tend to be overlooked • Tools and cases exist, but what is needed is capturing and sharing those • Research on situations where policies are not working • Cost-benefit analysis to include the cost of inaction and explore the real economic benefits of a good transport system • How to measure and communicate in a way that resonates
Stakeholder engagement	**How can widespread stakeholder support for decarbonisation be realised?** • What are the co-benefits that are most likely to drive uptake? • What kind of information empowers citizens to change their transport approaches? • How can business be engaged in strategy development and delivery? • What can cause rejection of transportation changes? • How can apathy be overcome? • How can we counteract misinformation? **What are the best models for effective stakeholder engagement?** • What are the essential characteristics of the effective approaches and how do they vary in different contexts? How should the wishes of different stakeholders be balanced?	• Stakeholders: general public, local businesses, industry, investors, civil society • Co-benefits: safety and health, including air quality / clean air, is easier to understand and can be more powerful motivators than sustainability or GHG emissions, which are more abstract / distant • Empowerment: ensure that citizens directly benefit financially or otherwise from the transition, rather than relying on outside investors • Interdisciplinary approaches are essential – for example, we need to include research on psychology and society and also culture – through the humanities • Public panels or surveys. Surveys confirm that people prioritise: connectivity, reliability, safety, environment, infrastructure equity, transport system coverage, costs • Neutrality: politicisation of climate is a risk, need to make decisions free from political agendas or third party interests

New mobility	**How can innovation and partnerships drive new mobility that is equitable?** • How can governments / agencies develop a culture of innovation that is understood internally and externally (e.g., policy makers, private sector, and the public)? • How can the partnerships between government and external groups support innovation in resilient sustainable transportation and land use? • How can inequalities be avoided?	• Type of infrastructure needed: lanes, parking, signage, traffic lights, charging • Integration public transport and micromobility • Co-existence of different micromobility modes, in particular with regards to safety regulations • The role of private sector: mobility and a service (MaaS), introduction of fat-bikes, electric vehicles, apps • Public administration expertise and capacity building

Table 8. Research questions and suggestions: Sustainable and Resilient Land Use and Transportation System Design

4. R&I Collaboration Pathways – Programming Level

This chapter presents an overview of EU and U.S. programmes and collaboration, with further details provided in Annexes D, E and F, plus the White Paper and Briefing Paper #5. The chapter also presents examples of successful research and collaborations and suggestions from Symposium participants for future research collaboration. This is based on expert feedback from a Slido poll and Group Discussions, held on Wednesday 12 June as part of sessions 4, 5 and 6 of the Symposium programme (see Annex B).

4.1. Setting the Scene: Overview of Programmes and Collaborations

4.1.1. EU Programmes

EU programmes for research and innovation are guided by the Strategic Transport Research and Innovation Agenda (STRIA) of the European Commission, including roadmaps for both electrification and alternative energy for transport. Horizon Europe is the EU's Framework Programme for research and innovation, comprising of different clusters, with Cluster 5 on climate, energy and mobility as one of the main tools to implement the STRIA. This is supplemented with EU public-private partnerships and missions, such as the Towards Zero Emission Road Transport partnership (2Zero), Zero-Emission Waterborne Transport Partnership (ZEWT), the Clean Aviation Joint Undertaking and the Climate-Neutral and Smart Cities Mission. Finally, European Technology Platforms are industry-led in support of road maps and align research priorities on technological innovation.

Annex D provides an overview of EU programmes and their relevance to the four exploratory topics.

4.1.2. U.S. Programmes

U.S. programmes related to climate research and services is set by the U.S. Global Change Research Program, involving 14 Federal Departments and Agencies. The Department of Transportation (DOT) established its Climate Change Research, Development and Technology Strategic Plan to bridge research and decision making across the U.S. Government covering five areas: safety, economic strength and global competitiveness, equity, climate and sustainability, and transformation. Other DOT programmes focus, among others, on University Transportation Centers and sustainable aviation fuels (SAF) and maritime fuels. The Department of Energy (DOE) supports programmes focused on on-road, off-road, marine, rail, and technology integration, amongst other through its Vehicle Technology Office. DOT and DOE collaborate through the Joint Office of Energy and Transportation (created under IIJA) on electric transportation infrastructure

Annex E provides an overview of U.S. programmes and their relevance to the four exploratory topics.

4.1.3. EU and U.S. Collaboration

The legal and administrative framework for collaboration is provided by the Agreement for Scientific and Technological Cooperation between the European Commission and the Government of the United States of America. Collaboration programmes can be bilateral or multilateral, which also involve other countries or external institutions.

Examples of bilateral collaborations and programmes include the collaboration between European Battery Alliance and U.S. Li-Bridge Alliance, the EU-U.S. Trade and Technology Council that focuses on establishing joint standards for EV charging infrastructure. The EU's Horizon Europe programme encourages international cooperation, including with U.S. researchers and organisations.

Examples of multilateral programmes are the Electric Vehicle Initiative of the Clean Energy Ministerial (CEM), resulting in a Global MOU for Zero Emission Trucks, and the International Energy Agency (IEA) led Hybrid and Electric Vehicle Technology Collaboration Programme (HEV TCP).

Annex F provides an overview of existing and past collaborations shared during the Symposium.

4.2. Opportunities, Challenges and Themes

Discussions on programming were structured around two discussion goals further described below:

- What are the R&I actions and themes to cooperate on in the field of transport decarbonisation, identifying a list of collaboration areas and priorities in the different transport sectors (based on the briefing papers and discussions at the Symposium)?
- What are the potential obstacles or barriers to achieve research and innovation actions (e.g., regulations, competition, or other framework conditions)?

Supporting questions to give input to the discussion are listed in the table below.

Topic	Question
Current Strategies and Models	• What are the environmental, economic, and social impacts of the current strategies for decarbonisation transportation, and how do these impacts differ between the U.S. and EU? • What are examples of successful research and collaborations? What about failed research or collaboration attempts? What aspects made them successful or unsuccessful, and where / how can we apply these lessons moving forward?

Short-term Programming Actions	• What should the U.S. and EU be prioritising now to set us on the best path towards a net- zero transportation sector? To what extent should U.S. and EU governments be prioritising deployment versus research and technology investments in the short-term? • What research topics and themes are the most important areas to focus on moving forward?
Long-term Programming Actions	• How do we bridge the different aspects of transportation decarbonisation research (i.e., technologies, digitalisation, land and transportation planning, social and environmental considerations) to create a research action plan? • Are there gaps in research that should be prioritised for future investments and EU-U.S. cooperation? If so, what are those gaps? • In what technical areas are there opportunities for additional collaboration and partnership between EC and U.S.DOT leaders on decarbonisation? • Are there other research areas that are ripe for international collaboration?

Table 9. Questions as input to programming discussions (Briefing Paper #5)

4.3. Priority Research Topics for EU-U.S. Research Collaboration

Participants were asked: *What specific research topic should be prioritised in the EU-U.S. collaboration for decarbonising transportation?* Priority research topics identified by participants using the Slido tool are listed in 10 along with an indicative categorisation into the four exploratory topics and across topics. It is noted that in addition to specific research topics identified for the four exploratory topics, a large number of priority research topics relate to overarching enablers.

GENERAL	EXPLORATORY TOPICS			
Relevant across exploratory topics	1. Electrification and alternative fuels (for road vehicles)	2. Just Transition to net-zero transport	3. Digitalisation, AI and other Technologies	4. Sustainable and resilient land-use and transportation system design
• Governance*; Data governance; Harmo-nisation of governance • Vision 2050	• Clean fuels* • Electrification* • Vehicle grid integration* • Fleets infrastructure • Charge systems optimisation	• Inequality* • Centring equity • Workforce transition • Global South (e.g. BRT – bus rapid transit)	• Systems of systems tools* • Traffic knowledge • Automation • Automated driving &	• Supply chain innovation • Supply chain resilience • Green corridors • Liveability and land use

• Narratives; Tailor made narratives • Sharing successes • Social / behavioural science • Regulation / data collection • New appraisal tools • Joint modelling platform • Practical policy pathways • Pre-standard-isation (e.g., standards for synthetic fuels, hydrogen in transportation, go to IMO / ICAO with joint proposal) • Harmonised product carbon footprint (PCF) / life cycle analysis (LCA)	• Decarbonising aviation • Circularity • New materials for EVs • Clean minerals extraction		SDV (software defined vehicle) • Shared automated vehicles (AVs) • Circular digital cars	

** Topics that were mentioned by multiple participants*

Table 10. Categorisation of priority research topics for EU-U.S. research collaboration identified by Symposium participants (Slido poll)

4.4. Short-Term Priorities for EU-U.S. Research Collaboration

Participants were asked: *What should the U.S. and EU be prioritising now to set us on the best path towards a net-zero transportation sector? To what extent should U.S. and EU governments be prioritising deployment versus research and technology investments in the short-term?* The main take-aways following a group discussion and the closing plenary are presented in the below table, making a distinction between vehicles, which is more technology-centric; social sciences, which is more people-centric; and land-use, which is more space-centric.

Topic	Recommended research questions	Other comments / suggestions
Technology: vehicles		
Electric vehicles (both passenger and freight vehicles)	• Charging infrastructure development, bidirectional charging, charging protocols, vehicle-to-grid charging, grid integration, financing • Software defined vehicles, considering automated driving, connected autonomous vehicles for shared mobility and freight transportation • Consideration of shared / pooled / automated vehicles and a public transportation option • System-of-systems topic is considered important because it is essential to bring decarbonisation and digitalisation closer together, new complexities could create own barriers, and may have strong implications for equity	
Batteries	• New technologies, moving beyond lithium-ion technologies • Critical materials, recyclability, and circular economy: 'digital passport' for battery components indicating the extent to which batteries meet sustainability standards • Battery safety, testing methods, thermal performance, standards and protocols	
Vehicle design	• Vehicle design with circularity in mind of the vehicle and its individual components and materials • Optimising for efficiency, decreasing vehicle weight, optimising aerodynamics • Specifically designed for global market	
Aviation / maritime / off-road	• Sustainable aviation fuels (SAF) and sustainable marine fuels, including fuel production capacity, infrastructure, life-cycle analysis, standards • Off-road vehicles offer unique challenges and opportunities for electrification and reduced air pollution	

People: social / behavioural sciences	
Engagement	• Engagement of lower-income / underserved communities, and ensuring that measures are not regressive, ensuring that these communities are not adversely impacted • Workforce transition and training • Women / gender considerations
Behaviour change	• Focus on convincing people to change to zero-emission vehicles or to walking, cycling and public transport • Consideration of mobility needs, e.g. accessibility, affordability, convenience • Understanding of drivers behind growth in mobility and freight, which cannot be solved by technological solutions alone • Influence of financing, e.g. congestion pricing, parking pricing and other pricing mechanisms • Telling impactful narratives
Policy	• Impact (positive and negative) on low-income / underserved communities, the workforce, and women. For example, ability to apply for subsidies. • How to avoid climate gentrification • Consideration of freight demand in addition to mobility demand
Space: land-use	
Planning	• Consideration of urban development needs (housing, transport, commercial) and connectivity to regions • Planning in collaboration with private sector and civil society / research • National and regional planning (France was cited as example of regional planning, as well as collaboration between 'sister regions') • Resources needed for local authorities • Linking research / planning with implementation in practice
Transport infrastructure	• GHG emission reduction across life-cycle • Resilience / adaptation increasingly important • Expansion from road to include other modes and transport nodes (e.g. train stations, warehouses)

Table 11. Categorisation of priority research topics for EU-U.S. research collaboration identified by Symposium participants (Slido poll)

5. R&I Collaboration Pathways – Policy Level

This chapter presents an overview of EU and U.S. policies, with further details provided in Annexes D and E, plus the White Paper and Briefing Paper #5. The chapter also presents expert feedback on tools and instruments, actions beyond research, and barriers to EU-U.S. research collaboration. This is based on results from a Slido poll and Group Discussions, held on Wednesday 12 June as part of sessions 4, 7 and 8 of the Symposium programme (see Annex B).

5.1. Setting the Scene: Overview of Policies

5.1.1. EU Policies

At the heart of EU climate policy is the EU Green Deal adopted in 2019 to make the EU a climate-neutral continent by 2050, underpinned by eight policy areas, one of which is sustainable mobility. The European Climate Law was adopted in 2021 to enshrine into law the objectives of carbon neutrality by 2050 and reducing GHGs by at least 55% from 1990 by 2030. Central to the EU's strategy is the Fit-for-55, a package of legislative proposals to deliver the EU 55% GHG reduction target by 2030 in real terms, which covers all sectors of the EU's economy, including for transport. The Smart and Sustainable Mobility Strategy further elaborates how to transform the transport sector and align it with the European Green Deal, by making it green, digital and resilient. This includes CO2 emission standards, the Alternative Fuels Infrastructure Regulation (AFIR), measures to stimulate the demand for zero emission vehicles (carbon pricing, taxation, road charging, changes to the rules on weights and dimensions, vehicles in corporate and urban fleets), and data sharing. The Urban Mobility Framework and TEN-T focus respectively on urban transportation and integration with broader trans-European networks, while the European Critical Infrastructure Protection Strategy looks at security and resilience of transportation systems across Member States. The Green Deal Industrial Plan aims to scale up manufacturing of green technologies such as EV batteries. Finally, a suite of plans, policies and regulations across transport, energy, industry, and other sectors further supports the transition to a 90% reduction in transport-related greenhouse gas emissions by 2050.

Annex D provides an overview of EU policies and their relevance to the four exploratory topics.

5.1.2. U.S. Policies

Policy in the U.S. to drive the transition to a net-zero future is defined by three laws. The 2022 Inflation Reduction Act (IRA) provides Federal investments in clean energy and transport deployment and provides tax incentives and regulatory action to reduce GHG and environmental pollution and advance environmental justice. The CHIPS and Science Act focuses on building domestic manufacturing capability for clean technology production. The Infrastructure Investment and Jobs Act (IIJA) provides new funding for various infrastructure projects, reauthorises several transportation programmes, and establishes new grant programmes for electric vehicles. Long-Term Strategy for the United States 2021 lays out how the United States can reach its ultimate goal of net-zero emissions no later than 2050. This is further worked out in the U.S. National Blueprint for Transportation Decarbonisation 2030, which centers round convenient, efficient and clean transportation. This is supplemented with executive orders and agency rulemakings, most notably emission standards (EPA Greenhouse Gas Rule) and fuel economy standards for vehicles (CAFE), and the Justice 40 Initiative that requires 40%+ of climate and clean energy investment

to benefits to disadvantaged communities. California stands out with the Low Carbon Fuel Standards and laws to advance clean cars, trucks and fleets.

Annex E provides an overview of U.S. policies and their relevance to the four exploratory topics.

5.2. Opportunities, Challenges and Themes

Discussions were structured around two discussion goals:

- How to organise and develop an action plan with concrete steps and strategic rationale for moving forward in transport research cooperation?
- Several programme-to-programme cooperation frameworks already exist between the EU and the U.S. How can we build on them (e.g. Mission Innovation, IEA, HEV-TCP, etc.)?

Supporting questions to give input to the discussion are listed in the table below.

Topic	Question
Current Strategies and Models	• At the level of programme-to-programme cooperation, what types of partnerships—such as between public agencies, private companies, academic institutions, and non-governmental organisations—do you consider to be the most effective, and why, in advancing transportation decarbonisation efforts in the EU and the U.S.? • What models exist for successful international partnerships in technology development and deployment, and how might these be applied to transatlantic collaborations, either at bilateral or multilateral level? • What are the possible instruments and tools that exist or to be developed at the U.S. and at the EU level to implement this R&I cooperation?
Short-term Programming Actions	• How can strategic planning be best used to align priorities on a proactive and multiannual basis? • What are the mechanisms, programmes, entry points, etc., for facilitating research collaboration? • What lessons learned or best practices can be shared between the EU and U.S. in terms of effective short-term strategies? • What tools and strategies can we use to develop programming in these areas and more effective collaborative efforts between the EC and U.S. DOT?
Long-term Programming Actions	• In what R&I policy areas are there opportunities for additional collaboration and partnership between EC and U.S. DOT on decarbonisation? • Where are the gaps in R&I policy investments towards transportation decarbonisation that should be prioritised for future investments and EU-U.S. cooperation? • What mechanisms can be put into place to ensure that the U.S DOT. and the EC not only share research findings, but also actively learn from one another's policy successes and setbacks in transportation decarbonisation?

Opportunities, Challenges and Barriers	• What barriers are in place that hinder collaborative action, and what options / opportunities are there to move past these barriers? Identify areas of opportunities, as well as bottlenecks, for collaboration between the EC and U.S. DOT.

Table 12. Questions as input to policy discussions (Briefing Paper #5)

5.3. Successful Research Collaborations

Participants were asked: What are examples of successful research collaborations? What about failed research collaboration attempts? What aspects made them successful or unsuccessful, and where / how can we apply these lessons moving forward?

It was widely agreed that analysing and learning from existing programmes and collaborations would greatly benefit EU-U.S. research collaborations going forward. Key examples provided during a roundtable discussion were (in cases when clear references were made to organisations involved, these are also mentioned in the following):

- **Joint programming**: partners who bring their own funding to joint proposals with shared goals, which mobilises each to work towards outcomes. Some country programmes required matching or own funding as a condition for collaboration. Universities are also known to collaborate through jointly funded programmes.
- **North-South development collaborations**: for example, the DOE national laboratories, MIT, other universities, research institutes and NGOs are working with counterparts in the Global South, such as India or China, on learning programmes, pilot projects, standard development, etc. Often this is funded by charitable foundations. The universities and research institutes can make the connection with relevant government agencies or ministries, thereby circumventing potential hurdles.
- **Multilateral collaborations**. For example, the Johns Hopkins University collaborates with a multi-country centre focused on clean energy / climate funded by Australia, EU, and U.S.. The International Transport Forum (ITF) hosts a summit each year in May and can support transport and climate discussions within and between governments and change the narrative in favour of decarbonisation policies. An Open Mobility Foundation includes Sweden, Norway, Columbia, Canada, US looking at curb data standards to enhance mobility and improve safety.
- **Collaboration in government-funded programmes**. If a programme is not a joint programme then a solution can be to invite government officials or experts from other countries in advisory councils. For example, Horizon Europe projects whereby advisory councils comprise experts from across stakeholder groups, including governments from other countries. It is a low-threshold collaboration for which there are no costs involved aside from travel to events.
- **Government-city collaborations.** Across the world there are many examples of collaborations and cross-pollination between cities. The U.S. DOT Smart City Challenge was successful in bringing cities together to share challenges and new ideas for smart transportation systems using data, applications and technology, and this included data standards. U.S. State DOTs and MPOs (Metropolitan Planning Organizations) use modelling to make land use choices together, but could benefit from innovative and unified sets of models that could save costs and improve data access and quality.
- **Government-industry collaborations**. Examples are the ITF's Corporate Partnership Board to obtain business insights to policy discussions and collaborate on issues of

common interest, including decarbonisation; PIARC (World Road Association) technical committees, including one on road infrastructure for road transport decarbonisation that can provide policy input; and USEPA's SmartWay programme that brings companies together to decarbonise the U.S. freight sector.

- **Multistakeholder collaboration**. The EMT Madrid charged with public transport planning put in place a Mobility Board of public, private, civil society and research representatives to shape policies, such as parking policies, by consensus and therefore ensuring success.
- **Collaboration with initiatives** led by NGOs, research / academic institutes, or industry. Government agencies and development agencies often face administrative barriers to join initiatives that are not government or UN-led. What has worked is for a government agency to nominate an expert to an NGO-led initiative rather than formally joining as an agency. An example is Smart Freight Centre's Global Logistics Emissions Council to develop a global framework on logistics emissions accounting and reporting (GLEC Framework), where the USEPA put an expert forward to participate, which ensured alignment with the USEPA SmartWay programme.
- **Collaboration on events and publications.** Invitations to speak at events / symposia are common and easy ways to engage stakeholder from the public sector, the private sector and civil society / research. Other examples are editors from different continents contributing to a U.S. journal, or papers that make use from datasets from other countries.
- **Collaboration in unilateral programmes / projects**. A frequent challenge is obtaining visa for international participants as well as funding conditions and expiration of funding periods,. One example is universities who are hampered in securing secondments or exchanges from abroad that bring in new expertise to their research. Another example is a European group using a US-built testbed developed through a USEPA CMAQ (Community Multiscale Air Quality Model) grant, which received a lot of exposure at the TRB Annual Meeting, but faced significant challenges in getting EU funding to be accepted by U.S. agencies and partners.
- **Collaboration on technology deployment**, for example charging infrastructure, only works if a variety of players is brought in, not through open solicitation, but carefully selected from both the EU and U.S. For example, transmission system operators (called Regional Transmission Organizations or RTOs in the U.S. and Transmission System Operators or TSOs in the EU) could need to work together with research hubs of major EU and U.S. universities to co-develop new ideas, and feed these into policy and governance models once they reach maturity.

5.4. Tools and Instruments for EU-U.S. Research Collaboration

Participants were asked: What tool or instrument could further enhance EU-U.S. collaboration in transportation decarbonisation research? Tools and instruments suggested by participants using the Slido poll are listed in Table 13.

Tool/Instrument	Suggestions by participants
Planning	• Mission 2050 EU-US • Align R&I goals and plans
Programme collaboration	• Programmes collaboration, joint programming, practical collaboration, joint calls • Joint initiatives, bilateral projects, pilot lighthouse projects • Common research programme • State to state collaboration, EU-US Research Council • Implementation • More interaction
Awareness, information and capacity	• Information-sharing venue • Common platform of knowledge • Best practices / best practice sharing • Data sharing • Interoperability testing • Shared SRIA (Strategic Research and Innovation Agenda), SRIA and KPIs • Capacity building • Graphics / visual aids • Educational programs • Secondments • Link with NGOs
Funding	• Funding / funds specific for collaboration, investments, match funding programmes including funds and time • Co-funding, co-funding programmes, shared funding programmes • Joint R&I fund, Funding mechanisms for technologies, University funding

Table 13. Tools and instruments for EU-U.S. research collaboration identified by Symposium participants (Slido poll)

5.5. Actions Beyond Research for EU-U.S. Research Collaboration

Participants were asked: What joint EU-US action beyond research could additionally accelerate the decarbonisation of transportation? Actions identified by participants using the Slido poll are listed in Table 14.

Tool / Instrument	Suggestions by participants
Policy and standards	• Common political topics, Coordinate policy engagement, Joint commitments, Policy, Roadmap alignment • Standards, Industry standards, Standardisation, Joint standardisation, Joint standardisation work, Standard harmonisation, EU-US RTO (regional transmission organisation) collaboration on standards • SUMP (sustainable urban mobility plans) to supplement urban planning • Worldwide carbon pricing
Implementation	• Development and deployment, Deployment actions, Scaling up solutions • Pilots to test research • City-led policy actions
Data / information	• Shared data and methods • International scans • Combat mis / disinformation
Collaboration	• Collaboration agreements • Joint academic programmes, Practitioners collaborate, Exchange of researchers • Joint fund for mission
Events	• Political alignment forum • Meetings and events, Meetings, Conferences • Dialogues like this Symposium
Stakeholder engagement	• Stakeholder engagement • Engage other regions • Ease industrial alliances • Coordinated supply chain

Table 14. Actions beyond research collaboration identified by Symposium participants (Slido poll)

5.6. Barriers to EU-U.S. Research Collaboration

A distinction is made between barriers to collaboration between the EU and the U.S. on research and barriers to decarbonisation that have an influence on the effectiveness of collaboration.

5.6.1. Barriers to research collaboration

Participants were asked: What barrier or challenge prevents successful EU-U.S. collaboration in transportation decarbonisation research? Barriers identified by participants using the Slido tool are listed in Table 15, and make a distinction between barriers to collaboration in general and that are due to differences between the EU and U.S.

Barrier type	Barriers to collaboration that apply to both the EU and U.S	Barriers to collaboration due to differences between the EU and U.S.
Governance / policy	• Only short term objectives • Complex landscape of deciders • No innovation in administration Standards	• Political differences • Lack of joint vision • Differing governance
Programmes	• Funding • Structured funding • Mismatched funding programmes	• Lack of joint funding programmes • Lack of common research calls • Unsynchronized programmes • Matching US R&I programme • Different research scales • DOT rules (funding cannot be used for travel or international collaboration)
Market	• Business culture • Lacking a link with business	• Competitiveness • Regulation competition
Other	• Time • Proximity • Dis / misinformation	• Different grid • Geographic context • City design

Table 15. Barriers to EU-U.S. research collaboration identified by Symposium participants (Slido poll)

5.6.2. Barriers to decarbonisation that affect collaboration

One observation made during the group discussion was that policies, standards, and investment schemes are largely in place, but the challenge is implementation at speed and scale. One cause is misalignment and missing links between local, state and Federal / EU institutions, different speeds of government policy and permitting compared with technological developments and private sector investments. For example, it takes years for utilities to plan for charging infrastructure.

The White Paper identified barriers to decarbonisation, which also impact collaboration:

- Public perception, acceptance and expectations
- Uncertainty in public policies
- Complexity of the innovation process (Gordian Knot): technology, society business, regulation, human factors
- Energy-transport-data system integration
- Global supply chain dependencies
- Multi-crisis impact.

Finally, the White Paper highlighted key differences between the EU and the U.S. that affect transport decarbonisation policies and programmes for each, and by extension collaboration. These are summarized in the table below.

Characteristics	EU	U.S.
Geography and transport	• Densely populated • Shorter distances between cities • Access to public transport • Trans-national railway networks	• Political differences • Lack of joint vision • Differing governance
Transport system management	• Detailed transnational planning and TEN-T network by the EC, and less control over national government's actions	• Decentralised, involving collaboration between local stakeholders, national agencies, and legislative branches
Implications for *emphasis* of transport decarbonisation policies and programmes	• Improving existing infrastructure • Shifting modes • Reducing on-road vehicle travel	• Regulation and incentives of the auto industry

Table 16. Key differences between EU and U.S. identified in the Symposium White Paper

Annex

Annex A. Source materials

The following documents were used as sources for the preparation of this paper:

Briefing Papers

White Paper Decarbonisation in the Transportation System: A Joint Perspective from the United States and the European Union – Kelly Fleming, Federation of American Scientists, and Gereon Meyer, VDI / VDE Innovation + Technik GmbH

Briefing Paper on Exploratory Topic #1 Accelerating the Transition to Electrification and Alternative Fuels – Chris Hendrickson, Carnegie Mellon University, and Gereon Meyer, VDI / VDE Innovation + Technik GmbH

Briefing Paper on Exploratory Topic #2 Ensuring a Just Transition to Net-Zero Transport – Paty Romero-Lankao, University of Toronto, and Karen Vancluysen, POLIS

Briefing Paper on Exploratory Topic #3 Leveraging Digitalization, Artificial Intelligence, and Other Integrated System-of-Systems Technologies to Decarbonize Transport – Margriet van Schijndel-de Nooij, Eindhoven University of Technology, and Heng Wei, University of Cincinnati

Briefing Paper on Exploratory Topic #4 Implementing Sustainable and Resilient Land Use and Transportation System Design – Tasman Crowe, University College Dublin, and Timothy Sexton, City of Minneapolis

Briefing Paper #5 United States and European Union Relevant Policies, Programming and Collaboration – Alasdair Cain and Gretchen Goldman, U.S. Department of Transportation, and Maria Carbone and Patrick Mercier-Handisyde, European Commission

Other

Presentation slides - Tuesday 11 June (sessions 1-5 in Symposium programme)

Presentation slides - Wednesday 12 June (sessions 1-4 in Symposium programme)

Notes from notetakers topics 1 to 4 - Tuesday 11 June (sessions 5-9 in Symposium programme)

Notes from notetaker day 2 on programming and policy group discussions – Wednesday 12 June (sessions 5-8 in Symposium programme)

Slido poll results – Wednesday 12 June (session 4 in Symposium programme)

Annex B. Symposium Agenda

Global Pathways to Net-Zero: Behavioural, Social, and Technological Research and Innovation (R&I) Strategies for Transportation Decarbonisation

Seventh EU-U.S. Transportation Research Symposium

Organised by the
European Commission
U.S. Department of Transportation
Transportation Research Board
Coordination and Support Action SYMPEUS

June 11—12, 2024
National Academies of Sciences, Engineering, and Medicine Building
2101 Constitution Ave. NW, Washington, D.C.

Tuesday, June 11 2024

Session	Programme
1	**Welcome and Opening Remarks** • Dr. Firas Ibrahim, Director of the Office of Research, Development and Technology, U.S. Department of Transportation • Dr. Gretchen Goldman, Climate Change Research and Technology Director, U.S. Department of Transportation • Torsten Klimke, Head of Innovation and Research, European Commission's Directorate-General for Mobility and Transport • Jane Amilhat, Head of Clean Transport Transitions, European Commission's Directorate-General for Research and Innovation
2	**Keynote Speakers – Importance of and Opportunities for Transport Decarbonisation** • Dr. Robert Hampshire, Deputy Assistant Secretary for Research & Technology, U.S. Department of Transportation • Ann Shikany, Deputy Assistant Secretary for Transportation Policy, U.S. Department of Transportation
3	**Introductions, Purpose, and Scope for the 7th EU-U.S. Symposium: Global Pathways to Net-Zero** • Dr. Chris Hendrickson, Professor Emeritus, Civil and Environmental Engineering, Carnegie Mellon University, co-chair • Dr. Gereon Meyer, Head of the Department European and International Business Development, VDI / VDE Innovation + Technik GmbH, cochair

4	**Presentation of White Paper: Decarbonisation in the Transportation System – A Joint Perspective from the United States and the European Union** • Dr. Kelly Fleming, Associate Director of Clean Energy, Federation of American Scientists • Dr. Gereon Meyer, Head of the Department European and International Business Development, VDI / VDE Innovation + Technik GmbH
5	**Review of the Four Explanatory Topics**
	Exploratory Topic 1: Accelerating the Transition to Electrification and Alternative Fuels • Dr. Chris Hendrickson, Professor Emeritus, Civil and Environmental Engineering, Carnegie Mellon University • Dr. Gereon Meyer, Head of the Department European and International Business Development, VDI / VDE Innovation + Technik GmbH
	Exploratory Topic 2: Ensuring a Just Transition to Net-Zero Transport • Dr. Patricia Romero-Lankao, Professor and Canada Excellence Research Chair in Sustainability Transitions, Department of Sociology, University of Toronto • Karen Vancluysen, Secretary General, POLIS
	Exploratory Topic 2: Ensuring a Just Transition to Net-Zero Transport • Dr. Patricia Romero-Lankao, Professor and Canada Excellence Research Chair in Sustainability Transitions, Department of Sociology, University of Toronto • Karen Vancluysen, Secretary General, POLIS
	Exploratory Topic 4: Implementing Sustainable and Resilient Land Use and Transportation System Design • Dr. Tasman Crowe, Professor and Vice-President for Sustainability, University College Dublin, Ireland • Timothy Sexton, Director of Public Works, City of Minneapolis
6	**Exploratory Topics: Group Discussions on Research and Innovation**
7	**Exploratory Topics: Group Discussions on Outcomes and Suggestions** Each topic group reconvenes for 1 hour to synthesize summary on outcomes, suggestions, and takeaways to be discussed with the larger group during the open discussion.

8	**Open Discussion on Exploratory Topics – Topics 1 & 2** Everyone convenes in the same room and allows for open discussion of each topic. Each topic gets 30 minutes – 5-minute outcomes summary by notetakers from the working group session, followed by 25 minutes of open discussion for additional comments on each topic.
9	**Open Discussion on Exploratory Topics – Topics 3 & 4** Everyone convenes in the same room and allows for open discussion of each topic. Each topic gets 30 minutes – 5-minute outcomes summary by notetakers from the working group session, followed by 25 minutes of open discussion for additional comments on each topic.

Wednesday, June 12 2024

Session	Programme
1	**Review of Day 2 Agenda and Goals** • Dr. Chris Hendrickson, Professor Emeritus, Civil and Environmental Engineering, Carnegie Mellon University, cochair • Dr. Gereon Meyer, Head of the Department European and International Business Development, VDI / VDE Innovation + Technik GmbH, cochair
2	**Report Out on the Exploratory Topic Discussions** Facilitated by members of the planning committee. Four testimonies given by one volunteer / notetaker for each exploratory topic
3	**Setting the Scene: Relevant U.S. and EU Policies, Programming, and Collaboration** • Dr. Gretchen Goldman, Climate Change Research and Technology Director, U.S. Department of Transportation • Torsten Klimke, Head of Innovation and Research, European Commission's Directorate-General for Mobility and Transport • Jane Amilhat, Head of Clean Transport Transitions, European Commission's Directorate-General for Research and Innovation
4	**Expert Feedback and Priorities** Review of participants' feedback and priorities from Slido poll
5	**R&I Collaboration Pathways – Programming Level: Opportunities, Challenges, and Themes** Moderated by Jane Amilhat and Dr. Gretchen Goldman

6	**Report Out on R&I Collaboration Pathways – Programming Level: Opportunities, Challenges, and Themes** Facilitated by notetakers.
7	**R&I Collaboration Pathways –Policy Level: Strategies, Instruments, & Tools** Moderated by Torsten Klimke and Ann Shikany
8	**Report Out on R&I Collaboration Pathways – Policy Level: Strategies, Instruments, & Tools** Facilitated by notetakers.
9	**Closing Debate: Last-Chance Assertions for Both Days** Facilitated by Dr. Chris Hendrickson and Dr. Gereon Meyer
10	**Next Steps and Closing Remarks by Lead Delegates** • Jane Amilhat, Head of Clean Transport Transitions, European Commission's Directorate-General for Research and Innovation • Torsten Klimke, Head of Innovation and Research, European Commission's Directorate-General for Mobility and Transport • Victoria Sheehan, Executive Director, Transportation Research Board, National Academies of Sciences, Engineering, and Medicine Dr. Firas Ibrahim, Director of the Office of Research, Development and Technology, U.S. Department of Transportation

Annex C. List of Expert Participants

* = group moderator	Name	Organisation	State / Country	US / Europe
Topic 1: Electrifi-cation and Alternate Fuels	Florian Allroggen	Massachusetts Institute of Technology	Massachusetts	United States
	Maria Boile	University of Piraeus	Greece	Europe
	Matthew Botill	California Air Resources Board	California	United States
	Cristina Corchero	Institut de Recerca en Energia de Catalunya	Spain	Europe
	Kelly Fleming	Federation of American Scientists	District of Columbia	United States
	Francoise Guaspare	Rep. Paris/Ile de France Brussels	France	Europe
	Chris Hendrickson*	Carnegie Mellon University	Pennsylvania	United States
	Michael Lunter	Dutch Ministry of Infrastructure and Water Management	The Netherlands	Europe
	Nicholas (Nic) Lutsey	General Motors	Michigan	United States
	Gereon Meyer*	VDI/VDE Innovation + Technik GmbH	Germany	Europe
	Craig E. Philip	Vanderbilt University	Tennessee	United States
	Mats Rosenquist	Volvo	Sweden	Europe
Topic 2: Just Transition to net-zero transport	Jean-Baptiste Burtscher	Valeo	France	Europe
	Pietro D'Arpa	Procter & Gamble	Italy	Europe
	Sergio Fernandez	EMT Madrid	Spain	Europe
	Shelley Francis	EVHybridNoire	Georgia	United States
	Shima Hamidi	John Hopkins University	Maryland	United States
	Oliver Lah	Wuppertal Institut für Klima, Umwelt, Energie	Germany	Europe
	Darwin Moosavi	California Department of Transportation	California	United States
	Simon Mui	Natural Resources Defense Council	California	United States
	Nina Nesterova	Breda University Of Applied Sciences	The Netherlands	Europe
	Paty Romero-Lankao*	University of Toronto	Ontario	Canada
	Benjamin Sovacool	Boston University	Massachusetts	United States
	Karen Vancluysen*	POLIS Network	Belgium	Europe
	Eric Ballot	Mines ParisTech	France	Europe

Topic 3: Digitali-sation, AI and other integrated systems-of-systems	Yao Cheng	University of Maryland, College Park	Maryland	United States
	Jari Kauppila	International Transport Forum	Finland	Europe
	Gorazd Lampic	Elaphe Propulsion Technologies Ltd.	Slovenia	Europe
	Nayantara Mehta	CMA CGM	Virginia	United States
	Suzanne Murtha	AECOM	Florida	United States
	Roberto Palacin	Newcastle University	UK/Spain	Europe
	Cristina Pronello	Politecnico di Torino	Italy	Europe
	Daniel Sperling	University of California, Davis	California	United States
	Anna Spurlock	Lawrence Berkeley National Lab	California	United States
	Guang Tian	University of New Orleans	Louisiana	United States
	Margriet van Schijndel de Nooij*	Universiteit Eindhoven	The Netherlands	Europe
	Heng Wei*	University of Cincinnati	Ohio	United States
Topic 4: Sus-tainable and resilient land-use and transportation system design	Maria Attard	Università ta'Malta	Malta	Europe
	Brian Caulfield	Trinity College Dublin	Ireland	Europe
	Tasman Crowe*	University College Dublin	United Kingdom	Europe
	Ben Holland	Rocky Mountain Institute	Colorado	United States
	Kim Lucas	City of Pittsburgh's Department of Mobility & Infrastructure	Pennsylvania	United States
	Maria Morfoulaki	Centre for Research and Technology Hellas	Greece	Europe
	Hayes Morrison	Massachusetts Department of Transportation	Massachusetts	United States
	Amanda Pietz	Oregon Department of Transportation	Oregon	United States
	Bàrbara Pons Giner	Barcelona Regional	Spain	Europe
	Sophie Punte	Smart Freight Centre	The Netherlands	Europe
	Timothy Sexton*	City of Minneapolis	Minnesota	United States
	Joe Zietsman	Texas A&M	Texas	United States
Planning Committee for	Chris Hendrickson*	Carnegie Mellon University	Pennsylvania	United States

the Seventh EU-US Transporttion Research Symposium	Gereon Meyer*	VDI/VDE Innovation + Technik GmbH	Germany	Europe
	Tasman Crowe*	University College Dublin	United Kingdom	Europe
	Paty Romero-Lankao*	University of Toronto	Ontario	Canada
	Timothy Sexton*	City of Minneapolis	Minnesota	United States
	Karen Vancluysen*	POLIS Network	Belgium	Europe
Topic Experts and Moderators	Margriet van Schijndel de Nooij*	Universiteit Eindhoven	The Netherlands	Europe
	Heng Wei*	University of Cincinnati	Ohio	United States
Liaisons, European Commission	Jane Amilhat	Directorate-General for Research and Innovation, Directorate Clean Planet	Belgium	Europe
	Maria Carbone	Directorate-General for Mobility and Transport	Belgium	Europe
	Torsten Klimke	Directorate-General for Mobility and Transport, Directorate Investment, Innovative & Sustainable Transport	Belgium	Europe
	Patrick Mercier-Handisyde	Directorate-General for Research and Innovation, Directorate Clean Planet	Belgium	Europe
Liaisons, European Conference of Transport Research Institutes	Caroline Almeras	ECTRI	Belgium	Europe
	Ingrid Skogsmo	VTI	Sweden	Europe
Liaisons, U.S Department of Transportation - Office of the Assistant Secretary for Research and Technology	Alasdair Cain	U.S. Department of Transportation	Washington	United States
	Gretchen Goldman	U.S. Department of Transportation	Washington	United States
	Firas Ibrahim	U.S. Department of Transportation	Washington	Unisted States
Transportation Research Board Staff	Brittany P. Bishop	Transportation Research Board	Washington	United States
	Thomas Menzies	Transportation Research Board	Washington	United States
	Victoria Sheehan	Transporation Research Board	Washington	United States

Annex D. EU Policies and Programmes

The tables below provide an overview of the main relevant EU policies and programmes and an *indication* of their relevance to the four exploratory topics. Other policies exist that are not listed here but are relevant to other transport modes / topics outside the scope of the Symposium. The White Paper and Briefing Paper #5 provide further details. The table also draws from an overview of EU policies created separately by the author, to provide a more comprehensive overview.[1]"

POLICIES		EXPLORATORY TOPICS			
EU policies and plans	Standards, programmes, funding, technical assistance	1. Electrifi-cation and alternative fuels (for road vehicles)	2. Just Transition to net-zero transport	3. Digitalisation, AI and other Technologies	4. Sustainable and resilient land-use and transportation system design
EU Green Deal & European Climate Law to enshrine 2050 climate-neutrality into law, with a 90% reduction in transport-related greenhouse gas emissions by 2050.	• 2030 Climate Target Plan • Fit for 55 Package to achieve 55% GHG reductions by 2030 compared to 1990 levels • Effort Sharing Regulation with reduction targets EU Member States	X	X	X	X
Sustainable and Smart Mobility Strategy (under EU Green Deal and other) and other transport	Trans-European Transport Network (TEN-T)	X			
	Alternative Fuel Infrastructure Regulation (AFIR) , and Alternative Fuel Infrastructure Facility (AFIF) with EUR 1 billion for 2024-2025	X			
	Weights and Dimensions Directive	X			
	CO2 emission standards for heavy-duty vehicles	X			
	Euro emission standards (Euro 7)	X			

[1] S. Punte, Actionable Framework for E-trucks and Charging – a reference paper to organise climate action. October 2023.

	Greening Freight Transport package	X			
	Directive on end-of-life vehicles (ELV Directive)	X			
	EU standards for safe and secure parking areas	X			X
	Eurovignette Directive	X			
	Urban Mobility Framework	X	X	X	X
	European Critical Infrastructure Protection Strategy (security and resilience of transportation systems)				X
Energy (under EU Green Deal and other)	EU Strategy on Energy System Integration	X	X	X	X
	Trans-European Energy Network (TEN-E)			X	X
	EU Strategy on Energy System Integration	X			
	EU Hydrogen Strategy	X			
	RePowerEU Plan	X	X		
	Energy Efficiency Directive	X			
	Renewable Energy Directive	X			
	Hydrogen and Decarbonised Gas Market Package	X			
	Electricity Market Design	X			
	Energy Performance of Buildings Directive (EPBD)	X			
Industry (under EU Green Deal and other)	Green Deal Industrial Plan, manufacturing of clean technologies e.g. EV batteries; covers regulations, funding, skills, open trade	X			

	Net-Zero Industry Act	X			
	Critical Minerals Act	X			
	Chips Act	X		X	
	Carbon Border Adjustment Mechanism (CBAM)	X	X		
	Ecodesign for Sustainable Products Regulation (ESPR)	X			
	Regulation on Batteries and Waste Batteries	X			
	Circular Economy Action Plan	X	X	X	X
Sustainable Europe Investment, Just transition, and Recovery finance	Just Transition Mechanism of the European Commissions which includes funds, budgetary guarantee and advisory support and a public loan facility to help mobilise around EUR 55 billion from 2021-2027. One of the core themes is the investment in public and sustainable transport.	X	X		
	Social Climate Fund for most affected EU regions and vulnerable groups through structural measures and investment in transport and energy: the fund will make available a maximum amount of EUR 65 billion for its implementation for the 2026-2032 period.	X	X		

	Ad hoc advice on topics linked to the transport transition such as the 'Commission Recommendation of 29.11.2023 on means to address the impact of automation and digitalisation on the transport workforce.	X	X	X	X
	InvestEU Programme	X	X	X	X
	NextGenerationEU (includes Recovery and Resilience Facility of EUR 723.8 billion and EUR 5.4 billion for Horizon Europe – 37% to projects that fight climate change, large share for sustainable mobility)	X	X	X	X
	EU New Cohesion Policy 2021-2027	X	X	X	X
	Emissions Trading Scheme (ETS) for Road Transport & Buildings (ETS II)	X			
	EU Taxonomy (classification and criteria for green investment)	X			
	Directive on Corporate Sustainability Due Diligence (EU-CSDD)	X	X		
EU Data Strategy	European Mobility Data Space (EMDS): data access, pooling and sharing for more efficient, safe, sustainable and resilient transport	X		X	X

Table 17. Relevant EU Research Programmes for the four exploratory topics

RESEARCH PROGRAMMES		EXPLORATORY TOPICS			
Title	Description	1. Electrification and alternative fuels (for road vehicles)	2. Just Transition to net-zero transport	3. Digitalisation, AI and other Technologies	4. Sustainable and resilient land-use and transportation system design
Global Approach to Research and Innovation	EU strategy for international cooperation	X	X	X	X
Strategic Transport Research and Innovation Agenda (STRIA)	Lon-term strategy for decarbonising transportation including roadmaps: • Electrification of the Transport System • Low Emission Alternative Energy for Transport	X			
Horizon Europe	EU's Framework Programme for research and innovation, and one of the main tools to implement the strategy, with EUR 95.5 billion 2021-2027				
• Cluster 5 on Climate Energy and Mobility	EUR 15.5 billion 2021-2027, with areas of intervention: • Climate science and solutions • Energy supply • Energy systems and grids • Buildings and industrial facilities in energy transition • Communities and cities • Industrial competitiveness in transport • Clean, safe and accessible transport and mobility • Smart mobility • Energy storage	X	X	X	X

EU Public-Private Partnerships & missions	Partnerships that foster collaboration between public and private stakeholders to accelerate the development of zero-emission transportation solutions	X	X	X	X
• Clean transport	• Towards Zero-Emission Road Transport (2Zero) • Zero-Emission Waterborne Transport (ZEWT) • Transforming Europe's Rail System • Clean Aviation	X			
• Others, contributing to decarbonised transport	• Clean Hydrogen • Batt4EU – towards a competitive European industrial battery value chain • CCAM – Connected, Cooperative and Automated Mobility • SESAR – integrated air traffic management	X		X	
• Cities	• Cities Mission – 100 Climate-Neutral and Smart Cities by 2030 • New European Bauhaus – sustainable, inclusive and innovative mobility solutions as part of transforming public spaces and cities towards a greener and more liveable future	X	X	X	X

European Technology Platforms	• European Road Transport Research Advisory Council (ERTRAC): research priorities and technological pathways under EU's Strategic Research Agenda (SRA) and Vision • Alliance for Logistics Innovation and Collaboration in Europe (ALICE): industry-led strategy for research, innovation and market deployment in the field of logistics and supply chain management in Europe	X		X	X

Table 18. Relevant EU Research Programmes for the four exploratory topics

Annex E. U.S. Policies for the four explanatory topics

The tables below provide an overview of the main relevant U.S. policies and programmes and an indication of their relevance to the four exploratory topics. Other policies exist that are not listed here but are relevant to other transport modes / topics outside the scope of the Symposium. The White Paper and Briefing Paper #5 provide further details.

POLICIES		EXPLORATORY TOPICS			
Federal policies and plans	Standards, programmes, funding, technical assistance	1. Electrification and alternative fuels (for road vehicles)	2. Just Transition to net-zero transport	3. Digitalisation, AI and other Technologies	4. Sustainable and resilient land-use and transportation system design
Inflation Reduction Act 2022 (IRA)	Federal investments in clean energy and transport deployment Tax incentives and regulatory action to reduce GHG and environmental pollution and advance environmental justice	X	X	X	X
• Grants and tax incentives / credits	• Electric vehicles, charges • Manufacturing credits for battery production and storage facilities • Tax credits for clean fuels, including clean fuels for vehicles, sustainable aviation fuel (SAF), synthetic fuels, hydrogen – stacking of IRA credits with state credits is possible • Tax credits for carbon capture	X			
• Just transition	• Creating energy credits for solar and wind facilities sited in low-income communities and USD 42	X	X		X

	million investments in Tribal and Native Hawaiian climate resilience • Greenhouse Reduction Fund allocates grant for state, local, regional and Tribal governments to provide financial or technical support • USD 7 billion of zero-emission technologies to be deployed in underserved and low-income communities, and USD 8 billion allocated entirely to low-income and disadvantaged communities				
• Research and development	• See Table 20. Relevant U.S. Research Programmes for the four exploratory topics	X	X	X	X
Infrastructure Investment and Jobs Act 2021 (IIJA)	Legislation includes around USD 550 billion in new federal investment in America's roads and bridges, water infrastructure, resilience, internet, and more. IIJA aims to grow the economy, enhance competitiveness, create good jobs, and make the economy more sustainable, resilient, and just.	X	X		
• Infrastructure	New funding for various				

	infrastructure projects, reauthorises several transportation programmes, and establishes new grant programmes for electric vehicles including: • Alternative Fueling Corridors, USD 7.5 billion, mainly focused on EV charging network • National Electric Vehicle Infrastructure (NEVI) programme to provide funding to States if EV charging infrastructure complies with minimum standards, including minimum 'Build America, Buy America' products				
• Environ-mental justice	Explicitly seeks to advance environmental justice through • Agencies to fund programmes that increase access to reliable, clean, affordable power, safe drinking water and broadband connectivity • Community resilience programmes such as health streets, flood mitigation and resilient infrastructure		X		X

CHIPS and Science Act	Building domestic manufacturing capability for clean technology production	X		X	
Long-Term Strategy for the United States 2021	Pathways to net-zero GHG emissions by 2050, including near complete decarbonisation of the transportation sector. It mentions R&I will lay the technology foundation necessary to maximize economic benefits from the post-2030 transformation to net zero.	X	X	X	X
U.S. National Blueprint for Transportation Decarbonisation 2030		X	X	X	X
• Convenient: improve community design and land-use planning (planning, telework e-commerce, transport demand management, active mobility)	Transit-oriented Development: Federal Transit Administration programme supports local planning				X
	Credit assistance eligibility for TOD infrastructure				X
	Active Transportation: USD 5 billion for safety action planning and implementation grants		X		X
	Reconnecting Communities Program: USD 1 billion to reconnect communities historically cut off from transportation access		X		X
	Carbon Reduction Program: USD 6.4 billion for projects to reduce	X			X

	transportation emissions and state carbon reduction strategies				
• Efficiency: increase options to travel more efficiently (pool riding, operational improvement, public trans-portation, rail & shipping, vehicle fuel economy	Movement Efficiency: USD 2.25 billion to improve the efficiency, safety, or reliability of goods movement at ports	X		X	
	Movement Efficiency: Up to USD 108 billion for public transportation	X	X		
	Corporate Average Fuel Economy (CAFE) standards, June 2024, covering passenger cars, vans, light trucks, heavy duty pickup trucks	X			
• Clean: transition to zero emission vehicles and fuels (clean electricity, sustainable biofuels, e-fuels, clean hydrogen)	National EV Infrastructure Formula Program USD 5 billion to deploy EV light, medium and heavy-duty charging infrastructure along designated Alternative Fuel Corridors (AFCs)	X			
	Charging and Fueling Infrastructure Discretionary Grant Program USD 2.5 billion to deploy EV charging and hydrogen / propane / natural gas fuelling infrastructure along AFCs and publicly accessible locations	X			
	Low and No-Emission Grants / Bus and Bus Facilities	X			

	Discretionary Grants USD 1.69 billion in 2024 for the purchase / lease of no / low emission transit buses, construction and leasing of supporting facilities				
	New EPA Vehicle Emissions Standards 2024, starting model year 2027 for light / medium / heavy duty passenger and freight vehicles	X			
Complete Streets of the Federal Highway Administration	Prioritises all street users (pedestrians, cyclists, public transport passengers), rolled out as a funding programme for cities and states		X		X
Biden Executive Order 14008	Justice40 Initiative mandates that 40%+ of climate and clean energy investment benefits disadvantaged communities. A Justice40 Scorecard provides public tracking by Federal agency		X		
	Approach to addressing environmental justice concerns: • White House Environmental Justice Advisory Council • Interagency Working Group on Coal and Power Plant Communities and Economic Revitalisation		X		

	• Climate and Economic Justice Screening Tool to identify disadvantaged communities for Justice 40 programmes				
EPA Greenhouse Gas Rule	Strict emissions standards for heavy-duty trucks, buses and other large vehicles, which take effect for model years 2027 through 2032				
California	• Low Carbon Fuel Standard with a crediting programme for fuel producers, including renewable electricity • Advanced Clean Car Act • Advanced Clean Trucks • Advanced Clean Fleets	X			

Table 19. Relevant U.S. Policies for the four exploratory topics

RESEARCH PROGRAMMES		**EXPLORATORY TOPICS**			
Title	Description	1. Electrification and alternative fuels (for road vehicles)	2. Just Transition to net-zero transport	3. Digitalisation, AI and other Technologies	4. Sustainable and resilient land-use and transportation system design
Federal: U.S. Global Change Research Program	Climate related research and climate services involving 14 Federal Departments and Agencies	X	X	X	X
Department of Transport (DOT)					
DOT Climate Change Research, Development and	Bridge research and decision making on decarbonisation	X	X	X	X

Technology Strategic Plan	and resilience efforts across the U.S. Government				
• Safety	Zero fatalities: advance a future without transportation-related serious injuries and fatalities • Human factors • Data-driven system safety • Cybersecurity			X	
• Economic strength and global competitiveness	Resilient supply chains: create a multi-modal freight system that can withstand and rapidly recover from severe disruptions • Resilient supply chains • Advanced asset management • System performance • Create pathways to good quality jobs		X	X	X
• Equity	Equitable mobility for all: create an equitable transportation system that provides safe, affordable, accessible and convenient mobility options for all users • Equity and accessibility assessment • Mobility innovation • Wealth creation		X	X	X
• Climate and sustainability	Net-zero emissions: create a transportation system that supports an economy with	X	X	X	X

	net-zero GHG emissions • Decarbonisation • Sustainable and resilient infrastructure				
• Transformation	The future transportation systems-of-systems: develop connected intelligent infrastructure that provides people-centred mobility • Integrated system-of-systems • Data-driven insight			X	X
Other DOT research programmes	DOT University Transportation Centers Program: research partnerships with university consortiums, including climate and environmental preservation	X	X	X	X
	Sustainable aviation fuel (SAF), maritime decarbonisation strategies and other key transportation decarbonisation research areas	X			
Department of Energy (DOE)	Vehicle Technology Office, Hydrogen and Fuel Cell Technology Office, Bioenergy Technology Office, advanced research project offices ARPA-E and ARPA-I				
• On-road	• Batteries: research new battery chemistries, reduce battery costs, increase	X	X	X	X

	energy density, increase life • Electrification: increase energy density of power electronics, reduce charge time • Materials technology: increase efficiency of light-, medium-, and heavy-duty vehicles • Mobility systems: increase convenience and effectiveness of transportation system as a whole				
• Off-road, marine, rail	• Electrification: ensure that hard-to-electrify sectors can transition to clean fuels • Hydrogen / fuel cells: optimise high-efficiency engines and emission control systems that can use low GFG, renewable fuels such as advanced biofuels, hydrogen, and e-fuels • Net-zero carbon fuels: integrate electrified and hybrid powertrains into vehicles to further reduce GHG emissions	X			
• Technology integration	• Clean Cities and Communities Partnership		X		X

Joint Office of Energy and Transportation (created under IIJA)	Work on electric transportation infrastructure, along with other areas, where DOE and DOT overlap in their priorities and goals	X			

Table 20. Relevant U.S. Research Programmes for the four exploratory topics

Annex F. EU and U.S. Collaboration

COLLABORATIONS		EXPLORATORY TOPICS			
Title	Description	1. Electrification and alternative fuels (for road vehicles)	2. Just Transition to net-zero transport	3. Digitalisation, AI and other Technologies	4. Sustainable and resilient land-use and transportation system design
Agreement for scientific and technological cooperation between the European Community and the Government of the USA	Provides the legal and administrative framework for cooperation in Science and Technology between the EU and the US. Steered by the EU-US Joint Consultative Group (JCG).	X	X	X	X
Bilateral programmes between EU and U.S.	• Previous EC – US DOT Transportation Research Project Twinning Initiative • ERA-NET Plus Infravation (infrastructure innovation) Program • FHWA International Transportation Pooled Fund (TFP) Program • Cooperation between EC and U.S. Federal Aviation Administration on R&I for sustainable aviation fuels and non-CO2 climate impacts of aviation • Collaboration between European Battery Alliance and U.S. Li-Bridge Alliance • EU-U.S. Trade and Technology Council: Joint standards for EV charging infrastructure; joint report on smart grid interoperability and electromobility; two sets of recommendations: Future public demonstrations of Vehicle-Grid integration pilots (April 2024) and Transatlantic Technical Recommendations for Government Funded Implementation of Electric Vehicle Charging Infrastructure (May 2023) • EU Joint Research Centre (JRC) and U.S. National Oceanic and Atmospheric Administration (NOAA) focusing on climate change risks, disaster modelling, space weather impacts and fisheries	X	X		

	• Information exchange at joint events				
Multilateral programmes	• International Energy Agency (IEA) cooperation in the research, development and deployment of Hybrid and Electric Vehicle Technology Collaboration Programme (HEV TCP) • Mission Innovation to accelerate clean energy innovation for waterborne transport (zero-emission shipping) • International Transport Forum – Joint Research Centre • Electric Vehicle Initiative of the Clean Energy Ministerial (CEM), resulting in a Global MOU for Zero Emission Trucks	X	X		
Horizon Europe	• Encourage international cooperation and is open to researchers and innovators all over the world • Open to US participants with no funding that need to be found • Rationale for international cooperation • Share experiences, knowledge and data collected in research projects and large-scale demonstration pilots • Identify common research areas and fields of cooperation to exploit synergies • In the longer term: cooperation can lead to harmonised approaches in terms of testing, methodologies and standards	X	X	X	X

Table 21. Research collaborations between the EU and the U.S. relevant to transportation

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The portal data.europa.eu provides access to open datasets from the EU institutions, bodies and agencies. These can be downloaded and reused for free, for both commercial and non-commercial purposes. The portal also provides access to a wealth of datasets from European countries.

This report presents the outcomes of the seventh EU-US Transportation Research Symposium held in Washington, DC, in June 2024. Organized by the European Commission (EC), U.S. Department of Transportation (DOT), and the Transportation Research Board (TRB), the symposium addressed decarbonising transportation through four key topics: electrification and alternative fuels, a just transition to net-zero transport, leveraging digitalisation and AI, and sustainable transportation systems.

It outlines strategic recommendations for EU-U.S. collaboration, including key research questions and programming and policy-level initiatives. It does so by highlighting the current research landscape and suggesting pathways to overcome collaboration barriers, particularly in the area of Decarbonisation. This document serves as a guide for future joint efforts towards sustainable transportation systems.

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