FEHRL

FEHRL Strategic European Road and cross-modal Research and implementation Plan

2017-2020

Incorporating

FOREVER OPEN ROAD
Redefining Road Transport for the 21st Century
FEHRL's Flagship Programme

FORx4 - FOREVER OPEN ROAD, RAIL, RUNWAY AND RIVER
Infrastructure innovation for seamless mobility

ABOUT FEHRL

FEHRL is a registered International Association with a permanent Secretariat based in Brussels. Formed in 1989 as the Forum of European National Highway Research Laboratories, FEHRL is governed by the Directors of each of the national institutes nominated by their respective countries.

It provides a coordinated structure for cooperation between more than 30 national research/ technical centres and third parties.

Through research collaboration, the objectives of FEHRL are:

- To provide scientific input to Europe and national government policy on highway engineering and road transport matters,
- To create and maintain an efficient and safe road network in Europe,
- To increase innovation in European road construction and road-using industries,
- To improve the energy efficiency of highway engineering and operations,
- To protect the environment and improve quality of life.

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1 CONTEXT

There are significant challenges faced by road authorities and infrastructure owners and operators, such as an ageing transport network, budgetary pressures, the threats of extreme weather events and climate change to name but a few. Added to this are the potential implications raised by disruptive technologies, in particular automated driving. Further, the road network now needs to be seen and managed in the context as part of a wider, multimodal and integrated transport system. FEHRL and its partners can help provide the solutions to help overcome these challenges and to take advantage of the new opportunities.

The strength of FEHRL comes from its 35 member and associate member institutes and from its own and its members' networks with governments, road authorities, industry, academia and other research institutes. As a result, FEHRL has a significant role in providing a comprehensive industry view to funding organisations and research bodies.

Since the last version of FEHRL's Strategic European Road Research Programme (SERRPV) covering the 2011 to 2016 period, there have been changes in the EC focus from single to multi modal transport infrastructure research and development in the Horizon 2020. The Forever Open Road programme, placed at the core of SERRP V, is still active and has generated a number of sister programmes within FEHRL members, whilst the cross-modal FORx4 (Forever Open Road, Rail, Runway and River) project has also been developed internally and through the award of three Horizon 2020 CSA projects, FOX (Forever Open Infrastructure across (X) all transport modes), USE-iT (Users, Safety, security, Energy in Transport infrastructure) which together with REFINET will form the basis of the FORx4 roadmap endorsed by a wide number of industry stakeholders from across all four modes.

There are two subtle, yet important changes to the title of this research document. The first is that 'cross modal' has been added in recognition of the potential to transfer knowledge to and from other modes, and act as a catalyst for innovation. The second change is the addition of implementation, to reflect the fact that FEHRL recognises that true value will only be created, when new technologies are implemented.

2 FEHRL MAIN PRIORITIES

The main FEHRL priorities are outlined below, and are designed in part to align with current EC transport research priorities, and in part to reflect the activities of FEHRL members. It is acknowledged that some FEHRL members will have different priorities due to their internal or national targets and that funding may not be available for projects in all areas.

Figure 1: SERRP Priority Areas

2.1 Health and safety

Safety is central to all six strategies, and technologies being developed in other areas should as a minimum provide at least the same safety level as existing technologies. Specifically, within this area, there will be a focus on supporting initiatives in the following areas:

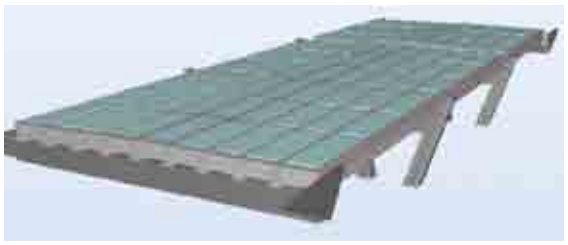
- Safety for vulnerable road users
- Self-explaining and forgiving road
- Safety for road users and operatives
- Safety improvement due to digital environment

Whilst improved safety is the key area for FEHRL, it is recognised that a number of the initiatives supported could have a positive impact upon public health, such as through increased walking and cycling, a reduction in respiratory illnesses through improved air quality and reduced traffic noise disturbance. The challenges of maintaining sustainable mobility for Europe's ageing population is also recognised. As public health generally falls outside the remit of most FEHRL institutes, no targets or specific activities are proposed in this area.

2.2 Maintenance and upgrading of ageing infrastructure

It is generally accepted that there will not be any major new road building programmes in Europe, however there will be a requirement to replace and/or upgrade certain sections to for example, cope with additional traffic loads, upgrade to modern safety standards or protect against extreme weather events and climate change.

This version of SERRP proposes a focus on technologies and processes for replacement and life extension of transport infrastructure, innovative and cost-effective maintenance solutions, improved safety for drivers and passengers through concepts such as self-explaining and forgiving roads and for roadworkers through prefabrication and removing them as far as possible from live roads. Areas for further exploration are to explore how on or off-site 3D printing could be used for repair or upgrading and understanding the potential for robots to be used to perform routine maintenance tasks.



2.3 Digitalisation

The digital environment is fast moving, particularly with respect to autonomous driving. FEHRL members need to understand and respond to the infrastructure challenges that automated driving might bring, either to accommodate automated driving on dedicated infrastructure or to make investment decisions based on future scenarios, where a large proportion of the vehicle fleet is autonomous. The wider digital environment will impact many facets of transport and transport infrastructure, including:

- Building Information Management (BIM) and how this impacts on asset information and management and maintenance activities.
- The use of augmented reality integrated with BIM for design applications.
- The Internet of Things and how this will likely have an impact on how vehicles communicate with the assets, how the assets communicate with central control and each other.
- Big data and how BIM, the Internet of Things, social media and other data generating technologies will be managed and turned into useful information, generating benefits for the management of the road network. In this context the use of artificial intelligence (AI) could be of significant benefit.
- How safety can be increased due to the digital environment.
- Cyber-security and how this impacts on the management of assets, hacking threats for infrastructure and connected vehicles and security standards for communication devices.
- Understanding and managing accordingly the role of transport engineers regarding threats to national security through e.g. BIM, increased data on critical infrastructure assets, if in the hands of those with malicious intentions.

2.4 Security and Resilience

Security and resilience in this version of SERRP will focus on understanding how infrastructure can be adapted to withstand the challenges of both man-made and natural hazards, as outlined below:

- The resilience of infrastructure to extreme weather events and climate change, as well as the challenges of extreme short term variations in temperature, the increased frequency and severity of storm events and the challenge of maintaining high levels of availability and high service and safety levels. There is an additional challenge of improving the prediction and modelling of weather events and their impact on transport infrastructure and operations.
- A secure infrastructure network, resilient to man--made hazards, such as vandalism, theft, malicious acts and terrorism.

2.5 Carbon and Environment

The environment can be an all-encompassing topic. In this programme, we are concerned that any innovation topic chosen in any other priority area is at least no more environmentally damaging the one it replaces, and ideally is environmentally beneficial. Beyond that, the specific focus concerns developing solutions for the following key challenges:

- Energy and carbon reduction (in construction and operation),
- Harvesting energy from transport infrastructure,
- Supporting electrification of the vehicle fleet,
- Reuse and recycling of materials,
- The circular economy and,
- Noise and air quality.

2.6 Cross and Multi-modal integration

Through activities such as FORx4 and multi-modal research projects such as FOX, USE-iT and REFINET, FEHRL has developed a reputation as a respected body covering transport infrastructure across modes. This priority has been chosen as a way to transfer solutions across modes, to acknowledge that the road network should be viewed as part of a wider transport network, to accommodate and improve the safety of increased walking and cycling particularly in the context of maintaining active mobility with an ageing European population and as a means of providing an infrastructure response to future mobility scenarios, such as autonomous driving and mobility as a service.

2.7 Governance for implementation

Governance and procurement have the potential to inhibit or facilitate the uptake and implementation of new technologies. Governance is one of the four domains of FORx4 and is also considered in the Forever Open Road roadmaps. For many concepts, not least automated driving, the role of governance is at least as important in ensuring uptake as the technological challenges.

Equally, there are examples of good governance and procurement strategies, where innovation is encouraged through non-prescriptive tenders, e.g. through asking for a solution to a problem or delivery of a service as the bidders see fit, or provision of a construction material that exhibits certain technical properties regarding strength rather than a specific type of aggregate for example. In addition to technology innovation, there is also the potential for Governance to be used to embed sustainability and resilience in contracts as well as price and quality. In addition, there will be a specific focus on the customer, managing the network for their benefit. In order for innovation to be fostered, there needs to be a sharing of risk between the infrastructure owner or authority and the contractor (through, for example, improved public-private partnership (PPP models), good practice needs to be shared and common European Governance and Procurement standards developed, so that a product or technology developed and approved for use in one country can automatically be used in another. This would not only benefit technology developers, but also infrastructure owners and operators, as not only does standardisation drive competition, lowering costs, but common open standards would prevent technology lock in. Governance will sit above and have influence in all other priorities.

3 FEHRL ACTIVITIES

3.1 Cooperative Research, Development and Implementation

A core FEHRL activity is to help its member institutes undertaking cooperative R&D&I projects through participation in, primarily, EC and CEDR projects. The main priorities outlined in the previous section represent the key challenges and disruptive technologies faced by the transport industry in Europe and beyond. FEHRL members can deliver enormous value in delivering research to address these areas.

SERRP should help FEHRL influence the research agenda and advise programmers, and should also assist its members to generate internal FEHRL cooperative R&D&I projects which are complementary to the ones funded by the EC, CEDR or other funding programmes. The model for this has been established by MIRIAM[1] where certain institutes have pooled their national programmes for greater benefit, and has subsequently led to a number of funded projects being awarded in the area. A similar, more formalised model is the FHWA Transportation Pooled Fund in the USA.

3.2 Knowledge Exchange, Dissemination

Knowledge exchange and dissemination is the most important role played by FERHL; the main route for this is the work undertaken by the Research Coordinators, but also through direct participation in CEDR and EC projects, production of e-newsletters and FEHRL Infrastructure Research Magazines (FIRM) and bi-annual FEHRL Infrastructure Research Meetings (FIRM), and a strong presence and participation at TRA and TRB.

The FEHRL priorities represent the views and shared issues of its members to a greater or lesser extent, i.e. some countries might have newer infrastructure than others, some countries might have a greater deployment of ITS and desire for more whilst all countries will experience the effects of climate change, some of which might be negative and some positive.

3.3 Foster Implementation

The realisation of true value from research comes in its implementation, linked to knowledge exchange, so that early adopters of technology and innovative schemes or systems can be seen as exemplars in advance of widespread adoption.

Implementation represents the final stage of a particular phase of research and demonstration. The stated FEHRL priorities represent those also of the Forever Open Road, a programme which now looks towards demonstrator projects and sub-system implementation in line with the milestones detailed in the roadmaps for each of the three elements.

3.4 Programming

3.4.1 Advisor to the European R&D&I Agenda

FEHRL has always played an important role in advising and influencing the national and European R&D&I agenda and voicing for the importance of funding for road, and more recently cross-modal infrastructure R&D&I funding. In turn, FEHRL is influenced by and responds to national and European programmes.

The previous versions of SERRP, as with this one represent the main position paper from the road infrastructure community, and link with other initiatives such as Forever Open Road, FORx4 and responses to the future H2020 topics as a combined response to and influencer of the research agenda in Europe.

3.4.2 Advisor to European R&D&I programmers

As with influencing the research agenda, FEHRL, via its pool of expertise spread out throughout Europe and worldwide, has an important role to play in advising national and European R&D&I programmers in monitoring the progress of projects and facilitating the exploitation of results. With disruptive technologies such as autonomous driving, this task is more important than ever. Renewing, upgrading or new construction of transport infrastructure involves extremely large budgets, long planning times and long design lives and yet new technologies and the rapid pace of change could mean that such investments would be required and that other investment choices would provide a better return.

[1] *http://www.miriam-co2.net/index.htm*

4 FEHRL PROGRAMMES

There two main FEHRL Programmes remain the Forever Open Road and FORx4 initiatives. These have been and will continue to be used to inform the community on the vision for the future of transport infrastructure, and for FORx4 in particular to bring cross-modal stakeholders together and to identify opportunities for modal shift and to encourage co-modal opportunities to enable mode neutral travel.

FEHRL initiated the Forever Open Road Programme in 2010 and placed it as the core of SERRP V in 2011. The Forever Open Road Programme works towards a next generation of advanced and affordable roads that can be adopted both for maintaining the existing network and building new roads. The Forever Open Road programme is based on three elements; the Adaptable Road, covering concepts such as prefabrication, self-cleaning and self-healing roads, integrated services and advanced construction and maintenance operations; the Automated Road, covering the communications between the driver, vehicle and operator; and the Resilient Road, seeking to minimise the impacts of extreme weather events and climate change. Additionally, initiatives on Asset Management and Transport Integrated with Land Use Planning have been developed to support the Adaptable Element, but which also contribute to the other elements.

Individual road authorities and national research institutes have their own national research programmes. In addition, there are 'sister' projects to and influenced by the Forever Open Road, as outlined below.

- Route 5ème Génération – R5G
  (The 5th Generation of Roads) - France
- Strasse im 21. Jahrhundert
  (Road in the 21st Century, R21C) – Germany
- Exploratory Advanced Research Program (EAR) – USA
- Coastal Highway Route E39 – Norway

In addition to the large programmes detailed above, there are a number of national projects that have been influenced by Forever Open Road, and form some of the building blocks of this programme.

In developing the Forever Open Road programme, it became apparent that other transport modes face many of the same issues as the road industry, and that the research programme developed for the Forever Open Road is broadly applicable to other sectors.

For this reason, FEHRL developed FORx4; a European programme of research and development that will merge the functionality of the four transport modes (road, rail, water and air) with four shared domains to form a holistic transport system for the future. These four domains are technology, infrastructure, governance and customers.

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5 ENABLERS

In order for FEHRL's targets and priorities to be realised, there needs to be an implementation strategy supporting by funding organisations and stakeholder bodies. The following supporting instruments have been identified.

5.1 FEHRL Joint Projects

In addition to the specific funding channels outlined below, there exists significant potential for FEHRL members and other institutes to collaborate on specific projects or initiatives using their own or national funds. Specific opportunities that may be applicable for FEHRL member institutes are outlined below.

5.1.1 FEHRL Institute Pooled Funding

Many FEHRL institutes are awarded national research funding; in some cases, two or more institutes may be awarded funding on the same or a complimentary topic. In such cases, there might be potential to pool funding or collaborate in some way to maximise the benefits of the combined funding. There is no single mechanism for undertaking such joint research, with options including bilateral agreements on research, forming expert groups or through a more formal process such as MIRIAM, where research institutes from Europe and the USA collectively raised internal funding to undertake research on rolling resistance.

5.1.2 Coastal Highway Route E39 – Norway

The E39 coastal highway in Norway, outlined in section 4 will, in addition to national activities, also release research calls within Europe in a variety of fields including materials, technologies and energy harvesting.

5.1.3 FHWA Pooled Fund

The Transportation Pooled fund enables federal, state, regional, local transportation agencies, academic institutions, foundations, or private firms to jointly fund research, planning and transport studies. This pooling of funds extends to European organisations.

5.1.4 Nordforsk

NordForsk is an organisation that facilitates and provides funding for Nordic research cooperation and research infrastructure. It is not specifically focussed on transport or transport infrastructure, but previously had a €2.2 million programme on 'Sustainable Freight and Logistics in a Nordic Sense' covering Norway, Sweden, Finland and Denmark.

5.2 CEDR Funding Scheme

CEDR, the Conference of European Directors of Roads (Conférence Européenne des Directeurs des Routes) is the road directors' platform for cooperation and promotion of improvements to the road system and its infrastructure, as an integral part of a sustainable transport system in Europe. Its members represent their respective national road authorities or equivalents and provide support and advice on decisions concerning the road transport system that are taken at national or international level.

CEDR runs two research calls to complement the research undertaken on a national level by its members, as detailed below.

- CEDR Transnational Call - each year, CEDR develops and manages a Transnational Road Research Programme, originally initiated via the ERA-NET Road project. Total funding is typically in the order of €3 – 4 million over 3 – 4 topic areas, with projects running over 2 years. There is an expectation that results will be implementable by National Road Authorities shortly after completion of the project.
- Infravation - the ERA-NET Plus Infravation 2014 Call was initiated as a pooled research fund to develop transport infrastructure innovations which address the challenges identified in the European Commission's White Paper on Transport: Smart, Green and Integrated transport. Its objective is to enable a high quality infrastructure offering high service levels to the user/economy/society through solutions for both new and existing infrastructure. For this Call, the available budget for co-financing was € 9 million.

5.3 EC Funding Schemes

The EC provides the single largest programme funding, primarily through Horizon 2020 (H2020) Research and Innovation and Coordination and Support Action projects. FEHRL, its member institutes and industry have been successful in recent years in being awarded EC funding, inc-

luding the ongoing USE-iT and FOX projects that FEHRL is managing.

FEHRL has strong links to DG MOVE and provides advice and input to their programmes. A recent trend is for funding to be based on cross-modal infrastructure rather than being mode specific and so FORx4 is an important element in this strategy, and the USE-iT and FOX projects feed directly into it. Importantly, both USE-iT and FOX in combination with REFINET have developed a significant cross modal stakeholder group and are encouraging information sharing.

6 STAKEHOLDERS

The execution of this version of SERRP will involve a wide range of stakeholders, as outlined below.

6.1 All FEHRL Members

The main stakeholders are the FEHRL Member and Associate Member Institutes and this programme is influenced by them and will only go forward with their explicit approval.

6.2 European Commission

The European Commission is a key partner, both as an organisation that funds research and development and through the policies it sets in regards to transport and other aligned areas such as energy. As such, there is an essential two-way dialogue to be held between FEHRL and the EC regarding this document.

6.3 Transport Authorities

Transport Authorities will be a key stakeholder both as potential funders but also to inform them of FEHRL's views and understand their priorities. CEDR will be the main stakeholder given the common highway background and Memorandum of Understanding between the two bodies, but other infrastructure authorities such as the European Rail Infrastructure Managers and Inland Navigation Europe will be targeted along with international organisations.

6.4 Industry

Industry will be key in implementing the priorities identified by FEHRL and research and development undertaken by FEHRL institutes. Whilst the likes of ENCORD, EUPAVE and EARPA represent the key industry associations, FEHRL members will work with the construction, technology and vehicle industries to implement improvements and new technologies on the European transport networks.

6.5 Research bodies

It has always been important for FEHRL and other European Research bodies covering transport to be aware of and occasionally input to each other's research programmes. The main ones that will be targeted are ECTRI, FERSI, Eurnex and Humanist.

6.6 Technology Platforms

As FEHRL and its members continue to undertake projects covering cross and multi modal infrastructure, it becomes increasingly important to engage with a wide range of technology platforms, as potential future project partners and for endorsement of specific research programmes. FORx4, and the FOX and USE-iT projects have resulted in an increasing network of stakeholders covering all modes. The specific platforms to engage with will be ERTRAC, ERRAC, Waterborne, ACARE and ECTP.

7 IMPLEMENTATION

Previous versions of SERRP have had a five-year timeframe. Given the fast changing environment, particularly regarding the automated road and connected vehicles, in order to stay relevant, this and future versions of SERRP will be shorter documents over a three-year timeframe. The role of FEHRL institutes is to support implementation, i.e. it will be the role of contractors or ICT suppliers for example to physically construct or commission technologies. Generally, FEHRL will undertake demonstration projects, create and operate 'living laboratories' or test fields, and will undertake assessments of potential impacts such as risk, return on investment, cost-benefit and management and maintenance strategies.

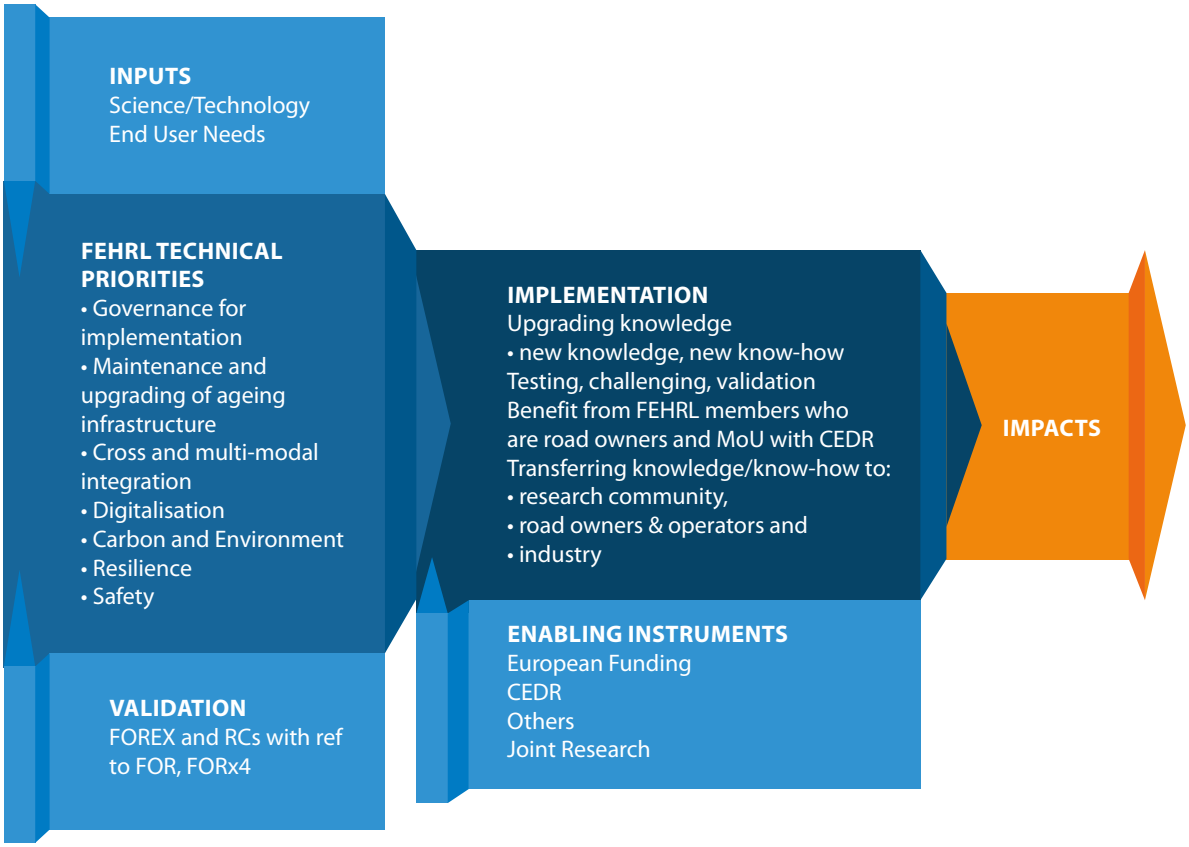

Figure 2 Interaction between FEHRL Priorities and Targets and Enabling Instruments

The main means by which FEHRL will contribute to implementation are as follows:

- Upgrading knowledge by creating new knowledge and new 'know-how', and provision of training in these areas.
- Through FEHRL members testing, challenging and validating R&D&I, especially benefitting from members who are also road owners, and from the Memorandum of Understanding with CEDR.
- Transferring knowledge and know-how to the research community, to road owners and operators and industry.
- Demonstration of new technologies, products and services.

Implementation will be supported in part through FEHRL self-funding and through the enabling instruments outlined in section 5.

8 IMPACTS

Whilst it is clearly the case the research has the potential to deliver meaningful advances in transport, either through incremental improvements, or occasionally through radical changes, there is ultimately a step between research and trials, to full implementation which is the responsibility of road authorities and industry. As such, it is difficult to set targets for impacts, yet the identified FEHRL priority areas have the potential to support defined targets defined in various national and European transport agency and industrial plans, as outlined below. The targets are indicative and will be reviewed by the FOREX team and FEHRL Research Coordinators.

FERHL Priority Area	Target	Basis of Target
Governance for implementation		
Customer focussed Governance	95% customer satisfaction	Exceed Highways England target[2] of 90% customer satisfaction by 2020
Governance based on performance criteria	Support 20 – 30% improvement in cost versus 2010 baseline by 2030	Joint European Construction Technology Platform Task Force target[3] Cost reduction of 30% by 2020 proposed in reFINE document[4]
Procurement for innovation	Development of 2 case studies showing good practice 33% total spend with SMEs	Some good practice documented in CEDR 'Efficiency in Road Public Procurement'[5] UK Government target (Highways England have 25% target). In 2011-12, more than 57% of Transport Scotland's direct suppliers were SMEs[6]. Also CEDR 'Efficiency in Road Public Procurement' states that in new Procurement Directive (2014/24/EU), facilitation of the participation of SMEs is an explicit goal
Innovative financing approaches	Development of 2 case studies showing good practice	

[2] *Highways England 2015. Better journeys, better conversations*

[3] *ERTRAC-ERRAC-Waterborne-ACARE-ECTP Task Force 2013. Roadmap for Cross-Modal Transport Infrastructure Innovation. Towards a Performing Infrastructure. A coordinated approach to addressing cross-modal infrastructure issues for an integrated European Transport System*

[4] *ERTRAC-ERRAC-Waterborne-ACARE-ECTP Task Force 2013. Roadmap for Cross-Modal Transport Infrastructure Innovation. Towards a Performing Infrastructure. A coordinated approach to addressing cross-modal infrastructure issues for an integrated European Transport System*

[5] *Holleman, W. (Rijkswaterstaat for CEDR), April 2016. Efficiency in Road Public Procurement*

[6] *Transport Scotland Procurement Strategy 2012 - 2015*

FERHL Priority Area	Target	Basis of Target
Green procurement	+50% green procurement around EU	Green Tenders document in Republic of Ireland set targets for 50% green procurements in eight product and service groups[7].
Asset management	Progress in line with Forever Open Road Asset Management Roadmap	Forever Open Road – Adaptable Road Roadmap. Forever Open Road – Asset Management Roadmap
Cross and multi-modal integration		
Road network as part of integrated transport system	Matching mobility demand (towards 100 % passenger / freight satisfaction) via an optimisation of the use of transport infrastructure (towards 100 % capacity use). +30% freight transport efficiency.	Highways England has 90% target. A number of rail operators have customer satisfaction levels in excess of 95% European White Paper on Transport goal for 30% modal shift to rail or water by 2030 and 50% by 2050 for freight moved over 300km ALICE mission 'to contribute to a 30% improvement of end to end logistics performance by 2030'[8]
Transfer of solutions (technologies,methodologies, standards etc.)	Two-way transfer of technologies via cross-modal stakeholder projects	Ongoing initiatives, e.g. FOX, USE-iT and REFINET projects
Infrastructure response to future mobility scenarios	+30% improvement and increase of infrastructure utility Achieve full compliance with existing air quality legislation by 2020 and further improve Europe's air quality by 2030 and thereafter Improvement of public health (thanks to healthy activity and safety trade off)	Research for Future Infrastructures in Europe (reFINE) document target[9] Proposed European Commission, Clean Air Policy Package for Europe[10] EC White Paper target to halve the use of 'conventionally fuelled' cars in urban transport by 2030 Research for Future Infrastructures in Europe (reFINE) expectation of 50% shift from conventionally powered cars by 2030 and 50% less local air pollution by 2050. Barcelona target to reduce traffic levels by over 20% by turning 60% of its streets into 'citizens spaces' No target set

[7] European Commission 2016. Buying Green – a handbook on green public procurement. 3rd edition. ISBN: 978-92-79-57821-2.

[8] ALICE (Alliance for Logistics Innovation through Collaboration in Europe) 2013. Corridors, Hubs and Synchromodality. Research & Innovation Roadmap

[9] European Construction Technology Platform, Research for Future Infrastructures in Europe (reFINE) 2012. Building Up Infrastructure Networks of a Sustainable Europe. Strategic Targets and Expected Impacts

[10] http://www.eea.europa.eu/themes/air/policy-context

FERHL Priority Area	Target	Basis of Target
Maintenance and upgrading of multi-modal infrastructure		
Upgrading	-50% time lost to upgrades	Research for Future Infrastructures in Europe (reFINE) target Work towards Joint European Construction Technology Platform Zero transport disruption caused by intrusion from inspection, upgrading and maintenance target
Life Extension	+50% extension of infrastructure life	Research for Future Infrastructures in Europe (reFINE) target for long distance corridors
Self-explaining and forgiving road	+40% reduction in KSIs	Research for Future Infrastructures in Europe (reFINE) target of -40% casualties by 2030
Prefabrication	Increase in off-site construction	No target set
Maintenance (including development of robotics)	Undertake technology scan. Prepare research document on potential for robotics to increase lane availability, reduce cost and reduce night time operations.	
Digitisation		
Adaptation of infrastructure to automated vehicles	Increase capacity of infrastructure for mobility by optimisation of space sharing (+20%)	Conservative estimate based on lower number of accidents, increased through put of vehicles and narrower lanes. Lower limit of capacity increase noted in study[11]
Infrastructure investment decisions	Support 20 – 30% improvement in cost versus 2010 baseline by 2030 Production of document detailing potential traffic scenarios as a result of mobility changes	Joint European Technology Platform Target. 30% target in Research for Future Infrastructures in Europe (reFINE) document
Big Data, BIM, Internet of Things & related cyber security	30% structural cost savings for design and construction by 2025	Estimated savings in UK[12]

[11] *Pinjari, A. R, Augustin, B, Menon, N (2013). Highway Capacity Impacts of Autonomous Vehicles: An Assessment. Center for Urban Transportation Research, Department of Civil and Environmental Engineering, University of South Florida*

[12] *Conference of European Road Directors (CEDR) 2016. Leaflet on BIM. http://www.cedr.fr/home/fileadmin/user_upload/Publications/2016/CEDR2016-leaflet01%20BIM.pdf*

FERHL Priority Area	Target	Basis of Target
Traffic management	+30% reduction of congestion	Research for Future Infrastructures in Europe (reFINE) target of 30% improvement and increase of infrastructure utility (capacity, safety and efficiency)
Smart, connected cities	Identify smart, connected city requirements and prepare FEHRL statement on infrastructure response	Engage with Smart Cities Electromobility and New Mobility Services *https://eu-smartcities.eu/content/sustainable-urban-mobility-0*
Carbon and Environment		
CO_2 reduction (embedded and operational)	-30% carbon intensity of road construction, maintenance and operation Progress supports EU Policy, Energy Union and upcoming STRIA	Research for Future Infrastructures in Europe (reFINE) target set for 2020[13] Barcelona target to reduce traffic levels by over 20% by turning 60% of its streets into 'citizens' spaces'
Decarbonisation / Supporting electrification	-40% CO_2 emissions and air pollutants Policy compliance	Corresponds to ERTRAC Guiding objectives[14] of 2030 of improvements of +80% urban passenger energy efficiency (pkm/kWh) and +40% (tkm/kWh) vs 2010 Research for Future Infrastructures in Europe (reFINE) expectation of 50% shift from conventionally powered cars by 2030 and 50% less local air pollution by 2050. In line with Energy Union Integrated Strategy on Research, Innovation and Competitive and Strategic Transport Research and Innovation Agenda
Energy Harvesting	Net energy production Establish baseline of current transport energy harvesting	Joint European Construction Technology Partnership Roadmap target[15]

[13] *ECTP reFINE. 2012. Building up Infrastructure Networks of a Sustainable Europe. Strategic Themes and Expected Impacts*

[14] *ERTRAC Multi-Annual Implementation Plan for Horizon 2020, March 2013*

[15] *ERTRAC-ERRAC-Waterborne-ACARE-ECTP Task Force 2013. Roadmap for Cross-Modal Transport Infrastructure Innovation. Towards a Performing Infrastructure. A coordinated approach to addressing cross-modal infrastructure issues for an integrated European Transport System*

FERHL Priority Area	Target	Basis of Target
Reduce rolling resistance	Continued development of low rolling resistance and low noise pavements. Determine lowest practical level achievable	FEHRL member institutes work on ROSANNE and ongoing work on MIRIAM project[16].
Reuse and recycling / Circular economy	100% recycling rate for concrete Increase in recycling rates, reduction in energy requirements and financial savings (target to be developed)	Research for Future Infrastructures in Europe (reFINE) target of 100% reuse of demolition waste by 2030 Forever Open Cross (X) modal infrastructure (FOX) CSA Project on best practice.
Noise and air quality	-40% CO_2 emissions and air pollutants Contribute to interim target of 55dB night-time noise[17] working to longer term WHO target[18] of 40dB night-time noise through quieter road surfaces and installation of noise barriers	Corresponds to ERTRAC Guiding objectives[19] of 2030 of improvements of +80% urban passenger energy efficiency (pkm/kWh) and +40% (tkm/kWh) vs 2010 European Environment Agency 55dB night time target World Health Organisation 40 dB night time target Corresponds to CEDR recommendation for research into noise abatement, including low noise pavements[20]
Security and Resilience		
Adaptation of infrastructure to extreme weather, climate change & man-made hazards	+50% reduction in downtime +10% improvement in service levels	Research for Future Infrastructures in Europe (reFINE) target is 100% reliable urban infrastructure in extreme events. Supports Mobility Continuity Plans outlined in EC White Paper

[16] *http://miriam-co2.net/index.htm*

[17] *http://www.eea.europa.eu/soer-2015/europe/noise#tab-related-briefings*

[18] *World Health Organisation Europe, 2009, Night Noise Guidelines for Europe. ISBN 978 92 890 4173 7*

[19] *ERTRAC Multi-Annual Implementation Plan for Horizon 2020, March 2013*

[20] *CEDR (2013) The European Noise Directive and NRAs: Final Summary Report CEDR Road Noise 2009-2013*

FERHL Priority Area	Target	Basis of Target
Health and Safety		
Improved safety in extreme weather conditions Safety improvement due to digital environment	+40% improvement +40% reduction in KSIs (by 2030)	Research for Future Infrastructures in Europe (reFINE) target of -30% accidents and -40% casualties Highways England target Supports EC White Paper 'zero vision' for road fatalities by 2050 ERTRAC target 60% improvement by 2030 vs 2010 baseline
Safety for road users and operatives	Eliminate need for road workers to be on foot on live carriageway Reduce exposure of road workers to live traffic – set KPI	Highways England target Highways England target
Safety for vulnerable road users	Set KSI in view of proposed increase in active travel Adaptation of infrastructure to new users.	Active Travel (Wales) Act 2013[21] makes it a legal requirement for local authorities in Wales to map and plan for suitable routes for active travel, and to build and improve infrastructure for walking and cycling every year.

9 CONCLUSIONS

This is the proposed strategy from FEHRL to boost research, development and implementation in Europe. Seven priorities have been outlined covering topics raised in the Forever Open Road, FORx4 and other transport and transport technology trends, covering:

- Health and safety
- Maintenance and upgrading of existing infrastructure
- Digitalisation
- Security and resilience
- Carbon and environment
- Cross and multi-modal integration
- Governance for implementation

These reflect the priorities of FEHRL's member institutes and are aligned with those identified by infrastructure owners and operators and other technology platforms. There remain significant challenges faced by road owners and operators and at the same time there are a number of disruptive technologies that promise to bring great benefits to transport, the economy, environment and society. Thanks to the commitment of the FEHRL community and its stakeholders, we are convinced that we can contribute to help realise these ambitions, and will develop solutions for improved road safety, increased service levels and environmental performance.

"Most people overestimate what they can do in one year and underestimate what they can do in ten years" Bill Gates

[21] *http://www.legislation.gov.uk/anaw/2013/7/contents*

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