How Horizon Europe can deliver a zero-emission transport sector

How EU research and innovation spending can contribute to achieve Europe's climate targets and maintain its industrial competitiveness in transport

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Summary

The EU has adopted legislation, known as *Horizon Europe*, to shape EU Research & Innovation (R&I) spending for the 2021-2027 period. With a proposed budget of almost €100 bn, the programme aims to stimulate technological innovation and help the EU decarbonise. It should be subject to a clear prioritisation of clean transport technologies in order to put the transport sector on a strategic pathway towards net-zero greenhouse gas (GHG) emissions by 2050 at the latest.

Horizon Europe's implementation must require 'nothing less than zero'. For road transport, only research in zero-emission vehicle technology, e.g. battery electric and fuel cell electric vehicles, should be eligible for public funding. For shipping, research priority should be given to battery-electric and green hydrogen/ammonia-based propulsion systems, including fuel cells. For aviation, the focus should lie on the development of breakthrough fuels, such as synthetic electrofuels produced from additional renewable electricity, with zero or near zero GHG emissions.

The successful transition to a zero-emission transport sector will hinge upon a better alignment and greater consistency between EU and Member States' policies. A more effective investment policy to accelerate production capacities and develop economies of scale is by all means needed. The weaker the overall regulatory policy framework is, the higher the amount of public investment which will be required to steer the sector's transition.

Transport, the EU's biggest climate problem,[1] needs a more effective and coherent R&I strategy. A closer coordination within the European Commission between DG RTD and other Directorate-Generals can contribute to align transport research spending with the broader decarbonisation imperative. The Joint Undertakings (particularly Single European Sky (SESAR) and Fuel Cell and Hydrogen (FCH)), currently dominated by industry stakeholders, must involve civil society representatives in their decision-making processes when establishing strategic objectives and undertaking projects.

1. Context

The next Framework Programme *Horizon Europe* will account for the bulk of the EU's public research & innovation (R&I) investment in the coming seven years and must leverage the development of zero-emission technology in the transport sector. Its climate mainstreaming target will remain at 35% across the programme, as it was the case for its predecessor programme *Horizon 2020*. Many climate-related areas of research will be treated in an integrated approach in the so-called 'cluster for climate, energy and mobility'.

[1] eea.europa.eu/publications/approximated-eu-greenhouse-gas-inventory-2016, transport (incl. international aviation and shipping) accounts for 27% of the EU's total GHG emissions (as of 2016).

Fossil fuel-based transportation is incompatible with the goal to decarbonise the European transport sector and fulfil the EU's commitment to reach net-zero greenhouse gas (GHG) emissions by 2050, as required under the Paris Agreement, and laid out in the European Commission's 2050 long-term strategy. Fossil fuel powertrain technology has already realised a great share of its optimisation potential. Incremental research can still improve the fuel economy of an internal combustion engine but the worsening cost-benefit ratio will stop this from being commercially viable and would move investment capacities away from alternative technologies.

The phase-out of fossil fuel transport technology will depend on the cost-competitiveness of clean, sustainable, and in the longer run - more profitable - alternatives. Providing greater funding resources to research minimum emission technologies, as well as a more effective regulatory framework, will be key in order to achieve their cost-competitiveness, i.e. reaching commercial scale, ramping up production capacities, and achieving large-scale market deployment.

Though the private sector will continue to account for a large share of the investment volume in transport research, it will need substantial public co-financing to steer the technological development in the right direction. In 2017 alone, European automotive and transportation players among the world's top 2,500 companies reported €58 billion of R&I spending.[2] The private sector, however, often averts business risks if it struggles to predict which technology pathway will prevail in the long run. Private actors also naturally put the particular interests of their respective industry first when allocating their R&I budget - a tendency which, contrary to the public interest, risks thwarting a carefully integrated and complementary research approach in accordance with the overarching decarbonisation objective.

2. Preventing private sector investment leakage

There are strong reasons for the public sector to step up its efforts and increase R&I funding. Regressive players within the automotive industry continue to plead for technological neutrality. The concern often brought forward is that regulatory preference for certain technologies over others would stifle competition and prevent innovation from prevailing on the market. The notion of technological neutrality in so far as it relates to transport should, however, be viewed as counterproductive when investing in R&I: If every single technology gets an equal slice of the cake, regardless of the extent to which it can contribute to decarbonisation, resources will be wasted and clearly preferable technological solutions will fall irrevocably by the wayside.[3] On the contrary, EU and MS lawmakers must not shy away from pushing certain technologies over others and close off specific avenues for their lack of social profitability. A holistic approach towards the transport sector's decarbonisation with a clear prioritisation of technology pathways, and taking into account the energy transition at large, must become the guiding principle for the implementation of the EU's next R&I framework programme.[4]

Generally, the EU is not on track to reach its Europe 2020 R&I intensity target. By 2020, the EU aimed to reach an overall R&I intensity of 3% of GDP, with the private sector accounting for two-thirds. While R&I intensity has indeed risen in most EU countries over the last decade from 1.93% of GDP in 2010 to 2.07% in 2017,[5] the

[2] iri.jrc.ec.europa.eu/scoreboard18.html

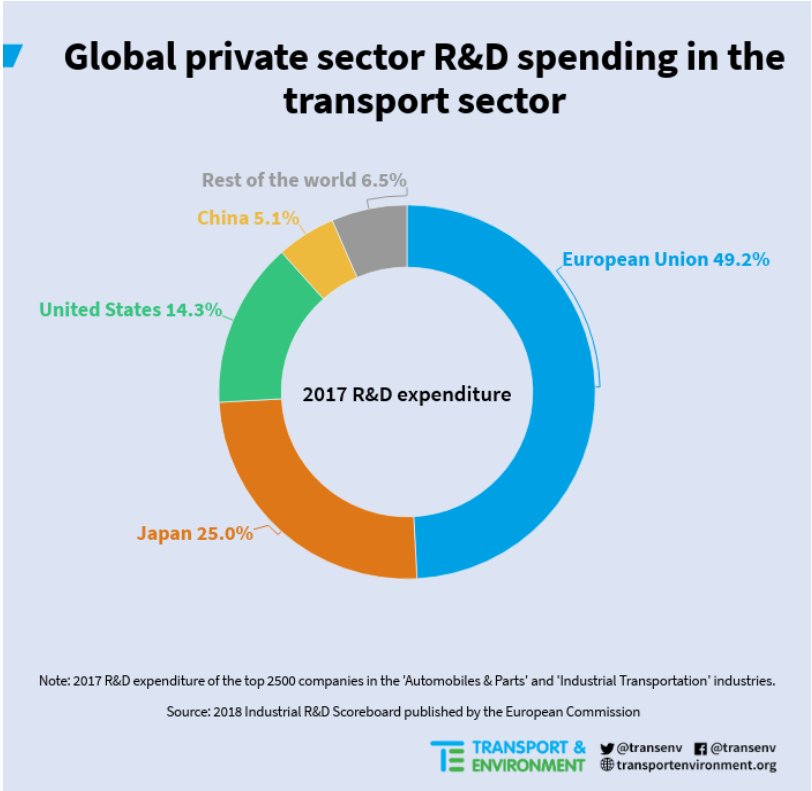
[3] There are clear signs of change from some car-makers such as VW; according to VW board chair Herbert Diess 'a consistent focus is paramount', and 'openness to other technologies will not help us in our endeavours – it only serves to put off the change in system until further into the future. Political and social forces must join up to focus on making the transformation to e-mobility in order to build up the critical mass and vital infrastructure. (…) We call on industry, politics and society to pull out all the stops and help e-mobility achieve a real breakthrough. (…)' Diess, VW Annual Media Conference, 12 March 2019.

[4] transportenvironment.org/sites/te/files/publications/2018_11_2050_synthesis_report_transport_decarbonisation.pdf, page 19. The amount of excess renewable electricity, which will be needed to decarbonise the road transport sector, varies greatly between different technologies. Synthetic electrofuels would require an additional 179%, hydrogen 108%, and direct electrification 43% of the EU's current total electricity generation. Bearing in mind that shipping and aviation will mostly depend on the former two, electrification of road transport to the largest extent possible is imperative from an efficiency and cost perspective.

[5] ec.europa.eu/eurostat/documents/2995521/9483597/9-10012019-AP-EN.pdf/856ce1d3-b8a8-4fa6-bf00-a8ded6dd1cc1, page 1.

EU will clearly fail to reach 3% by next year.[6] In times of limited budgetary resources, it is not to be expected that this will change any time soon.

Technological innovation in the transport and particularly automotive sector is the result of development cycles. The path dependency of technological development begins with investing in first-stage applied research. The EU accounts for the bulk of global R&I spending in the automotive and transportation sectors (49%) and this share hasn't changed much in the past decade. This confirms that the investment capacity is available. It is all the more surprising why the European industry is then trailing behind its competitors in the deployment of zero-emission technologies. One needs to assume that EU automakers still invest a large proportion of their spending for incremental research in fossil fuel technology, as a Bruegel analysis based on EPO Patstat data also indicates.[7]



The Commission's Joint Research Centre (JRC) reports a shift of zero-emission R&I efforts towards automotive players in East Asia. The reasons for this are often supply chain infrastructure considerations, closer proximity to clients and customers, and the availability of a well-educated and specialised workforce. China, Japan, and South Korea's strengths in electric drivetrain technology, battery development, battery cell and pack manufacturing, as well as electronics in general, tend to favour the development of industrial clusters which include research, pre-commercial development, and serial production activities.[8] The EU automotive sector, on the other hand, is only slowly shifting its focus from the internal combustion engine, which represents its traditional competitive advantage. And when it comes to reallocating larger volumes of investment towards zero-emission powertrain technology, the European automotive sector is putting almost half its money in China. Of the €150 billion or so that European carmakers plan to invest in electric vehicles and batteries over the next five to ten years, 45% is going to China and 55% to their European home base.[9] The EU risks falling victim to wholesale investment leakage and hence losing its industrial sovereignty in the transport sector if it does not change course more drastically. Nowhere is this drastic shift easier to carry out than in EU R&I investment.

[6] Ibid.
[7] bruegel.org/2019/01/how-europe-could-yet-take-the-lead-in-the-global-electric-vehicle-development-race/, figure 3.
[8] ec.europa.eu/jrc/sites/jrcsh/files/jrc115449.pdf, page 4.
[9] graphics.reuters.com/AUTOS-INVESTMENT-ELECTRIC/010081ZB3HD/index.html, excluding Fiat Chrysler.

3. EU-funded transport research: past, present and future

3.1. Reviewing Horizon 2020

In its Horizon 2020 interim report, the Commission estimates that, over its seven-year lifespan, the programme will represent less than 10% of total public R&I spending in the EU.[10] Its indicative breakdown allocates €6.3 billion (8.3% of the total €77 billion budget) to the smart, green, and integrated transport cluster.[11] Transport-related Horizon 2020 spending therefore amounts to less than 1% of total public R&I spending in the EU and the latter constitutes a small portion compared to the private sector's annual €58 billion R&I investment (see above). This disparity in public and private spending highlights the need for Horizon Europe to be utilised in the best possible strategic way with a view towards decarbonisation.

Decarbonising the transport sector can only succeed in conjunction with the energy transition at large and embedded in a broader regulatory climate action framework. Despite cross-cutting provisions in the programme, Horizon 2020 revealed a structural weakness in that its decarbonisation-related research activity suffers from a fragmentation between three different societal challenges: 'secure, clean and efficient energy'; 'smart, green and integrated transport'; and 'climate action, environment, resource efficiency and raw materials'.[12] The lack of synergies between transport, energy, and climate will have likely contributed to a less efficient utilisation of funding resources.

The European Court of Auditors (ECA) found that a majority of the Commission's measures to simplify and streamline the management of Horizon 2020 grants had led to a reduction of the administrative burden for beneficiaries, although room for further improvement still exists.[13] The Commission estimates in its interim report that applicants had spent €636 million annually to write project proposals, of which 30% were spent on high quality proposals which eventually failed to receive funding.[14]

Horizon 2020 also contains a climate mainstreaming target of at least 35% across all areas between 2014 and 2020. The interim report states that with an achieved share of 27% after three years of this period, the framework programme risks missing this target.[15]

The Joint Undertakings (JUs) are a system whereby roughly half of the research funding comes from the EU budget while the other 50% comes from the relevant industry actors.[16] These public-private partnerships aim to strengthen the linkage between the framework programme and the respective industry sectors. Their research focus is inherently driven by the shared, often conservative, interests of its members and suffers from an insufficient input from civil society stakeholders. As the Commission indicates in its interim report on the JUs, input from consumer organisations, NGOs, safety campaigners, trade unions, and academia should be taken more into account when establishing strategic objectives.[17] The Fuel Cells and Hydrogen (FCH) Joint Undertaking provides a particularly clear example. It focuses on hydrogen cars when it is now clear to most stakeholders (outside this JU) that attention needs to shift away from light duty hydrogen vehicles and on to trucks, ships and greening the hydrogen supply chain for these applications. In this way the FCH JU would become better aligned with Europe's broader decarbonisation imperative. A similar point applies to Single European Sky (SESAR): Future aviation research proposals receiving EU funding must deliver tangible benefits with a view to 2050.[18]

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[10] eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018DC0002&from=EN, page 2.
[11] eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R1291&from=EN, page 173.
[12] Ibid.
[13] eca.europa.eu/Lists/ECADocuments/SR18_28/SR_HORIZON_2020_EN.pdf, page 8.
[14] ec.europa.eu/research/evaluations/pdf/archive/h2020_evaluations/swd(2017)220-in-depth-interim_evaluation-h2020.pdf, page 60.
[15] ec.europa.eu/research/evaluations/pdf/archive/h2020_evaluations/swd(2017)220-in-depth-interim_evaluation-h2020.pdf, page 22-23.
[16] publications.europa.eu/en/publication-detail/-/publication/ac451695-dd24-11e8-afb3-01aa75ed71a1, page 9.
[17] Ibid., page 4.
[18] eca.europa.eu/lists/ecadocuments/insr19_11/insr_sesar_deployment_en.pdf

3.2. How to maximize the effectiveness of Horizon Europe

Horizon Europe has addressed a great share of the previously mentioned structural weaknesses. Climate, energy and transport research will in future be incorporated in one integrated cluster and thus benefit from synergies. The not yet designated *Missions* offer the opportunity to facilitate a cross-cutting and more target-driven approach when aiming for concrete decarbonisation goals within a given time frame. The climate mainstreaming target will remain at 35% across the programme. It must be ensured that this target is, at least, fully achieved in practice. The newly established *European Innovation Council* may constitute an effective instrument to bridge the funding gap between breakthrough innovation and the successful commercialisation of technologies.

The JUs should, as indicated, improve input from other stakeholders to allow for a wider representation of interests, and rebut the critique that JUs merely constitute an extended arm of industry. The administrative complexity of the application and funding process could be further reduced, and high quality ideas from non-JU members better integrated into the open calls. A possible new cross-sectoral partnership on battery development could enhance cooperation and bundle research efforts on this matter.

Irrespective of the programme's eventual budget, Horizon Europe's spending volume will remain a small share of total public and private R&I investment in the EU. A strategic long-term approach for the work programmes, including the prioritisation of technologies most needed, will be paramount to maximise the programme's effectiveness in spurring the transport sector's decarbonisation.

3.3. Aligning policies with R&I spending

Developing innovative technological breakthroughs and deploying them requires time, which in turn requires a certain degree of investment certainty. It is therefore paramount that lawmakers pursue a long-term strategy, taking into account the regulatory framework, R&I investment, and investment beyond R&I.

1) Regulatory policy framework

Lawmakers have a range of policy instruments at their disposal which can serve as effective push and pull levers to accelerate the uptake of zero-emission technology. Reducing GHG emissions can be achieved by performance standards such as for fuel efficiency or tailpipe CO2 emissions,[19] adjusted fuel tax rates to account for their GHG content and climate impact. Pollutant emissions standards as well as safety standards can be effective for alleviating health- and accident-related social costs. Member States can go further and adapt their vehicle taxes and implement vehicle sales restrictions. The EU can implement sustainability and low-carbon production standards for raw material sourcing, battery manufacturing, and end-of-life recycling ('cradle-to-grave'). Trade-related measures such as border carbon adjustments could also be considered, the aim being to prevent cross-border carbon leakage, hedge against unfair international competition, and help spread environmental and climate norms in a global context.

2) R&I spending

On the basis of the considerations above, R&I spending should be designed and implemented in a target-driven approach and with a clear prioritisation of zero-emission technology pathways. Both the EU through its framework programme as well as the Member States need to increase their research funding efforts in the very early phases when the private sector is hesitant to invest. Once the technology moves closer to commercialisation and market deployment, private actors will be willing to take a more active role and public funding support can be reduced accordingly. The more effective policy measures are in place to promote clean technologies, the more private sector investment will be leveraged (thus the smaller the impact is on public budgets).

[19] theicct.org/sites/default/files/publications/ZEV_Regulation_Briefing_20181017.pdf, various pages.

3) Investment beyond R&I

In order to facilitate the large-scale deployment of cost-competitive zero-emission technology and ensure that a large share of the economic value added remains in Europe, production capacities require the associated upscaling. For this to succeed, the public sector ought to become more closely involved through a more active investment policy by providing lending, subsidies, grants, or guarantees (where private investment is unavailable). Once investment certainty and economies of scale have been achieved and private sector investment is sufficiently leveraged, the public sector may again wish to reduce its financial commitment.

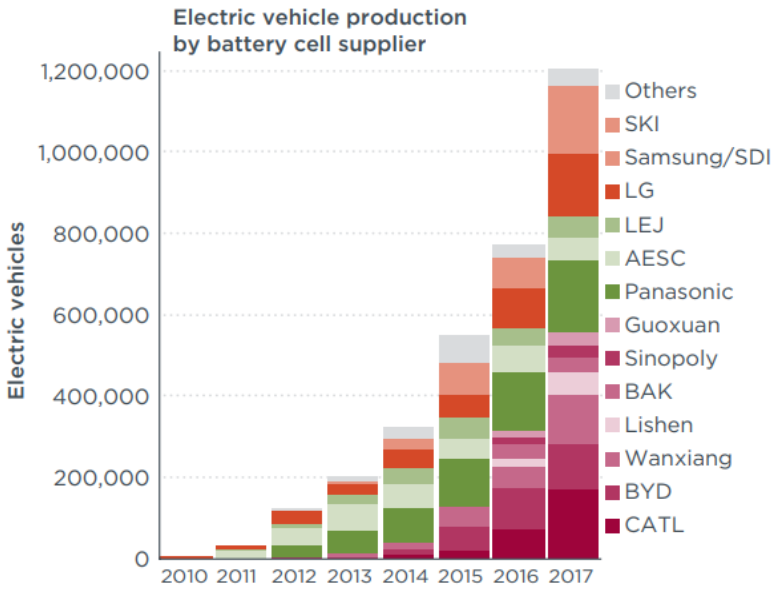
As public and private R&I investment increasingly promotes the maturity of zero-emission technology, economies of scale will continue to grow, manufacturing experience develops, and supply chain structures sophisticate, strengthening cost-competitiveness.

3.4. Leading from behind: Europe's slow start on battery production

Late investment in battery production exemplifies how Europe could fail to embrace innovation in all three tiers described above. For too long, a patchwork of EU and Member State regulation has favoured the internal combustion engine and, at the same time, neglected the strategic necessity to provide investment certainty and push the market demand for battery-electric vehicles. Given the high capital costs, the absence of policies, that would guarantee the 'take off' in demand of electric vehicles, has led to insufficient efforts to scale up production capacities.

Despite considerable public and private research efforts in Europe, OEMs had considerable doubts that the business case for battery-electric vehicles would be supported by the right policy framework conditions and had, thus, initially abandoned plans to ramp up battery cell production and secure a relevant global market share. Contrary to China or South Korea, Europe had deemed an active industrial policy unnecessary, at least until now. The biggest automotive supplier Bosch, for example, announced a retreat from the market in early 2018 due to unpredictable investment risks.[20]

Unsurprisingly, the EU has currently comparatively little capacity to produce batteries on a large scale.[21] The market is still dominated by Chinese, South Korean, and Japanese manufacturers, as global production data published by the ICCT shows (infographic on the right).[22] The tide is only slowly changing. According to recent announcements, European manufacturing facilities will reach a production capacity of 131 GWh and a global market share of 14% in 2023.[23] At least 11 large-scale factories are confirmed and five more are likely to be confirmed soon.[24]



It is estimated that producing and assembling batteries constitutes around

[20] reuters.com/article/r-bosch-batteries/update-2-bosch-shuns-battery-cell-production-in-blow-to-europe-idUSL8N1QI56P
[21] europa.eu/rapid/press-release_MEMO-18-6113_en.htm
[22] theicct.org/sites/default/files/publications/EV_Government_WhitePaper_20180514.pdf, page 5.
[23] elexica.com/-/media/files/training/2019/03%20march/mining%20masterclass/benchmark%20mineral%20intelligence%20-%20robert%20colbourn%20presentation.pdf
[24] transportenvironment.org/sites/te/files/publications/2019_07_TE_electric_cars_report_final.pdf

30 to 40% of the economic value added in the electric vehicle supply chain today.[25] This requires fundamental changes for the European automotive and supplier industry. It risks losing a great share of the economic value added if it fails to make up ground in the global battery production race. Driven by geographic proximity to clients and customers and the ability to better integrate value chain structures, the production locations of cars and car parts tend to cluster together.

For the short-term, it will indeed be difficult for new entrants to penetrate the current generation lithium-ion battery market, simply because incumbents can use their excess production to manufacture (or threaten to manufacture) more batteries at a marginal cost. As the EU has no other choice now than entering the market as a 'second mover', it faces difficulties to generate a competitive advantage unless it capitalises on its structural technological edge and focuses particularly on the next generations of battery technology.[26]

In a recent report, the ECA warned that Europe risks losing the market race for innovative energy storage technology and that the 'current EU strategic framework will not meet the challenges of the energy transition'. Public R&I funding remained too complex with participation often requiring too many resources from participants. The ECA criticises the EU's failure of not having sufficiently supported the market deployment of storage technology, neither in the energy nor in the transport sector. To overcome this, it called for a supportive legislative framework and a more concerted European strategy which would entail the removal of investment obstacles to ramp-up market deployment.[27]

The letter of intent jointly published by France[28] and Germany[29] to the Commission[30] to establish one or more European battery cell production consortia is a further step in the right direction. The initiative, which shall be designated as an Important Project of Common European Interest (IPCEI) in order to comply with EU state aid rules,[31] should be complemented by similar efforts to accelerate the development of a competitive European battery industry. EU financing programmes, such as the European Fund for Strategic Investment (EFSI) successor InvestEU and European Investment Bank (EIB) lending in general, could increase their role in this context.

Going forward, the focus of EU R&I investment should lie on projects that promote better and more sustainable raw material sourcing, improve manufacturing processes, and optimise recycling efficiency. With a view towards the next-generation (3b and 4) lithium-ion battery technology, the focus should be placed on better cathode and anode materials to increase durability, lifetime, and safety (also in regards to ultrafast charging and vehicle-to-grid) as well as new post-lithium chemistries and solid electrolytes.

The existing technological know-how, industrial strength, strong environmental safeguards, well-developed value chain structure, and excellent research environment gives Europe a good starting position to become a great beneficiary of the powertrain transition towards electrification. In order for this to happen, however, it is necessary for regulators to act accordingly.

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[25] nationale-plattform-elektromobilitaet.de/fileadmin/user_upload/Redaktion/Publikationen/AG2_Roadmap_Zellfertigung_eng_bf.pdf, page 7.
[26] eca.europa.eu/lists/ecadocuments/brp_energy/brp_energy_en.pdf, page 17-18. It should be noted that this share will likely decrease as batteries become cheaper.
[27] Ibid, page 3-4.
[28] minefi.hosting.augure.com/Augure_Minefi/r/ContenuEnLigne/Download?id=20B1731A-DC00-4F59-8D94-F6302BEBA447&filename=1202%20-%20Conf%C3%A9rence%20de%20presse%20conjointe%20avec%20Peter%20Altmaier%20et%20Maro%C5%A1%20%C5%A0ef%C4%8Dovi%C4%8D%20sur%20la%20politique%20industrielle%20europ%C3%A9enne%20%E2%80%93%20Jeudi%202%20mai%202019.pdf
[29] bmwi.de/Redaktion/DE/Pressemitteilungen/2019/20190502-altmaier-wollen-zuegige-unterstuetzung-fuer-unternehmen.html
[30] europa.eu/rapid/press-release_SPEECH-19-2352_en.htm?locale=FR
[31] eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=LEGISSUM:0802_5&from=EN, Commission approval pending.

3.5. Different research priorities for different transport modes

Apart from batteries and the necessity to scale up their research and investment capacities, the rationale why public R&I funding for light duty vehicles should be confined to vehicles with zero tailpipe emissions, has been set out in T&E's roadmap to decarbonising European cars.[32]

Similar reasoning applies to the decarbonisation of land freight. No more public funding should be provided for any further development or optimisation of internal combustion engines, including gas. Instead, it should be limited to battery-electric and hydrogen technology. T&E has also published a research paper on the analysis of long haul battery electric trucks in the EU.[33]

For shipping, research priority should be given to battery-electric and green hydrogen/ammonia-based propulsion systems, including fuel cells. T&E has laid out these criteria in its roadmap to decarbonising European shipping.[34]

For aviation, the focus should lie on the development of breakthrough fuels, such as synthetic electrofuels produced from additional renewable electricity, with zero or near zero GHG emissions. In particular research should focus on bringing down the energy requirements and costs of these fuels, in a manner which supports the need for them to meet strict sustainability criteria. T&E's roadmap to decarbonising European aviation examines this further.[35]

4. Conclusions

The EU must ensure Horizon Europe funding goes to projects that help the EU reach its climate goals. Research projects that look into technologies or systems that hinder or fail to meaningfully contribute to net-zero by 2050 should not be eligible for EU R&I funds any longer.

- Effective policies are by all means needed. The weaker the overall regulatory policy framework is, the higher the amount public R&I will be which is needed to steer the sector's transition.
- Too often, innovative ideas fail to reach the stage of commercialisation due to the funding gap. The EU could make more use of funds and lending institutions, such as InvestEU and the EIB, to bring innovation successfully to market.
- The JUs are currently dominated by industry stakeholders. Involving civil society representatives in their decision-making processes can offer an opportunity to align them closer with the broader decarbonisation imperative, particularly in the case of the SESAR and the FCH JUs.
- In terms of transport technologies and funding criteria, Horizon Europe's implementation must require 'nothing less than zero' where possible. For road transport, only research in zero-emission vehicle technology, i.e. battery-electric and fuel cell vehicles, should be eligible for funding. For shipping, research priority should be given to battery-electric and green hydrogen/ammonia-based propulsion systems, including fuel cells. For aviation, the focus should lie on the development of breakthrough fuels, such as synthetic electrofuels produced from additional renewable electricity, with zero or near zero GHG emissions.

Further information

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[34] transportenvironment.org/sites/te/files/publications/2018_11_Roadmap_decarbonising_European_shipping.pdf
[35] transportenvironment.org/sites/te/files/publications/2018_10_Aviation_decarbonisation_paper_final.pdf