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Financing innovation in clean and sustainable mobility

Study on access to finance for the innovative road transport sector

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Study on access to finance for the innovative road transport sector

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Foreword

Cleaner and more sustainable mobility is one of the great challenges of our time. The road transport industry is changing rapidly and is today at a crossroad. Legacy technologies are being disrupted; established market players are being threatened by younger and more innovative companies; consumer behaviour is shifting towards more sustainable mobility models; and major trends like “big data”, connectivity and digitisation are also affecting the transport industry in ways that we have only begun to see and understand. As innovation brings self-driving cars, alternative fuel vehicles, ride-sharing, and other technologies to more people, road transport will become cleaner, faster, and safer.

In such a dynamic environment, European Institutions have a pivotal role to play in the setting of targets, standards and regulatory principles, but even more so in spurring investment into cleaner and more sustainable mobility.

The European Investment Bank (EIB) is playing a major role in the decarbonisation of transport in Europe: lending to sustainable transport sectors – including rail and urban public transport – has been steadily increasing and now constitutes the majority of our yearly transport lending volumes. I invite you to consult our toolkit on financing and advisory instruments for Cleaner Transport covering the Investment Plan for Europe, InnovFin and the Connecting Europe Facility.

Against this background, the InnovFin Advisory study comes at the right time: much has been achieved – but, as European Institutions, we must have the ambition to strive for more. The findings and recommendations of this work provide food for thought for the European Commission (EC), the EIB and the wider industry on current market needs and gaps in the innovative road transport sector.

I wish to thank Carlos Moedas for his continued leadership in this field. And I would like to extend my gratitude to the Innovation Finance Advisory team of the EIB for this insightful piece of research and the EC services, particularly DG RTD and DG MOVE, for commissioning this study and joining forces in fostering sustainable mobility solutions.

Werner Hoyer

President of the European Investment Bank

Preface

I very much welcome the Assessment Report on 'Access to Finance for Innovative Road Transport' carried out by the European Investment Bank, in partnership with the European Commission in the context of the InnovFin Advisory service.

It clearly states that easier access to finance can make the difference in three major areas: urban green mobility; low carbon vehicles, and, not least, automated and connected road transport.

I am confident that this report will raise awareness and, in the end, mobilise investment, so that the transition towards low carbon transport, a key priority for Europe, becomes a major investment opportunity.

Innovators need access to risk finance to bring new ideas to the market. The European Commission and the EIB are therefore joining forces to put in place the right framework conditions to create an environment in which innovations can blossom and allow game changers to shape the future transport system.

I am convinced that the new Framework Programme for Research and Innovation covering the period 2021-2027 will enable Europe to ride this new global wave of breakthrough innovations and successfully support the scaling up of current levels of funding for sustainable transport infrastructure and services.

Jean-Eric Paquet

Director-General

Directorate-General for Research and Innovation

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EXECUTIVE SUMMARY

The road transport industry finds itself at a crossroads. Legacy technologies are being disrupted by new products and services; incumbents and established market players are being threatened by younger and more innovative companies; and the traditional stakeholder landscape is being reshuffled with new entrants from industries that had, until recently, little to do with the transport sector. Consumer behaviour is also slowly but progressively shifting from traditional models of mobility (e.g. private car ownership) to new and more sustainable ones (e.g. mobility on demand). More recently, triggered by environmental concerns and emerging challenges around established technologies and fuels, such trends have witnessed an acceleration and intensification creating even more momentum for zero-emission and more sustainable mobility technologies and services.

Such a dynamic environment has attracted major investments, with global funding volumes doubling annually over the past five years. However, the distribution of money has remained highly uneven, concentrated on specific business models and on a few individual companies, most of them outside the EU.

Europe has always enjoyed a strong and highly competitive automotive and transportation industry; and yet today it is mostly non-European companies that are driving the disruption in critical areas of Innovative Transport.

The European Commission aims to help the automotive and road transport sector in Europe become more innovative, competitive and sustainable. Its key policies to achieve this objective focus on green mobility, automation and safety. In order to attain the promise of more sustainable mobility in Europe in the near future, it is critical to identify bottlenecks and barriers to innovation and market development. Innovative Transport technologies and services often lack standards, common definitions and a clear legislative and regulatory framework that allows them to develop and grow (e.g. common definitions of mobility services and standards for connected and autonomous driving). This is even more the case in Europe with its fragmented transport market.

Lack of standards and common regulations go hand in hand with the other bottleneck of access to suitable financing opportunities. Indeed, this study identified a large overall financing gap and sub-optimal access-to-finance conditions for European companies developing these technologies and services.

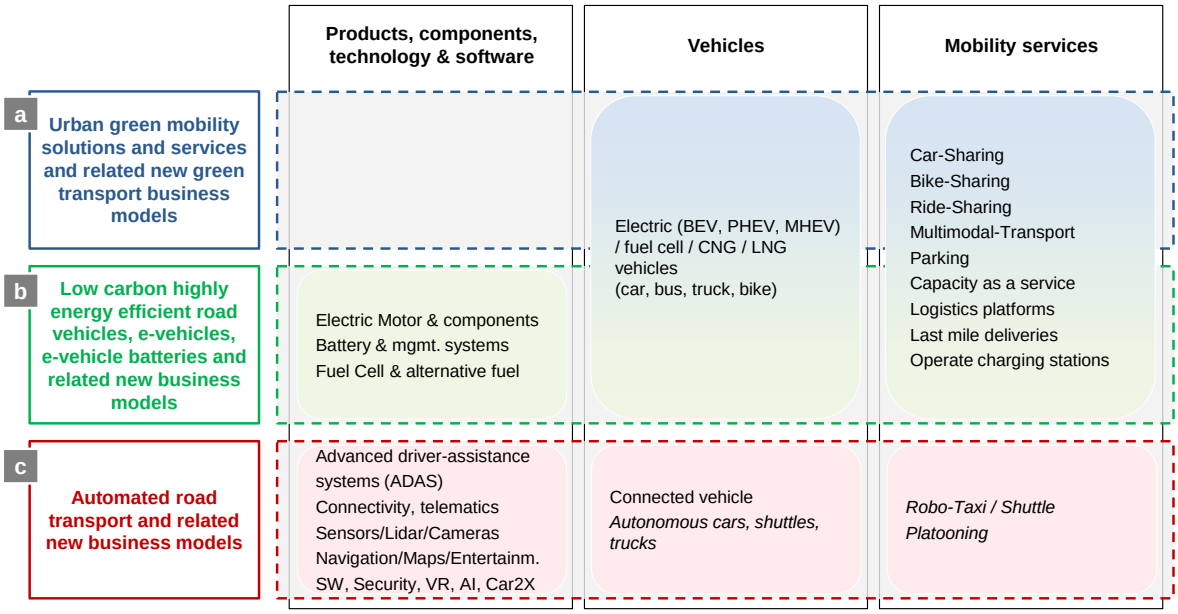
Despite the significant budget dedicated to transport research and innovation under Horizon 2020, and the financing instruments available at EU and national level, many road transport companies struggle to raise sufficient funding due to the high level of risk and large capital requirements typical of road transport innovation.

Furthermore, due to its traditionally smaller venture capital (VC) markets, resulting in smaller average ticket sizes as well as lower availability of scale-up capital, Europe is losing out compared with the US and parts of Asia, even in areas where it could enjoy a “natural” competitive edge. The corporate VC arms of the major European OEMs (Original Equipment Manufacturers) are, however, very active investors in Innovative Transport technologies. This development increases the quantum of risk capital in Europe and provides for more available exit options to founders and early stage investors, notwithstanding questions around concentration of power, alternative exit options and both strategic as well as geographic ownership of the IP.

Easier access to finance could benefit the sector in the following three emerging areas, which represent the scope of this work and have a high potential to contribute to the Commission's objectives:

- **Urban green mobility solutions and services**
- **Low carbon highly energy efficient road vehicles**
- **Automated and connected road transport**

Throughout the report, these three sectors are jointly referred to as "**Innovative Transport**". The study focused on the technology aspects of Innovative Transport as summarised in the figure below, with the angle of infrastructure deployment only tangentially analysed to complement the work and provide, where needed, a more comprehensive picture (particularly in areas like low carbon vehicles where the aspects of technology development, market uptake and infrastructure availability are closely linked).



Products, technologies and services within Innovative Transport

The purpose of this study is to provide a **comprehensive analysis of the competitiveness of the European Innovative Transport sector and on the access-to-finance conditions of the various market participants**. In order to remove the obstacles identified and improve access to finance for Innovative Transport companies in Europe, the study provides a set of **nine policy and finance-related recommendations**. By doing so, this study aims to contribute constructively to the development of European Innovative Transport policy.

Demand and supply analysis

The study involved the analysis of market data and interviews with experts from Innovative Transport companies (the "demand" side) and financial institutions (the "supply" side). On the demand side, an initial dataset of some 800 companies was reduced to a representative sample of 38 companies based on location, size and innovativeness. They included automotive OEMs (Original Equipment Manufacturers) and suppliers, transportation companies, PTOs (Public Transport Operators), start-ups, IT & software companies, research institutes and industry associations. These 38 mostly European companies were interviewed regarding their activities in Innovative Transport as well as their funding situation.

To supplement and verify the findings from the demand side, the researchers also interviewed financial institutions regarding their investment activities and interest in Innovative Transport companies. Overall, 14 financial institutions were interviewed, including venture capital and private equity firms, banks and a financial marketplace provider.

The findings from the demand and supply side were further enriched by looking at past financial transactions in the sector to identify key investment trends and patterns.

In order to further assess the risk profiles and access-to-finance conditions of the underlying companies and technologies, the study identified four main business models that are widely applied and accepted by market participants:

1) **Product Sales** – selling vehicles, components or software; e.g. OEMs, automotive suppliers and software companies
2) **Usage-Based Payment** – payment for rides or for temporary usage of vehicles; e.g. car-sharing, ride-sharing or mobility service platforms and companies
3) **Operation of Alternative Fuel Infrastructure** (e.g. hydrogen, electricity sales) – using different models
4) **Monetisation of User Data** – selling user data or related services; e.g. software companies

Throughout the study, such a matrix approach (combining the three market segments, the four business models and the underlying products and services) proved useful in identifying the critical aspects and development patterns of the industry as well as in analysing the risk profile and financing needs of the underlying companies.

Europe's financing gap

The key finding of this study is the **existence of a *financing gap for European Innovative Transport*** *start-ups and SMEs estimated to range between €5.5bn and €13bn annually, under varying assumptions, and composed of both an equity and debt financing gap*. The financing gap is especially acute for companies in the *growth phase that are investing in urban green mobility solutions and highly energy efficient road vehicles*.

This study confirmed that Europe has a strong and highly competitive automotive and transportation industry dominated by big companies and OEMs that are investing heavily into R&D. However, large parts of this investment are still dedicated to legacy technologies.

Alternative fuel and autonomous vehicles as well as new mobility services are disrupting the traditional automotive and transportation sector and are posing significant challenges to established market incumbents. In addition, new players from the technology sector and the start-up world are entering the market and are increasing the competitive pressure.

In electric mobility and mobility services, the European industry is threatened by competition from the US and Asia, often in the form of start-ups. The European automated transport segment seems to be better positioned from a technology development and financing standpoint, although it is facing legal and regulatory challenges.

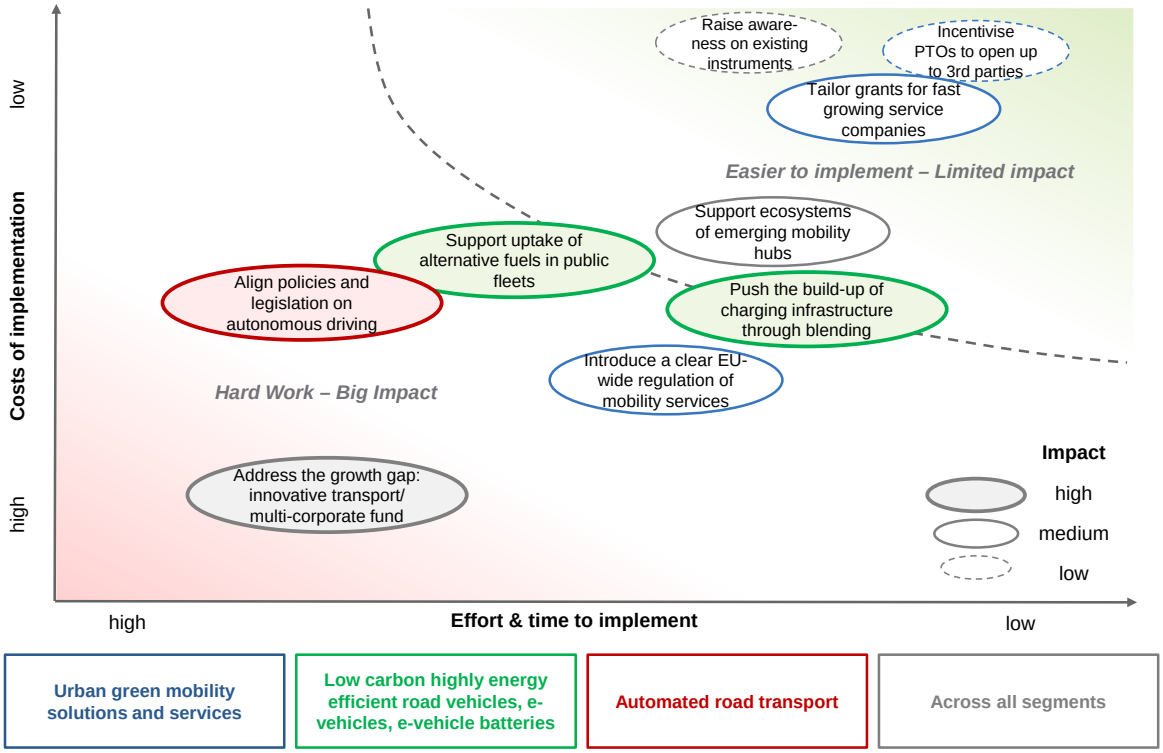
Established OEMs and automotive suppliers are responding to all these developments by taking minority stakes in start-ups or acquiring companies that offer innovative technologies. There is also significant cooperation ongoing or under development with the IT & Software sector. Whereas this increases the amount of risk capital available for such companies, questions arise as to the capability of established players and incumbents to sustainably enhance the innovation of the overall sector.

In general, however, overall access to finance for European Innovative Transport seems to be more challenging, especially when compared to its US and Asian competitors.

Recommendations

As a result of the analysis and market consultation carried out as part of this study, **a set of nine recommendations was developed to address the financing gap and further barriers to innovation and access to finance in European Innovative Transport**. **Recommendations 1 to 6 are aimed directly at the respective sub-segments of the Innovative Transport sector while Recommendations 7 to 9 apply across the board.**

Considering the ambition of supporting the acceleration and take-up of clean and sustainable transport solutions and technologies, the proposed actions should not be seen in isolation, but rather complementary and synergetic when designing an implementation plan. The guiding principle behind the recommendations is that European Institutions are well placed to facilitate the transition to sustainable mobility, by designing or refocusing financing instruments and by promoting a friendly regulatory and policy environment, particularly in areas where European companies could have a competitive edge. Considering the challenge ahead, priority should be given to the most impactful actions, which could however be piloted in specific technology areas or geographies.



Assessment of costs, ease and time of implementation vs potential impact of recommendations

In the field of **urban green mobility solutions and services**:

Mobility solutions and services are today mostly dominated by non-European start-ups. This is mainly due to: 1) better access to equity financing for non-European companies (see Uber, Lyft, Didi) and 2) more difficulties in scaling up in Europe due to heterogeneous markets with regards to policies, legislation and regulation. The sector attracts the selective interest of VC. Grants would be helpful but are available only to a lesser extent due to the service-based nature of most of these businesses.

RECOMMENDATION 1: Incentivise Public Transport Operators (PTOs) and Authorities (PTAs) to open up to third party digital mobility platforms

In theory, Europe has a global advantage compared to other geographies when it comes to alternative mobility to private car ownership. Almost every mid-sized to large European city has a comprehensive and dense public transport network, which is a prerequisite for accessing mobility on demand (i.e. integrating existing public transport offers with alternative means such as bike-, car- or ride-sharing). In practice, companies offering multimodal mobility platforms in Europe are facing a challenge when it comes to integrating public transportation on a European, national or even municipal level. This is because PTO/As are generally not willing (despite the opportunity to increase usage of public transport services) to open up to third party mobility platforms that are trying to integrate journey planning and booking across several modes of transport. This poses a threat to businesses with major potential on the European landscape.

The introduction of new mobility concepts requires the full determination of municipal, national and European governments. **The European Commission is encouraged to work closely with national governments with the objective of harmonising laws and regulations covering different means of transportation, and ensuring that public transportation companies are opening up to new mobility concepts**. Open data access and standardised interfaces (APIs) for public and private mobility offerings are a necessary prerequisite to integrating different means of transport as well as public transportation. Existing urban infrastructure will require critical changes to enable this trend (e.g. charging stations, parking areas, etc.).

RECOMMENDATION 2: Introduce a clear and standardised EU-wide definition and regulation of mobility services

Mobility services such as ride-sharing are a relatively new trend and, as such, a European-wide definition and regulation is not yet in place. Current definitions and regulation of mobility services differ widely between EU Member States, which challenges the expansion of fast-growing companies. While some Member States like Estonia, the Netherlands and other markets like Warsaw are welcoming ride-sharing as a business model and alternative mobility option, the service is banned or restricted in most European countries. Bans and restrictions often followed strong protests from incumbent operators that felt threatened by the new competition through ride-sharing companies. Yet, models of co-existence have been developed (for example, the Estonian law on ride-sharing requires digital platforms to meet certain standards on transparency and safety while also lowering barriers for incumbent taxi operators to allow for fair competition).

As a first step, a **clear Europe-wide definition of the different mobility services** such as ride-sharing, ride-pooling, car-sharing and others is necessary. A common definition would be a good baseline for further discussion on how these services should be treated from a regulatory standpoint. The European Commission has already initiated several discussions around mobility and other shared services such as the "European Agenda for the Collaborative Economy" where it states that "absolute bans and quantitative restrictions should only be used as a measure of last resort". Beyond standardisation, European-wide legislation to open up markets is a necessary pre-condition for innovative products and services affecting European mobility patterns.

RECOMMENDATION 3: Tailor flexible grants for fast growing service companies

The selection criteria for (European and national) public support and grant programmes are often not geared towards development of services but rather more focused on physical products and technologies. Furthermore, such programmes are often inflexible vis-à-vis the ambitious growth and regularly changing business models of mobility service companies.

It is critical that **grants are designed in flexible terms with regards to the outcome of the project**: mobility service companies in particular are operating in an ever-changing environment and often need to modify and adapt their business models or mode of operation accordingly and within a short period of time to react to market feedback and competition.

Furthermore, considering the dynamism of this segment, grants targeting such service companies could be structured as a contingent convertible instrument, enabling the grant provider to participate in the upside in the event of success (the grant would be converted into common equity if an agreed milestone were successfully achieved). Contingent public grants have been successfully implemented outside of Europe, e.g. in Israel since the early 1990s or in the US Small Business Administration.

In the field of **low carbon highly energy efficient road vehicles**:

The aim of the following two recommendations is to increase the uptake of alternative fuel vehicles in public and private fleets by **improving the economics of a segment where the challenge of accessing finance is most acute and where the social and economic impact is arguably most relevant**. As mentioned above, these efforts should go hand in hand with the development of an enabling legislative and regulatory framework (e.g. requirements of certain network density, definitions of standards, etc.).

RECOMMENDATION 4: Push the build-up of charging infrastructure through blending grants with flexible debt

Of the technologies and solutions within the scope of this study, the deployment of alternative fuel infrastructure was identified as one of the areas needing the most financing support. A combination of **uncertainty about the adoption of alternative fuel vehicles and poor economics in the early years of operation is holding back investment in this area**. As the uptake of alternative fuel vehicles is closely related to the availability of charging stations, more support is needed to ramp up the infrastructure.

Charging station operators should receive more incentives to **accelerate the ramp-up of the charging infrastructure**, especially for high power charging along European cross-border transport corridors. The EU could build on existing instruments to develop a set of incentives for this purpose – a combination of guarantees, grants and debt on flexible terms (the Connecting Europe Facility - CEF “Blending Call”, combining grants with third party financing, is a positive development is this direction).

Due to the typically poor economics of such ventures in the early years of operations, grants should in such a scenario not only cover the initial installation costs of the infrastructure but also parts of the operating costs in the following years. (Soft) debt could be blended with the grants to increase the financing further. Such debt could be triggered at specific inflection points of the venture. Further uncertainty about the market uptake could be mitigated by introducing uptake guarantees, longer grace periods and more flexible conditions until a certain milestone is achieved. Eventually, the debt portion could also be structured as a convertible instrument in order to reduce the burden on the recipient in case of slower-than-expected uptake.

In order to achieve the highest impact, such actions should be prioritised towards select technologies instead of following a technology-agnostic approach and spreading the funding too thinly across the various alternative fuels technologies. This would give more certainty and planning security to the whole industry.

RECOMMENDATION 5: Support the uptake of alternative fuels in public fleets and the related value chain

The share of alternative fuels in public fleets today is only improving slowly while the industry awaits big orders to achieve economies of scale. A number of actions should be considered for this segment:

i. using grants and incentives to mitigate the higher purchase price of alternative fuel buses (the grant would cover the price premium compared to a diesel bus);

ii. organising and coordinating joint procurement initiatives for alternative fuel public fleets in order to allow manufacturers to achieve economies of scale. A more ambitious option would be to launch a European procurement platform for public fleets, to obtain critical mass and economies of scale with a requirement to buy from European resident or/and European-based IP technologies and services;

iii. encouraging public authorities to facilitate the inclusion of young innovative manufacturing and service companies to bid in public tenders; furthermore, any (semi-)public financing of PTO/As should be linked more explicitly to the upgrading of fleets with alternative fuel vehicles;

iv. developing flexible forms of financing solution to support the leasing and purchasing of zero-emission fleets (e.g. including indirect support for lease financers and direct supply chain financing for young scale-ups that provide zero-emission transport solutions).

In the field of **automated road transport**:

Within automated road transport, this study found that uncertainty with regard to policy, regulation and liability are the key challenges for companies developing such technologies, rather than access to finance.

RECOMMENDATION 6: Align and amend European policies and legislation on autonomous driving and push for a technology-friendly testing environment

European policies and regulation for autonomous driving are still under development and differ between Member States, while the testing of autonomous technology is mostly done in the US. This presents a major challenge for a business wishing to provide a product or service in a trans-European market.

The European Commission, Member States and stakeholders in the transport industry should develop a **coherent and joint strategy for connected and autonomous driving**. This strategy should cover a broad range of topics, including but not limited to: i) ownership of data and data privacy while also enabling data-sharing for real-time traffic, accident, hazard and maintenance information; ii) standards for V2V (Vehicle-to-Vehicle) and V2X (Vehicle-to-Everything) communication; iii) identification and certification of dedicated test tracks for connected and autonomous driving with a special focus on cross-border initiatives. Testing should also include truck platooning and automated urban mobility scenarios; iv) alignment and amendment where needed of relevant policies and directives.

Across **the three sectors**:

RECOMMENDATION 7: Support and enhance ecosystems of existing and emerging mobility hubs

There is no equivalent of Silicon Valley in Europe. There is no similarly powerful and geographically focused aggregation of capital, a strong academic and labour market, governmental support, successful flagship companies and strong industry presence. However, several smaller hubs in Europe are emerging with some of them also focusing on the Innovative Transport sector. Equally important are those cities and municipalities that are testing new transport models and championing the transition to more sustainable mobility. They deserve attention and support.

An integrated ecosystem is a strong driver of economic activity and supports innovative companies. It provides a platform for sharing and enhanced collaboration that will foster cluster development. The role of the European Commission (EC) and European Investment Bank (EIB) could be to identify mobility clusters and hotspots with high growth potential and to support them through a combination of grants, further EIB financial and advisory support, as well as networking, best practice sharing and coaching activities.

RECOMMENDATION 8: Address the growth-phase financing gap by supporting dedicated Innovative Transport or multi-corporate funds

This study identified that the financing gap in European Innovative Transport is currently most glaring for growth stage financing. In parallel we observed that i) Original Equipment Manufacturers

(OEMs) and technology companies as well as knowledge intensive services companies (KIS) are investing heavily into the Innovative Transport sector and at an increasing rate; and ii) OEMs are today more willing to cooperate for important strategic topics that require large investments and would benefit from standardisation and economies of scale.

Such recent developments could offer opportunities for the EU to **address the growth financing gap by leveraging public support and the networks of the OEMs and KIS to increase access to financing for Innovative Transport companies.**

The EU could facilitate and support the establishment of (a) dedicated investment vehicle(s) (potentially deploying both equity and high-risk debt) focusing on supporting the scale-up phase of fast growing companies active either in the general Innovative Transport sector or one of its sub-segments. Support from the EU could come through the provision of bedrock equity into the fund and/or the acceptance of asymmetric returns in order to maximise the catalytic effect on private sector participation. Co-investments with already active transport/OEM funds using existing financing instruments (e.g. those developed under the European Fund for Strategic Investments – EFSI) could also provide additional firepower.

A more interesting but potentially more challenging option would be to set up the fund in the form of a multi-OEM/KIS or multi-corporate investor vehicle. Such a construct would leverage the common interests of corporate investors in the sector along with their financial capabilities while also mitigating the concerns of start-ups being dependent on a single OEM. This option should first be vetted via a target consultation amongst OEMs to i) identify areas of common interest to verify alignment with policy objectives and build the investment strategy around and ii) understand their willingness to invest, on which terms and under which type of structure.

RECOMMENDATION 9: Raise awareness of existing instruments

The interviews carried out as part of this study showed only **limited awareness of existing financing instruments** from the EIB Group or at EU level.

The EIB Group and EC should raise further awareness of existing financing instruments in the Innovative Transport sector, especially with start-ups and SMEs. This could happen through multiple channels. The EU already has a major presence at relevant industry conferences and start-up networks, including hosting its own workshops and conferences. Not only should this activity be continued and expanded, but, just as Innovative Transport cuts across services and modes, there is also a need for much more proactive, tighter coordination of the various initiatives and participation by EU services. The objective should be for the EU to provide “one face” to the users of transport and mobility services. In addition, partnerships with incubators, accelerators and national/regional innovation agencies could be strengthened to ensure young innovative companies find adequate support in accessing EU funding.

Findings and recommendations summary map

FINDINGS	SO WHAT?	RECOMMENDATIONS
RELATED TO THE INDUSTRY, MARKET TRENDS AND INNOVATION - Europe has a strong and highly competitive transport industry dominated by big companies and OEMs that are investing heavily into R&D. However, until recently, larger parts of the R&D investments were still dedicated to legacy technologies - The sector is facing significant challenges and disruption through new technologies, which are transforming the entire value chain - The established European industry has been hesitant to follow many of these trends which led to new players entering the market - OEMs and automotive suppliers are now active in taking minority stakes in start-ups or in taking over companies that are offering innovative technologies. There is also significant cooperation from the IT & Software sector	- Europe is currently losing out compared to the US and parts of Asia, even in areas where it could enjoy a competitive edge - Need for public intervention at all levels down to cities and communities which can play a critical role in promoting Innovative Transport solutions and technologies	RECOMMENDATION 1: Incentivise Public Transport Operators (PTOs) and Authorities (PTAs) to open up to third party digital mobility platforms RECOMMENDATION 2: Introduce a clear and standardised EU-wide definition and regulation of mobility services RECOMMENDATION 3: Tailor flexible grants for fast growing service companies RECOMMENDATION 4: Push the build-up of charging infrastructure through blending grants with flexible debt RECOMMENDATION 5: Support the uptake of alternative fuels in public fleets and the related value chain RECOMMENDATION 6: Align and amend European policies and legislation on autonomous driving and push for a technology-friendly testing environment RECOMMENDATION 7: Support and enhance ecosystems of existing and emerging mobility hubs RECOMMENDATION 8: Address the growth-phase financing gap by supporting dedicated Innovative Transport or multi-corporate funds RECOMMENDATION 9: Raise awareness of existing instruments
RELATED TO BUSINESS MODELS - While the overall financing situation in the sector has improved, the distribution of money is highly concentrated in a few individual businesses outside of the EU and within specific business models. European companies have been profiting to a much lesser extent from this boom - Product Sales, Usage-Based Payment, Operating Alternative Fuel Infrastructure and Monetisation of User Data are the predominant business models in Innovative Transport - The four business models differ significantly in regards to their risk profile, financing requirements and technology maturity - However, for all business models (with the partial exception of Monetisation of User Data), the profitability break-even point is late in the company lifecycle (for asset-heavy models this is due to the longer lead time and technology development; for asset-light businesses this is due to efforts in customer acquisition and in rapid scaling-up)	- The Innovative Transport sector is multi-faceted and requires different types of intervention depending on the business model - The investments across the sector are very unevenly distributed - This implies that market forces alone cannot address all Innovative Transport challenges	
RELATED TO AVAILABLE CAPITAL & FUNDING GAP - Half of the interview sample considered their financing and access-to-finance conditions as sub-optimal - Financing conditions for European companies remain more challenging than for US and Asian peers across the spectrum (equity and debt) - Public grants and other public financing exist but they are often not geared towards the fast-paced and often service-based Innovative Transport sector - The total financing gap in European Innovative Transport is estimated to be in the range of ca. €5.5bn to €13bn a year	- Significant financing gaps exist in the European Innovative Transport sector, particularly in the growth phase and within specific business models	

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STUDY FACTSHEET

SCOPE OF WORK	Within this framework, this study sought to: ▪ Frame the investment landscape and segment the market ▪ Understand the key market participants and dominant business models ▪ Describe the key financing requirements, challenges and risks related to the financing of investments in Innovative Transport ▪ Formulate recommendations to remove potential financing bottlenecks
GEOGRAPHICAL FOCUS	EU-28 or Horizon 2020 associated countries
SOURCE OF INNOVATION	OEMs, automotive suppliers, technology companies, service providers and transportation companies, utilities, research and academic landscape. Companies of all sizes and maturity stages including start-ups, SMEs, mid-caps and big corporates were considered in the context of this study
SOURCE OF FINANCING ANALYSED	▪ Debt instruments – senior debt, project financing, asset-backed debt ▪ Equity instruments – private equity, venture capital ▪ Hybrid instruments – venture debt, mezzanine, quasi equity ▪ Public and risk mitigation instruments – grants, public loans & guarantees, PPP
METHODOLOGICAL APPROACH	The study followed a structured five-step approach to identify findings and develop recommendations on the access-to-finance conditions and challenges for innovative road transport companies: 1. Market segmentation 2. Market analytics 3. Interviews and market consultation for validation and future outlook 4. Matching demand and supply side, identification of market gaps and suboptimal investment conditions 5. Findings and recommendations

SCOPE AND OBJECTIVES

The main objective of this study was to **assess the access-to-finance conditions for innovative European road transportation companies**, in the fields of:

a) Urban green mobility solutions and services, and related new green transport business models.

b) Low carbon highly energy efficient road vehicles, e-vehicles, e-vehicle batteries and related new business models.

c) Automated road transport and related new business models.

Innovative Transport is defined in this study to include innovative road transport solutions (i.e. technologies and services) within the three sectors mentioned above. From a high-level value chain standpoint, this includes products, components, software and other technologies as well as vehicles and mobility services. Alternative fuel infrastructure deployment was not within the scope of the present work, but was nevertheless tangentially analysed in order to gather a more comprehensive view of the existing business models and its linkages, particularly with regards to financing aspects.

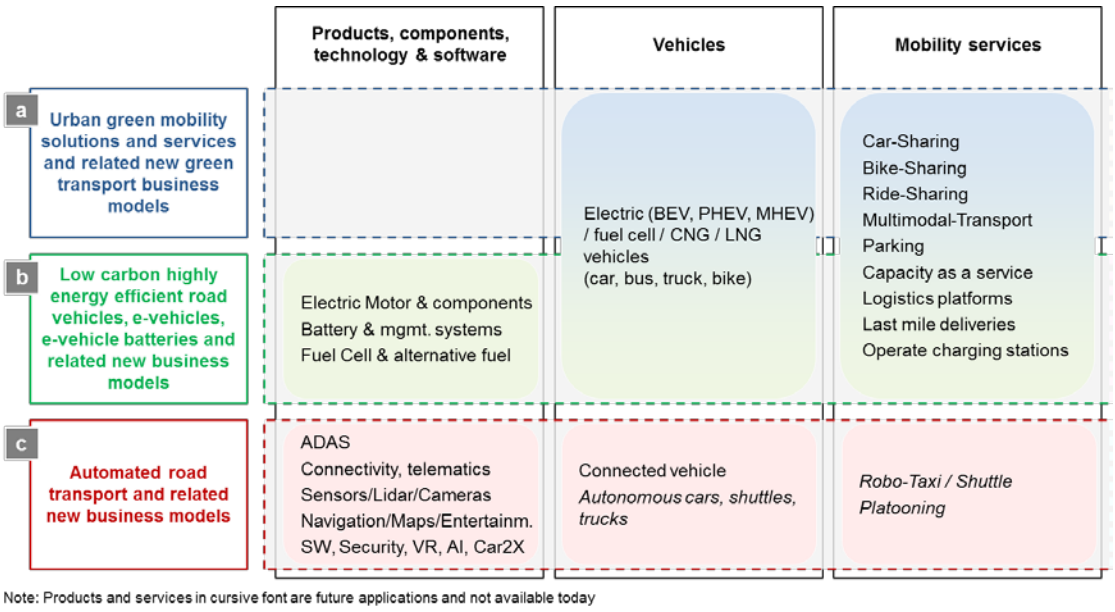


Figure 1 – Products, technologies and services within Innovative Transport

SECTION I – The European Innovative Transport Competitive Landscape

In this section the following points are addressed:

- How is Europe placed on the global scene of Innovative Transport technologies and services?
- How is the industry performing, globally?
- What are the emerging business models within Innovative Transport?
- Who are the key market stakeholders today and tomorrow?
- What are the financing requirements and risk profiles observed for each business model?

1. Europe has a thriving Innovative Transport industry but new technologies and services are disrupting the industry

SUMMARY BOX

- **Europe has a strong and highly competitive automotive and transportation industry** making significant investments into R&D
- Established OEMs and suppliers were, until recently, still dedicating **a high proportion of their R&D investments to legacy technologies**
- **Innovative Transport is disrupting the automotive and transport sector worldwide** – new technologies, business models and players are emerging
- The established European industry has been hesitant to follow many of these trends which has led to new players entering the market
- **Non-European companies are driving the disruption in many areas of Innovative Transport –** especially in the context of urban mobility services and electric vehicles
- **The revenue and profit pools will be subject to major changes** in the near future
- **Investments into the sector globally increased** over the past three years although the **allocation of funding remains very uneven**
- The **European landscape is lagging behind the US** on almost all metrics i.e. number of start-ups and early-stage companies, the total financing dedicated to these companies, the size of the average financing rounds, the number and size of VCs, total investments by VCs and the overall number of transactions
- In this dynamic environment, the **European venture capitalist market remains less mature and more risk averse**, leaving opportunities for US investors to move in. The corporate VC arms of the major European OEMs are now partly catching up

Europe has a strong and highly competitive automotive and transportation industry dominated by major corporates and OEMs that are investing heavily in research and development (R&D). More than 12m people in Europe (5.6% of the workforce) are employed in the automotive sector. They are also responsible for the production of 18.4m cars, vans, trucks and buses in 296 vehicle plants in Europe. The turnover generated by the automotive sector represents 6.5% of European GDP and European automotive companies are annually investing €44.7bn into R&D, generating around 6 000 patents.

Europe's automotive industry is a global leader in research and development but much of this has been focusing, until recently, on legacy technology

Europe's automotive industry is dominated by several big global OEMs and suppliers that make significant annual R&D investments of around €44bn, far outpacing their US (€15bn) and Japanese competitors (€25bn)[1]. This is especially true for the premium European (predominantly German) OEMs, which are at the forefront of introducing new technologies. Europe also has several commercial vehicle manufacturers – and hundreds of suppliers of systems, parts and technology – that work closely with the OEMs.

[1] Source: ACEA Pocket Guide 2016

The strong European R&D footprint is also reflected in the number of automotive patents in Figure 2 below. Europe is clearly in the lead for general automotive patents with 64% of all new worldwide automotive patents in 2015.

While this would point to a very innovative industry, most of the patents are still related to legacy technologies. For instance, when looking at patents dedicated to autonomous driving related technology, Europe is in second place behind Asian companies. Moreover, innovation in mobility services is not reflected in patent numbers, as the innovation is frequently not patentable.

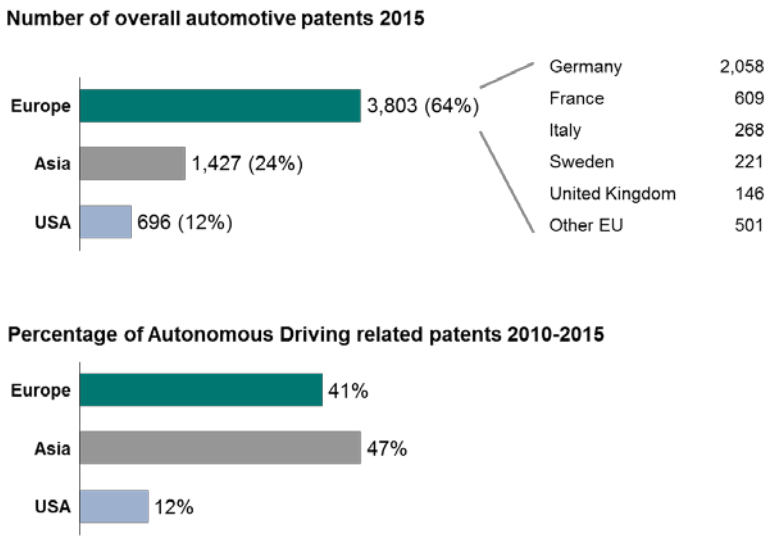


Figure 2 – Automotive patents by geography[2]

Public transport in Europe comprises multiple national and regional operators and a broad range of manufacturers

Europe has a fragmented mixture of thousands of regional PTO/As as well as national and regional operators of long-distance train or bus networks. PTO/As are based on several modes of transportation such as trams, metros, buses, etc. The market of manufacturers in Europe ranges from big manufacturers such as Daimler, MAN and Irizar to smaller OEMs.

Goods transport is currently dominated by big global logistics companies and several delivery companies for the last mile

The European transportation and logistics sector accounts for €960bn in annual revenues and moves 18.6 billion tonnes of goods per year, 78% of which is transported by road[3]. The industry consists of big European companies including Deutsche Post DHL, Maersk, DB Schenker and Kühne+Nagel as well as several smaller companies (especially in the context of last mile deliveries).

Finding Box

(1) Europe has a strong and highly competitive automotive and transportation industry dominated by big companies and OEMs that are investing heavily into R&D. However, until recently, larger parts of the R&D investments were still dedicated to legacy technologies.

A market being disrupted

[2] Source: ACEA Pocket Guide 2016, Grunecker 2016

[3] Source: Fraunhofer Top 100 in European Transport and Logistics 2015/2016

While the development of the automotive and transportation industry in Europe in the past has clearly been a success story, the sector is facing significant challenges and is being disrupted through several key developments and trends in all the areas within the scope of this work:

- **Urban green mobility solutions and services**: consumer behaviour is shifting from private car ownership to on-demand use of mobility services. Mega cities are growing worldwide with ongoing urbanisation, especially in emerging economies, and are posing new challenges for the mobility of the future.
- **Low carbon highly energy efficient road vehicles**: stricter CO2 regulation and advancement of technology are driving the adoption of alternative fuel vehicles and are pointing to the end of diesel and petrol powered cars.
- **Automated road transport**: the race for the first driverless cars in public streets is on. This would enable a whole range of new services and business models.

In addition, trends such as **connected cars, digitalisation and big data** are enhancing existing products and technologies and are also driving the development of new services and business models (Figure 2).

The established European automotive and transportation industry has been hesitant to follow many of these trends and technologies in the recent past, which has led several new players from the technology sector and the start-up world to enter the market and drive developments in these areas. Within Innovative Transport, **new technologies, products, services and business models have emerged** that are leading to **changing revenue and profit pools**.

The European automotive and transportation sector is now under pressure to react to these challenges and major developments can be observed over the past few years. OEMs and suppliers are cooperating with technology companies in the areas of autonomous driving, connected cars and data analytics while also looking to invest in innovative start-ups through newly set-up corporate venture arms.

Finding Box

(2) The automotive and transportation sector is facing significant challenges and disruption through new technologies such as electric and autonomous vehicles as well as mobility services.

(3) The established European industry has been hesitant to follow many of these trends, which has led to new players from the technology sector and the start-up world entering the market.

European Innovative Transport by sector

i) Urban green mobility solutions and services

Several European OEMs are active in car-sharing and are already experimenting with other types of mobility services such as multimodal platforms. However, ride-sharing is the fastest growing mobility services segment with possibly the highest disruptive potential, and is dominated by non-European start-ups (the exception for long-distance ride-pooling is BlaBlaCar, a European start-up). Companies such as Uber, Lyft, Didi Chuxing and Ola Cabs are attracting billions of euros in venture capital money and are splitting the market worldwide among themselves. This segment might therefore be considered as highly competitive and already mature in terms of established and well-funded players. Furthermore, Europe (as the home market to the companies in scope of this study) is much more restrictive from a legal and policy perspective when it comes to ride-sharing services.

Another mobility services segment with high potential is the integration of several modes of transportation into one multimodal offering that could replace private car ownership, at least in urban areas. Again, start-ups are most active in this segment with OEMs such as Daimler also trying to compete. This segment could in theory also field a competitive advantage to Europe-based companies due to the high availability of public

transport in European cities. In practice, as we will see in the following sections, the European PTO/As are often an obstacle for the take-up of third party multimodal platforms and offerings.

"We really need the innovative spirit of start-ups for mobility services. OEMs are instead focusing on technology and either do not want to or cannot change so fast."
Director Research Network

"Our aim is to change people's behaviors towards mobility as a service and to make them abandon private car ownership."
CFO Mobility Start-up

"We are opening up our data for traffic information and scheduling but not for booking through third party resellers. This is due to commercial and strategic reasons."
CFO Public Transport Operator

ii) Low carbon highly energy efficient road vehicles

The uptake for electric vehicles (EVs) in most EU Member States is still at a low level, not even reaching 1% of the annual number of new car registrations. One exception is Norway, where high buying incentives are in place and the charging infrastructure is already quite dense: consequently, EVs already account for 22.4% of new car registrations[4]. The EV sales numbers of European OEMs are also still at a low level with only a few models offered in the market to date. This is expected to change over the next few years because several European OEMs have announced new EV models to hit the market from 2018 onwards. In the meantime, there is competition from the US (Tesla), and several Chinese OEMs are already selling EVs on a much larger scale. For mid-range and plug-in hybrids, Toyota is the clear market leader with more than 10m hybrid electric vehicles (HEVs) and plug-in-electric vehicles (PHEVs) sold over the last 20 years[5]. The biggest EV market so far is China with more than half a million EVs sold per year[6] (see Figure 3 below). High buying incentives and regional as well as local policies are pushing the Chinese EV market forward. Out of the 20 most sold EVs in China, 19 have been produced by local OEMs with Tesla being the only non-Chinese representative.

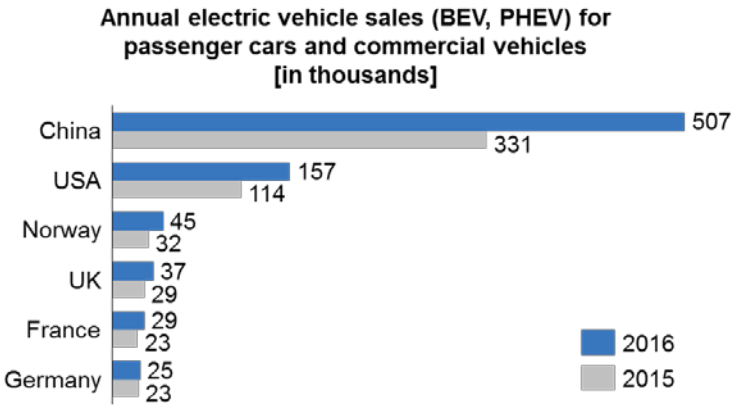


Figure 3 – Annual electric vehicle sales[7]

[4] Source: ACEA website, February 2017

[5] Source: http://www.autonews.com/article/20170220/MOBILITY/302209927/toyota-gets-serious-about-plug-in-hybrids

[6] Source: "AutomotiveINNOVATIONS study 2016", Center of Automotive Management (CAM)

[7] Source: Center Automotive Management (CAM), 2017

The key component and cost driver of EVs is the battery, a market that is also dominated by Asian companies including Panasonic, LG and Samsung, with production taking place mostly in China. Faster adoption of EVs in Europe is also being delayed by the fragmented charging infrastructure, with only a low density of charging stations in many regions.

For hydrogen fuel cell technology, Japan and South Korea are now the "technology-forcing" lead markets with Europe still more in a "demonstration" phase.[8] Furthermore, Asia is the leading geography for shipped fuel cells with a 75% market share in 2015. Japan is also at the forefront of deploying fuel cell electric cars by offering buying incentives of $20 000 per vehicle, with Toyota being the first OEM to sell a fuel cell electric car worldwide (Toyota Mirai).[9]

This is further underlined by forecasts that the worldwide fuel cell vehicle (FCV) market will be driven by Asia, and more specifically, Japan. The Japanese government's ambitious targets for the adoption of fuel cell vehicles are 40 000 FCVs on the road in Japan by 2020, 200 000 by 2025 and 800 000 by 2030. This is supported by the build-up of hydrogen refuelling stations and driven by advancements related to technology and costs. The costs of fuel cells are expected to be half their current level by 2020 and one quarter by 2025.[10]

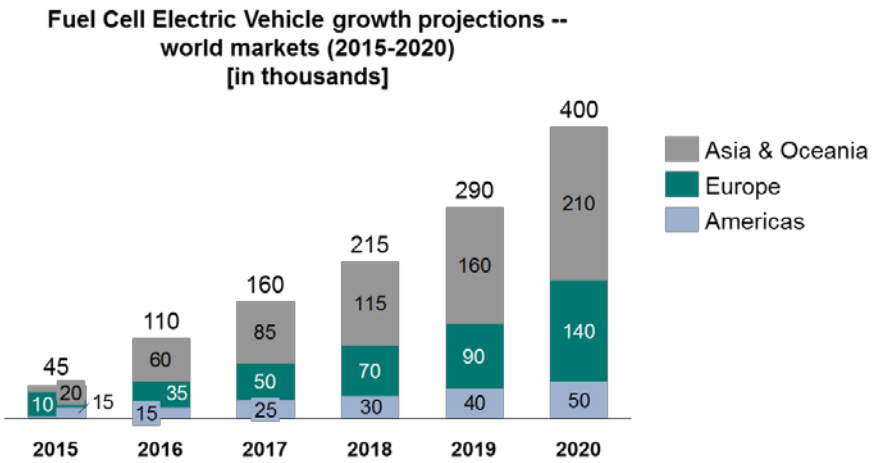


Figure 4 – Fuel Cell worldwide vehicle sales forecast[11]

[8] http://www.h2fcsupergen.com/wp-content/uploads/2016/01/2_Website_FuelCell-and-Hydrogen-Annual-Review-2015.pdf

[9] http://insideevs.com/japanese-government-offer-20000-subsidy-fuel-cell-vehicle-purchases/

[10] Source: „The Fuel Cell and Hydrogen Annual Review", 4th Energy Wave, 2016

[11] Source: Pike Research, 2015

"Major battery developments are driven by Asian companies; they already have a Gigafactory in place in China. The European industry risks becoming completely dependent on Asian batteries."
CEO Electric Commercial Vehicle OEM

"We are running our whole fleet on diesel because the time is still not right for electric vehicles. It is really frustrating that there is no sufficient charging infrastructure and also no attractive electric cars offered in the market that cater to our needs."
CEO Car Hire Company

"PTOs prefer to buy diesel buses because the purchase price is lower and they know the technology. Heavy policy support, preferably on a European level, is needed to push forward the electrification of public fleets"
Head of E-mobility Commercial Vehicle OEM

"We would love to invest more into green vehicle technology start-ups in Europe but there are not many interesting companies out there."
Manager Corporate VC

iii) Automated road transport

European OEMs are very active in developing autonomous driving technology and advanced driver assistance systems. European premium manufacturers in particular are putting a strong emphasis on building the latest technology into their new models. The underlying technology is often developed in partnership with technology companies from the US or Israel to strengthen software and artificial intelligence development capabilities. Globally, the race is on to be the first OEM to produce a fully autonomous car. Next to the European premium OEMs and Japanese OEMs, several start-ups such as Tesla and Uber and technology companies including Google or Baidu are very active in this area. One disadvantage of European companies at the moment is the fragmented market of Member State laws and policies regarding autonomous driving. European OEMs have a strong interest in achieving clarity on liability issues and on certification and testing of their autonomous technology.

"OEMs and Tier-1 suppliers lack the capabilities and resources to develop autonomous and connectivity features. That's why they are all looking at start-ups and partnering with technology companies."
Managing Director Software Company

"Autonomous driving will be a big change for the whole automotive industry."
CEO Mobility Start-up

"Regulation is the highest hurdle to bringing fully autonomous vehicles onto the streets, not the technology. Certification and testing requirements of systems and software are also still unclear. In the USA it is much easier to do testing on autonomous vehicles."
Product Manager Autonomous Driving Start-up

iv) The importance of start-ups to Innovative Transport and the economy

Start-ups and SMEs are key drivers for innovation in the sector but this segment is largely underfinanced in Europe[12]:

"Responses to the consultation identified expansion finance as the stage where the EU financial system underperforms the most. As these firms have the potential to grow into future large employers, the missed opportunities for EU society can be very large. Evidence from 15 OECD countries for 2001-11 shows that young businesses play a crucial role in employment creation. Young firms systematically create more jobs than they shed. In particular, young firms with fewer than 50 employees represent around 11% of employment and generally account for more than 33% of total job creation in the business sector, while their share in job losses is around 17%.[13]

"Venture capital has a key part to play in supporting growth and offering entrepreneurs an option to raise funding in Europe as well as from overseas. Venture capital is typically long-term (equity) capital, channelled through funds that pool investor interest and diversify risk. However, EU venture capital funds remain relatively small. At around €60m, the average European venture capital fund is only half the size of that in the US, and around 90% of EU venture capital investment is concentrated in only eight Member States[14]."

This study elaborated on how many of these findings also apply to the Innovative Transport sector in Europe.

Finding Box

(4) The European industry is threatened by US and Asian competition in the sectors of electric mobility (China is leading the market for public electric buses and already selling more than 100 000 units per year) and mobility services.

(5) Even for solutions such as multimodal mobility platforms, where Europe would in theory have a competitive edge with its capillary public transport networks, in practice the European PTO/As are often an obstacle for the take up of third-party multimodal platforms and offerings. Within the sector of automated transport, the European industry seems to be better positioned although facing legal and policy challenges.

The overall financing environment for the sector

The **financing environment today is perceived as having improved** compared to three years ago, with an expectation of further growth due to the long-term prospects of the industry (expected to grow by some 15-25% annually).

Due to this fast-paced development prospect, the investments into Innovative Transport companies worldwide have almost doubled per annum in recent years, especially in the past three years: investments rose from $2.2bn in 2013 to $16.3bn in the first half of 2016. Uber also started to raise significant amounts of capital in 2013 with its first nine-digit financing round of $363m. One year later in 2014, Uber secured $2.6bn through two additional rounds. The years 2013 and 2014 can thus be considered a tipping point in the financing of Innovative Transport, where mobility services started to raise significant interest from venture capital investors. Overall, more than $50bn of financing was invested into the sector between 2011 and the first half of 2016.

[12] Source: European Commission – Action Plan on Building a Capital Markets Union, 2015

[13] Source: OECD (2013), Science, Technology and Industry Scoreboard

[14] Source: European Private Equity & Venture Capital Association

However, as we will see in Section III, this high volume of funding has not been shared evenly, with only **a few select cases in key market segments benefiting disproportionally** (Uber, Didi Chuxing, Tesla, Lyft, Ola, Grab and Gett received more than half of the overall $50bn invested in the sector in the past five years). With the exception of Tesla, all of these companies are mobility services that apply a Usage-Based Payment business model. Moreover, all of these companies are from the US or Asia with the exception of the Israeli start-up, Gett. The European start-up with the highest funding round over the same period is BlaBlaCar ($0.3bn).

Finding Box

(6) While the overall financing situation in the sector has improved, the distribution of money is highly concentrated in a few individual businesses outside of the EU and within specific business models. European companies have been profiting to a much lesser extent from this boom.

Revenue and profit pools will be subject to major changes

The emergence of new mobility services, technologies and products in the context of Innovative Transport is disrupting the traditional industry. Changes in the value chain and customer behaviour will also transform the traditional revenue and profit pools of OEMs and automotive suppliers. Today, still more than 90% of the revenues and profits of selling a car are related to legacy technologies and products.

Compared to this, revenues from mobility services such as car-sharing and ride-sharing are today still relatively low (€6bn to €8bn in 2016). However, the annual growth rates over the past few years and the potential speed of future growth will increase these figures. This study expects compound annual growth rates (CAGR) for mobility services to be between 25–35%[15] over the next 10 to 15 years and thus similar to the rates observed in the past three years. This would result in annual revenues of €400bn to €600bn by about 2030. Important trends underlying this growth are increasing urbanisation, less private car ownership and the introduction of new mobility concepts featuring autonomous vehicles.

Within the vehicle itself, and for the traditional business model of selling parts and components (the “Product Sales” business model, as we will see in the following section), the share of Innovative Transport is also growing strongly. Important drivers for this are: connectivity and entertainment features, more sophisticated advanced driver assistance systems with (part) automation, and the adoption of electric vehicles. More specifically, for electric cars the Innovative Transport value share of the battery, electric drivetrain and electronics combined today exceeds 50% of the total vehicle costs.[16] While this share will probably be slightly lower in the future due to decreasing battery prices, it is still significant. The expectation is that these Innovative Transport areas combined across all vehicle types will grow 10-20% annually resulting in 25-40% of total car revenues by 2030.[17]

When looking at the profit pools of today and in the future, the picture is similar. For mobility services, most companies are not achieving profitability at the moment due to fierce competition for market share as well as the maturity of services and technologies behind them. Nevertheless, it is expected that consolidation in these market areas will leave only a handful of companies dominating the market. These companies may then be able to achieve profitability levels with earnings before interest, tax, depreciation and amortisation (EBITDA)[18] above 10%.

[15] “Connected Car Study 2015”, Strategy&; “Automotive revolution – perspective towards 2030”, McKinsey; PA Consulting Group estimate

[16] Source: PA Consulting estimates and project experience

[17] Source: IHS research, 2016; PA Consulting analysis, 2017

[18] Earnings Before Interest, Taxes, Depreciation and Amortization – a profitability metric

The profit pools for Innovative Transport parts, technologies and vehicles will also grow in line with revenues. The innovativeness of these products might make EBITDA slightly higher than for legacy automotive technologies.

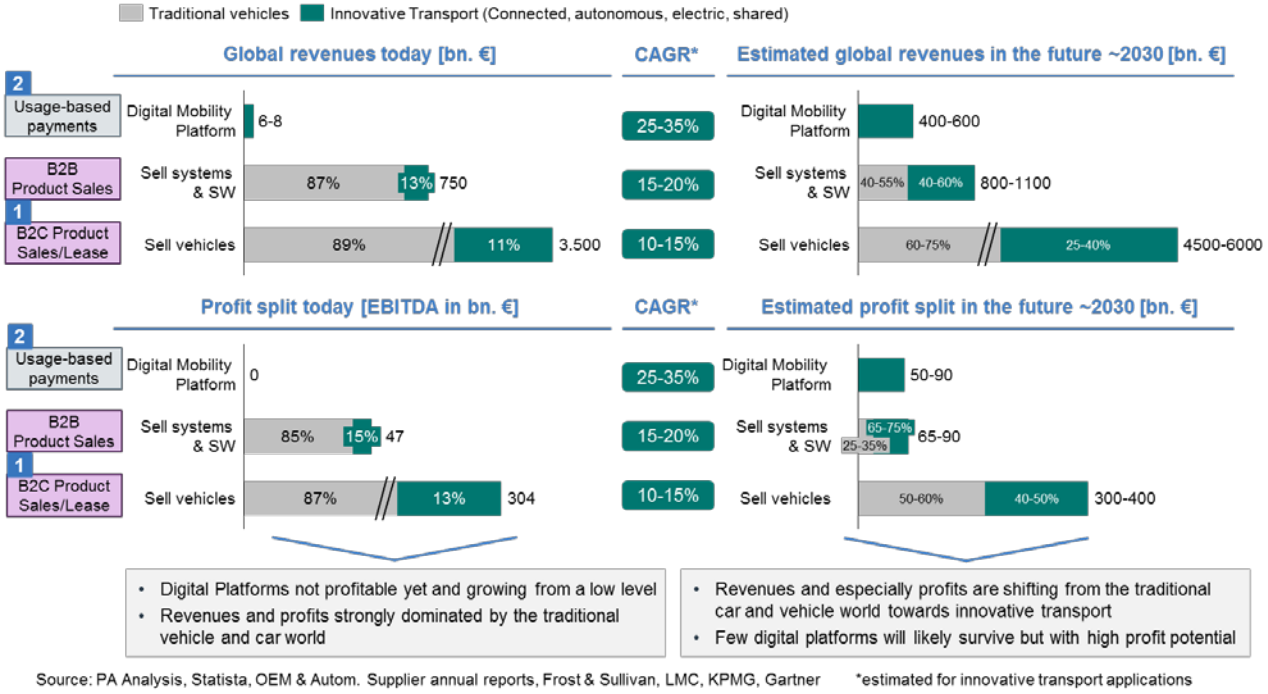


Figure 5 – Revenue and profit pools of companies following the main Innovative Transport business models

Finding Box

(7) The revenue and profit pools will be subject to major change in the near future

(8) This is the main reason why automotive OEMs and suppliers are looking more and more at innovative technologies, services and start-ups to invest in.

2. There are four key business models in the global Innovative Transport industry

SUMMARY BOX

- The Innovative Transport industry in Europe comprises **four main business models: Product Sales, Usage-Based Payment, Electricity Sales** and **Monetisation of User Data**
- Product Sales is still the most common business model in the Innovative Transport sector with Usage-Based Payment experiencing strong growth through a significant number of start-ups, most of them non-European
- The four business models can be mapped against the three market segments within the scope of this work: **urban green mobility solutions and services, low carbon highly energy efficient road vehicles** and **automated road transport**
- This makes it easier to assess the **risk profile** and **financing requirements** of companies in the current European market landscape

In order to reflect on the **risk profile and financing requirements** of the companies developing technologies and services within the Innovative Transport industry, the study identified **four main business models** as predominant in the current market landscape: Product Sales, Usage-Based Payment, Electricity Sales and Monetisation of User Data:

1) **Product Sales** – Describes the "traditional" business model of developing, manufacturing and selling parts, components, software as well as the entire vehicle.

2) **Usage-Based Payment** – Includes the offering of mobility services such as car-sharing and ride-sharing as well as services through a digital platform or app. Many active companies are start-ups. Revenues are generated from customers paying for rides or vehicles by time and/or distance as well as through commission fees.

3) **Operating Alternative Fuel Infrastructure** – As mentioned above, alternative fuel infrastructure deployment was not the primary focus of this study. However, in order to gather a more comprehensive picture of the state of the industry and its financing requirements, the business model of deployment and operation of alternative fuel infrastructure was tangentially analysed, with particular focus on charging infrastructure for electric vehicles, as the ripest technology for mass market deployment. In the following sections we will therefore look at the "electricity sales" business model as representative of the alternative fuel infrastructure business model (the financing requirement and implications generally apply and can be extrapolated to other alternative fuel infrastructure).

4) **Monetisation of User Data** – Data is in every part of the vehicle and also a key enabler for mobility services. This business model is about collecting data from different sources inside and outside the vehicle, the driver, the infrastructure and the environment. Big data allows for detailed analytics and tailored services that can then be sold to other businesses.

This study analysed the four business models, and particularly **Product Sales and Usage-Based Payment** as the most relevant for the purpose of this work, against their respective financing requirements, risk profiles and typical investment needs.

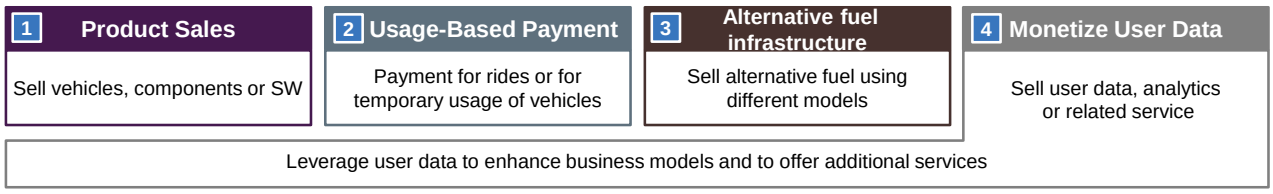


Figure 6 – The four main business models in Innovative Transport

The four business models can be mapped against the products, components, software, vehicles and mobility services, and against the three sectors of Innovative Transport that are within the scope of this work (as shown in Figures 7 and 8 below, respectively).

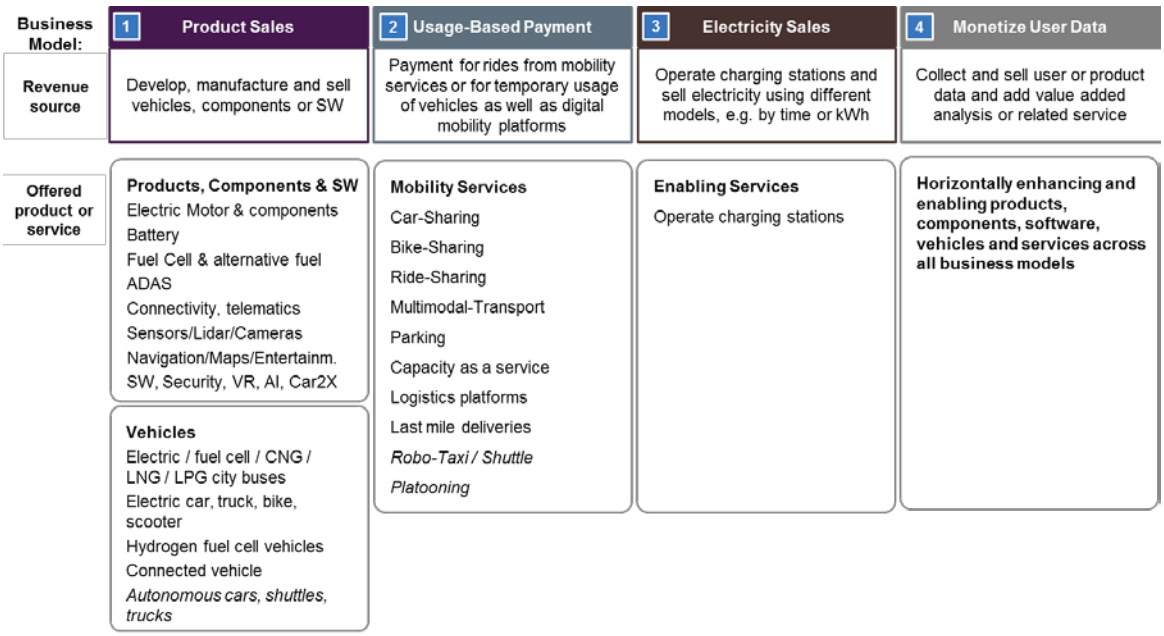


Figure 7 – Products, vehicles and mobility services by business model

Throughout the study, such a **matrix approach** (combining the three market segments, the four business models and the underlying products and services) proved **useful in identifying the critical aspects and development patterns of the industry as well as in analysing the risk profile and financing needs** of the underlying companies.

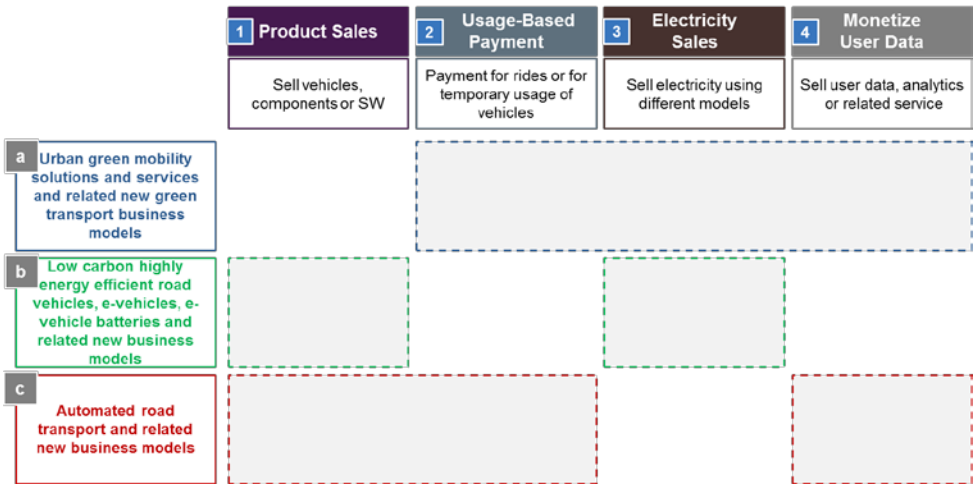


Figure 8 – Mapping the three dimensions of Innovative Transport to the four business models

Dimension **a**, *urban green mobility solutions*, is mainly based on the Usage-Based Payment business model, e.g. for car-sharing and ride-sharing or multimodal and platform-based services. Most of these services are only enabled through the intelligent collection and analysis of data and hence this dimension also includes the Monetise User Data business model. Furthermore, this dimension includes, to some degree, Electricity Sales for providing the charging infrastructure for urban means of transport.

Dimension **b**, *low carbon highly energy efficient road vehicles*, is focused on developing innovative hardware such as parts, components and vehicles for green transport. As such, the main business model applied in this dimension is Product Sales to sell (for example) batteries, electric motors or electric cars. Electricity Sales is an important complementing business model to ramping up and operating the infrastructure for electric vehicle charging.

Within dimension **c**, *automated road transport*, Product Sales as well as Usage-Based Payment are the dominant business models. While autonomous technology and parts are mainly sold via Product Sales to OEMs, new services – emerging by applying the technology in the future – will most likely following the Usage-Based Payment route.

Each of the four business models includes also several variations that are briefly described below:

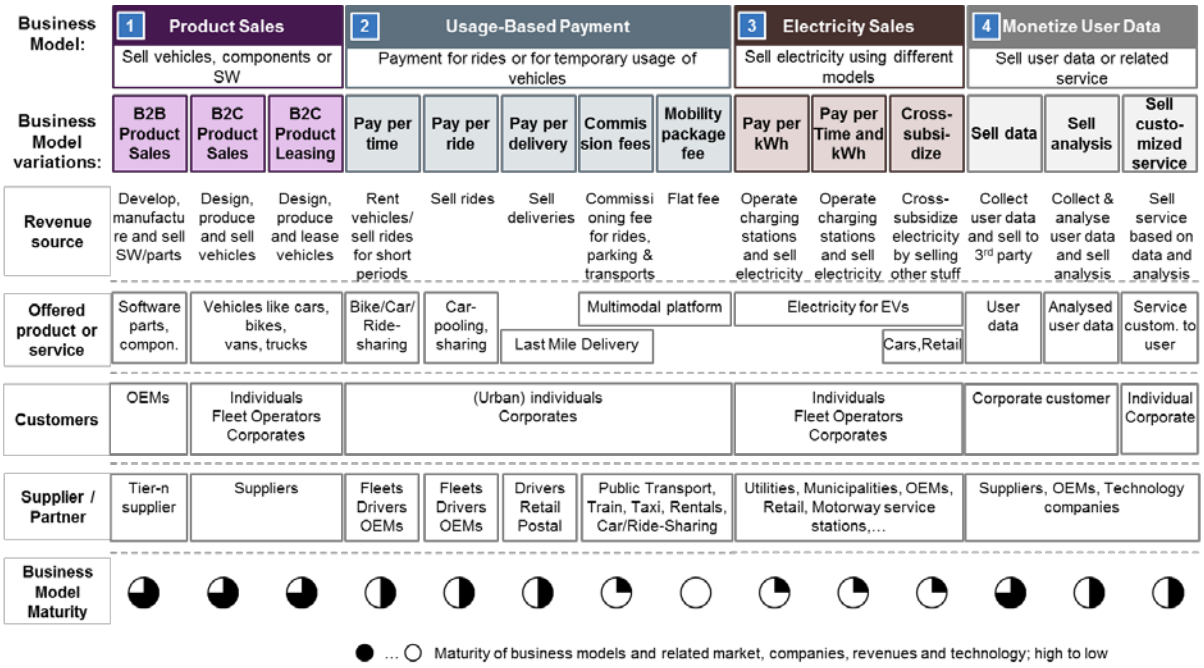


Figure 9 – Business model overview and variations

Product Sales

Product sales can be subdivided into B2B (Business to Business) sales, B2C (Business to Customer) sales and B2C leasing. B2B Product Sales comprises developing, manufacturing and selling parts, components or software to other businesses, predominantly OEMs. B2C Product Sales and leasing involves designing, producing and selling vehicles to customers including private individuals, fleet operators and corporates. Leasing is another financing vehicle to stretch the purchase price over a pre-defined time frame, e.g. three to five years.

All three are **rather mature and well-established business models** and bear rather limited risk, but the underlying technologies in the context of Innovative Transport are partly in the early stage or still under development (e.g. autonomous/semi-autonomous vehicles).

Usage-Based Payment

Usage-based payment includes pay per time, per-ride or per-delivery, commission fees, mobility package fees or a combination. These services are mostly aimed at individuals living in dense urban areas and also at corporate customers.

Pay per time: This is often used for car-sharing or ride-sharing services, where customers are paying for their rides or short-term vehicle rentals by time, e.g. per minute or hour. Some companies charge by a combination of distance or time. This business model is somewhat mature as there are already many companies active in these services. However, there is still a long way to go in terms of profitability and usability and there are several legislative and regulatory barriers to overcome.

Pay per ride: This model is often used for car-pooling. Customers pay a fixed fee to be driven to their destination. The fare is often set by the platform provider and based on a charging model that includes factors such as distance, traffic, time and number of co-travellers.

Pay per delivery: Customers order products such as parcels or food through a platform and pay per delivery. The fee depends on factors such as distance, freight measurements, urgency, time of day and mode of transport.

Commission fees: Journey planning and booking platforms are typically free to use for the end-customer. The platform receives a commission fee from the transport providers that are selling their tickets through the platform. This business model is rather immature as most platforms either do not allow the booking of tickets and instead redirect to the transport provider, or do not include all means of transport available in a specific region.

Mobility package fee: This is a relatively new concept for multimodal booking platforms to sell different means of transport all together for one package or monthly subscription fee. The user is then guaranteed a certain mobility service level and the use of transport depending on the package purchased. Again, this is not a mature business model and is currently used only by a few companies, mostly on a pilot phase basis. However, there is significant potential as the business model aims to replace private car ownership by assuring mobility at all times to its customers.

Operating Alternative Fuel Infrastructure (e.g. Electricity Sales)

Variations for electricity sales include pay per kWh, time plus kWh, and cross-subsidisation. The business model varies depending how customers pay for charging their cars at public or private charging stations.

Pay per kWh: Users pay for charging their cars by kWh: the more electricity they need, the more they pay.

Pay per time and kWh: In order to avoid having users parked at charging stations and blocking the access of other users, many operators are applying a mixed tariff based on time and kWh. The model is also used for price discrimination regarding the speed of the charging process. It is cheaper to charge the car at slow chargers than at fast chargers.

Cross-subsidise: In this model, users are typically not paying directly for charging. The electricity used is instead paid for by a third party. This might be an OEM such as Tesla, which offers its customers free charging along its super charger network. Costs for charging are thus already covered by purchasing the car. Another model is that users charge their car while shopping, e.g. at a retailer. The retailer covers the electricity costs, which is similar to offering free parking to consumers when they are spending above a certain amount.

Monetisation of User Data

For the monetisation of user data, this study differentiates between selling data, selling analysis and selling a customised service. The business model variations can also be seen as additions or enhancements to the other three business models.

Selling data: User data, driving data or data concerning the environment of the car is collected and sold to other companies.

Selling analysis: Data is collected and analysed for specific purposes. For example, driving data can be collected and analysed for driving safety and speeding and then sold to insurance companies.

Selling a customised service: Based on data and advanced analytics, specific offerings and services are developed, e.g. for car owners or fleet managers.

As we will see in the following sections, each business model and its variations offer very different risk profiles and financing needs.

Finding Box

(9) Product Sales, Usage-Based Payment, Operating Alternative Fuel Infrastructure and Monetisation of User Data are the predominant business models in Innovative Transport. Each of the business models also has several variations.

3. The Innovative Transport industry stakeholders landscape is stretching to include technology companies and service providers

SUMMARY BOX

- The key stakeholders in the European transport market are OEMs, suppliers and transportation companies, but **new players** are beginning to appear such as **technology companies and service providers**
- Europe's **supplier market is fragmented,** with companies of all sizes. They account for an **impressive 40% of global automotive R&D –** a percentage that is expected to increase
- The **technology segment** is dominated by big players such as Google, Apple, Microsoft and Nvidia, but smaller companies are benefiting from the **growing importance of data** in Innovative Transport
- Service providers range from **mobility start-ups with asset-light businesses** to **traditional PTOs** such as bus and rail companies
- The transportation market in Europe is dominated by **a few low-margin players** now being challenged at several levels by companies ranging from **Amazon to digital start-ups**
- Industrial and utility companies are providing the **charging infrastructure** – hardware and software – for **electric vehicles**

This study has mapped the key stakeholders directly or indirectly active in shaping the European Innovative Transport industry (in the next section, we will also analyse their focus areas across the four business models):

	Stakeholder Description	Revenue Sources	Typical revenue [€ bn.]	Typical EBIT expectations*	Typical Fixed assets turnover ratio**
OEM	Manufacturer of passenger cars and commercial vehicles	Design, manufacture and sell cars	40-90	5-10%	2 - 5
Automotive Supplier	Develop, manufacture and sell components	Develop, manufacture and sell components	1-50	5-12%	4 - 10
Technology Companies	Big IT companies active in software, platform and service development	Develop and sell software and platforms	1-80	20-30%	2 - 12
Service Provider	Usually start-ups that offer a mobility platform/app; often backed by equity investors	Receive commission fees for selling services	0-2	25-35%	n/a***
Transportation Companies	Logistics and parcel companies as well as public transportation providers	Receive fee for transporting goods or persons	5-60	5-8%	0.1 - 5
Utility/ Industry	Utility companies or industrial companies active in providing charging infrastructure	Sell energy or products	1-50	4-6%	0.5 - 8

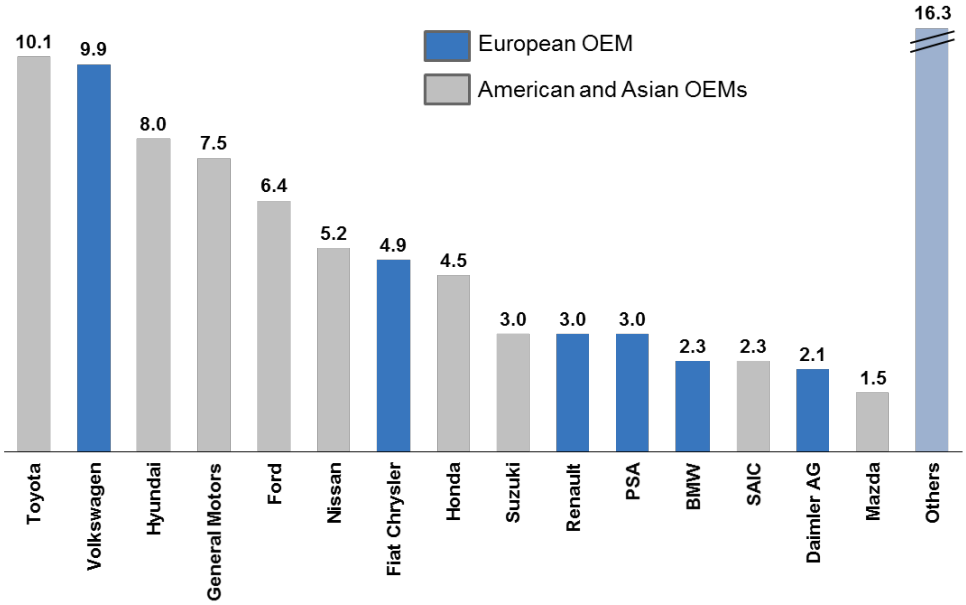
* w/o one-time effects ** Fixed asset turnover = Net Sales 2015/Net property, plant & equipment 2015 ***no data, yet ~10 expected
Source: PA Analysis, Annual reports, Morningstar

Figure 10 – Key stakeholders within Innovative Transport

OEMs

The traditional business of OEMs is to develop and manufacture gasoline or diesel-powered vehicles for passenger transport or for commercial purposes. The market is dominated by large companies that produce millions of vehicles each year. Europe has a very strong automotive industry with several OEMs for passenger cars and commercial vehicles. In premium cars, Europe has leading companies and brands such

as BMW, Daimler, Audi, Jaguar and Volvo. The premium car manufacturers are also at the forefront of technology and usually the first to develop and adapt innovations.



Source: OICA: World ranking of manufacturers 2015

Figure 11 – Annual car production volumes by OEM, 2015

Automotive suppliers

Automotive suppliers are providing OEMs with parts, systems and software. They are also very active in R&D. Today about 40% of automotive global R&D value is created by these companies and this share is expected to increase in the future.[19]

The automotive supplier market is very fragmented, with big tier-1 suppliers such as Continental, Bosch, Denso, and Valeo and many small to medium-sized companies in the market. The largest market for automotive suppliers is Europe, with a 38.2% share of the global revenue of the top 100 suppliers, followed by Japan with 29.3% (see Figure 12).

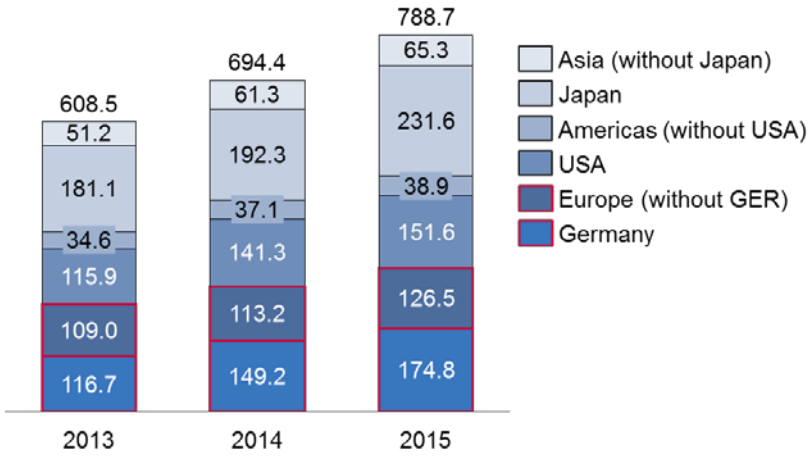


Figure 12 – Turnover development by region of the global top 100 automotive suppliers [€bn.][20]

[19] Source: ACEA website, February 2017

Technology companies

Technology and software companies are focusing on software, data and technology-rich products and services such as connected cars, autonomous driving and data or mobility services. As data gets more and more important, technology companies can bring their expertise into many new market segments. The market is dominated by big players such as Google, Apple, Microsoft, Intel and Nvidia, but many small companies benefit from the overall trends in Innovative Transport.

Service providers

Service providers are a heterogeneous group focused on passenger transport. On the one hand, the group consists of many start-ups such as the mobility start-ups Uber, Lyft and Gett. The main characteristic of these companies is that they often do not own or produce assets. Rather, they are focused on urban mobility services such as ride-sharing and car-sharing, multimodal transport and digital logistics platforms.

On the other hand, there are traditional service providers in passenger transport such as PTO/As, long-distance bus operators or long-distance train companies including Deutsche Bahn, SNCF and RENFE.

Transportation companies

Transportation companies are focused on the delivery of freight, parcels and other goods. The transportation market is compartmentalised with a variety of companies, but is dominated by big players such as DB Schenker and DHL. The market is characterised by high pressure on margins and therefore high efficiency and utilisation requirements.

New players such as Amazon are entering the market by building their own transportation service to take full control of their fulfilment process. In addition, several start-ups are trying to digitalise parts of the business by offering freight platforms to match supply and demand.

Industrial and utility companies

Industrial and utility companies focus mainly on infrastructure-related products and services in the context of Innovative Transport. They are active in the deployment and operation of charging infrastructure for electric vehicles by either producing the hardware or delivering and selling the electricity. Operating the charging infrastructure in Europe is mostly done by big energy companies including Innogy, Endesa, EDF, Enel and Fortum or their subsidiaries while there are also some smaller regional operators and a handful of start-ups active in the sector.

Finding Box

(10) OEMs, suppliers and transportation companies are traditionally considered the main stakeholders in the automotive and transportation sector. With the emergence of Innovative Transport products and services, new players such as technology companies and service providers are expanding the stakeholder environment.

[20] Source: IHS research, 2016

4. New market dynamics in the Innovative Transport sector

SUMMARY BOX

- OEMs and automotive suppliers are very active in taking minority stakes in start-ups or in taking over companies that are offering innovative technologies. There is also significant cooperation with companies from the IT & Software sector
- Major shifts in consumer behaviour away from private car ownership towards the use of mobility services may imply that OEMs, with their current business models, would lose some of their direct access to the end-consumer

A new landscape and new market dynamics in the Innovative Transport sector

This section matches stakeholders to the business models in which they are active. Established stakeholders such as OEMs and automotive suppliers are rethinking and extending their business models to react to new players entering the Innovative Transport market and defend their position.

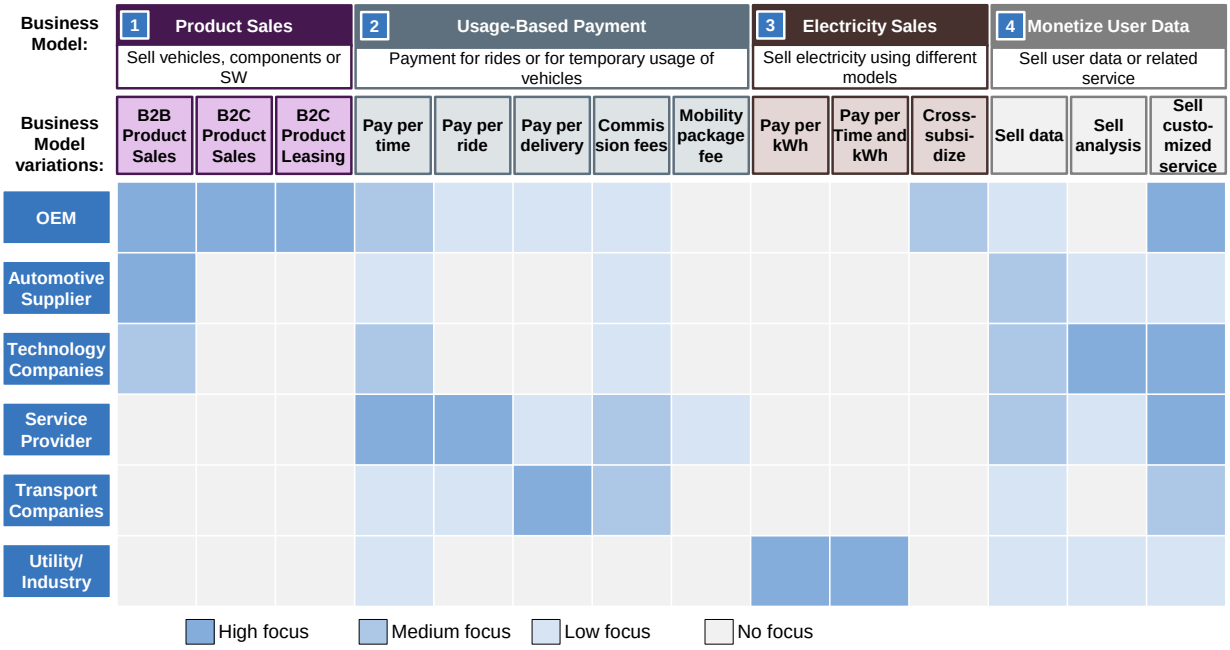


Figure 13 – Mapping stakeholders and their business model focus

OEMs traditionally follow B2C Product Sales and B2C product leasing business models. OEMs will apply these business models to selling electric vehicles for the foreseeable future, but they are also reacting to the emerging trend of mobility services. They are investing in business models such as pay-per-time and pay-per-ride either by setting up their own services, as Daimler did with the car-sharing offering car2go and BMW with DriveNow, or through taking minority stakes in ride-sharing and ride-hailing services, as with VWs investment in Gett or GM in Lyft. Daimler is also active in multimodal platforms through its subsidiary company, moovel.

Alternative fuel infrastructure deployment and operation (e.g. electricity sales) is also relevant to OEMs as a strategic enabler for selling more alternative fuel vehicles. Tesla Motors has been a first-mover in setting up fast chargers along highways that are cross-subsidised by their vehicle sales. There are also plans for a consortium of German OEMs and Ford to invest in charging infrastructure although it remains to be seen if they will also operate the charging network on their own.

The monetisation of user data is also a highly strategic topic for OEMs and automotive suppliers. Data can be used to offer tailored services to customers or to sell it to third parties for advertising purposes. The current debate is on who will be the owner of driver's, driving and environmental data in the future.

Automotive suppliers are focused mainly on B2B Product Sales by selling parts, components and software to OEMs. Consequently, most of their investments in start-ups or R&D are dedicated to technology that is close to their core business. Some suppliers are also experimenting with mobility services, including Bosch, with its electric scooter sharing COUP, and ZF, with its mobility platform uflip. However, this is not expected to become a key trend for most suppliers.

Technology companies are developing software for OEMs and automotive suppliers that they are either selling to directly or through licence fees by applying the B2B Product Sales model. Companies including Google are also very active in collecting and analysing data that they are using for targeted marketing and to create additional services. Another focus of technology companies such as Intel, Microsoft or Google is on mergers and acquisitions (M&A) and taking stakes in start-ups active in all kinds of mobility services and technologies. Intel Ventures is among the most active corporate VCs with a specific focus on autonomous technology, big data, connectivity and new mobility concepts. Google is competing in the ride-pooling market with its app Waze.

Service providers are mainly focusing on the Usage-Based Payment business model by offering mobility services of all kinds. They are very active in the field of ride-sharing and ride-pooling with companies such as Uber, Lyft and BlaBlaCar. Several start-ups, including MaaS Global, Citymapper and UbiGo, are looking into digital multimodal platforms that help users plan and partly book journeys by connecting multiple different modes of transport. They are offering such services using a commission fee or mobility package fee. Service providers are also looking at enhancing their services through leveraging the user data they are collecting and analysing. This is also being used for targeted advertising.

Transportation companies are very active in all forms of Usage-Based Payment business models but compared to service providers they are more focused on transporting and matching goods, parcels or deliveries.

Utilities are very active in electricity sales, setting up and operating charging infrastructure.

Finding Box

(11) The Product Sales business model is mainly followed by OEMs, automotive suppliers and technology companies.

(12) For Usage-Based Payment, the stakeholder landscape is still evolving with companies from all stakeholder groups being involved. The strongest focus on the business model is from service providers.

(13) Electricity Sales is followed by electricity providers, utilities and some municipalities with more and more OEMs also focusing on this area.

(14) Monetisation of User Data is being considered by companies in all stakeholder groups. In most cases, it is applied to enhance existing products and services rather than as a stand-alone business model.

(15) OEMs and automotive suppliers are very active in taking minority stakes in start-ups or in taking over companies that are offering innovative technologies. There is also significant cooperation from the IT & Software sector.

The increasing focus of established players such as OEMs and suppliers – as well as of new market entrants including technology companies – can also be observed by looking at past transactions and partnerships in the Innovative Transport sector, as illustrated in simplified form in Figure 14 below. The detailed list of transaction and cooperation activities related to this Figure can be found in Appendix D.

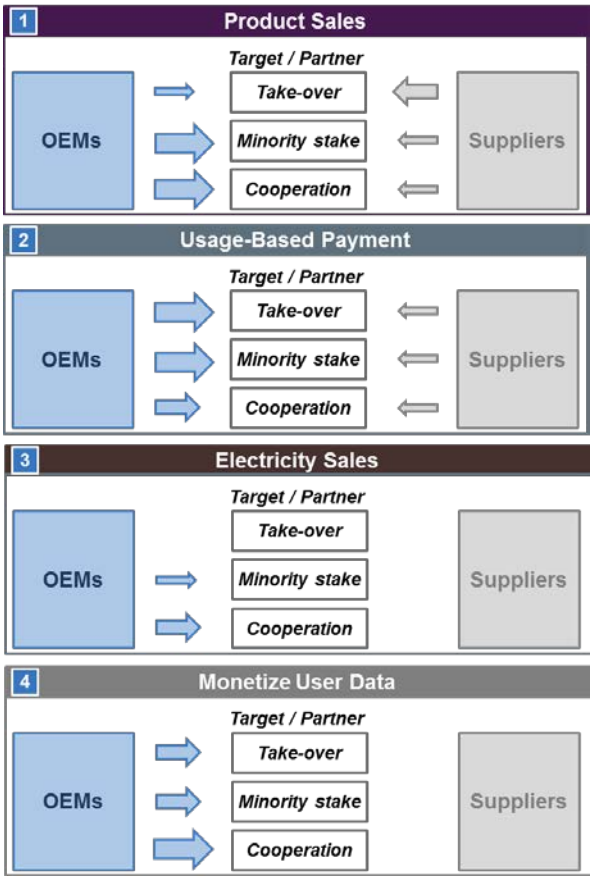


Figure 14 – Typical investment activities of OEMs and suppliers by business model

Based on a database of recent transactions, Figure 14 illustrates that OEMs are taking a significant number of minority stakes in start-ups that are active in Product Sales for autonomous or connectivity technologies, while also cooperating with big technology companies. Big suppliers on the other hand are more focused on completely taking over companies that they consider a good fit to make their product and services portfolio more innovative. For Usage-Based Payment, OEMs are more active than suppliers. Although OEMs are partly taking over start-ups in this area, the dominant strategy at the moment seems to be to take minority stakes in several companies and support them in growing their business.

For Monetise User Data and Electricity Sales, some minority stakes and a few take-overs by OEMs have been observed. OEMs are also working in cooperation and joint ventures for both business models to split development and marketing costs while aiming at creating an industry standard platform. Supplier activity in these business models is rare.

Changes in the value chain

The high-level value chain includes products, components, technology & software, vehicles, mobility services and enabling services. This section adds more detail to the value chain of Innovative Transport by including stakeholders and their respective business models. The focus in the illustration below is on Product Sales and Usage-Based Payment as these are regarded as the two main business models.

The value chain today consists primarily of automotive suppliers and technology companies applying the B2B Product Sales business models to sell parts, components and software to OEMs that then sell vehicles to end-customers or fleet operators via the B2C Product Sales and leasing business models.

Over the past few years, mobility services have emerged that offer services to end-customers through the business model variations of Usage-Based Payment. Apart from OEMs, several new stakeholders are involved in these services such as technology companies, service providers and transportation companies.

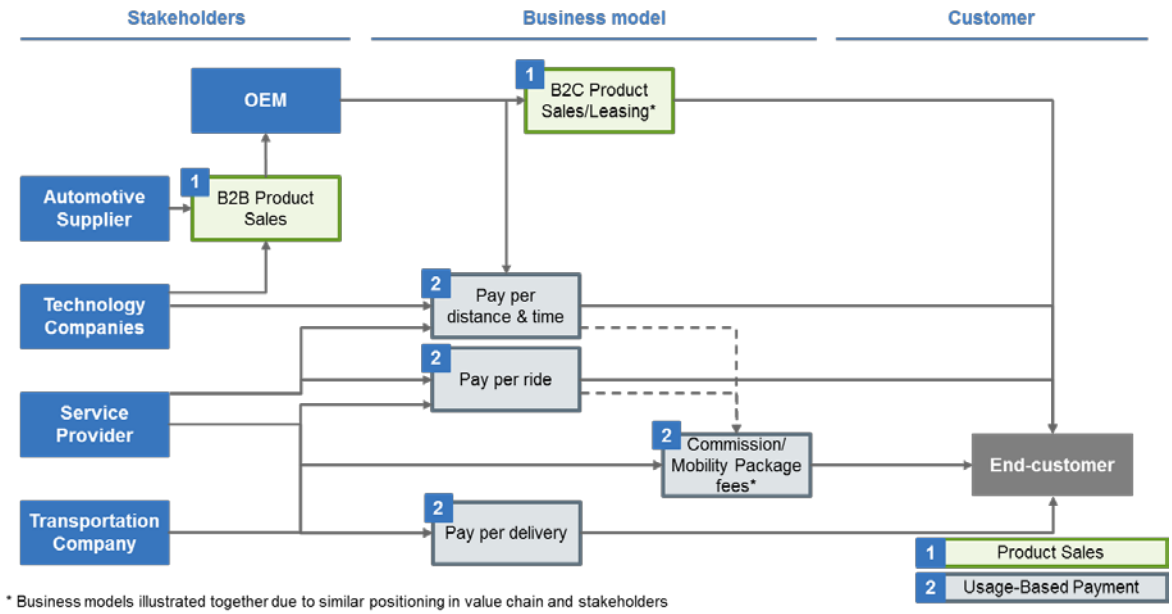


Figure 15 – Value chain for Innovative Transport today

The value chain of the future is likely to change significantly. Private car ownership seems to have become less important to customers, especially in dense urban areas. Instead, people are looking for mobility on demand that can be accessed everywhere in a convenient way. Such a one-stop solution for mobility can come in the form of an app or digital platform where users select and book the modes of transportation that best fit their current needs including from cost, comfort and speed perspectives.

New concepts such as autonomous cars, robo-taxis and autonomous shuttle buses will also change the way people use mobility products and services in the future.

While OEMs and suppliers will still focus largely on jointly developing and producing cars, it is not yet clear who will emerge as the dominant players for mobility-on-demand services and one-stop shops. Usually, with such digital platform business models, after an initial phase of fierce competition between many players, the market consolidates into an oligopoly of a few big players that leave little room for new market entrants. This has been a regular pattern in the past with companies such as Airbnb, eBay, Amazon, Spotify and Netflix.

New players from the start-up scene and the technology sector are looking closely at such services and are putting pressure on OEMs to develop services or coordinate their efforts.

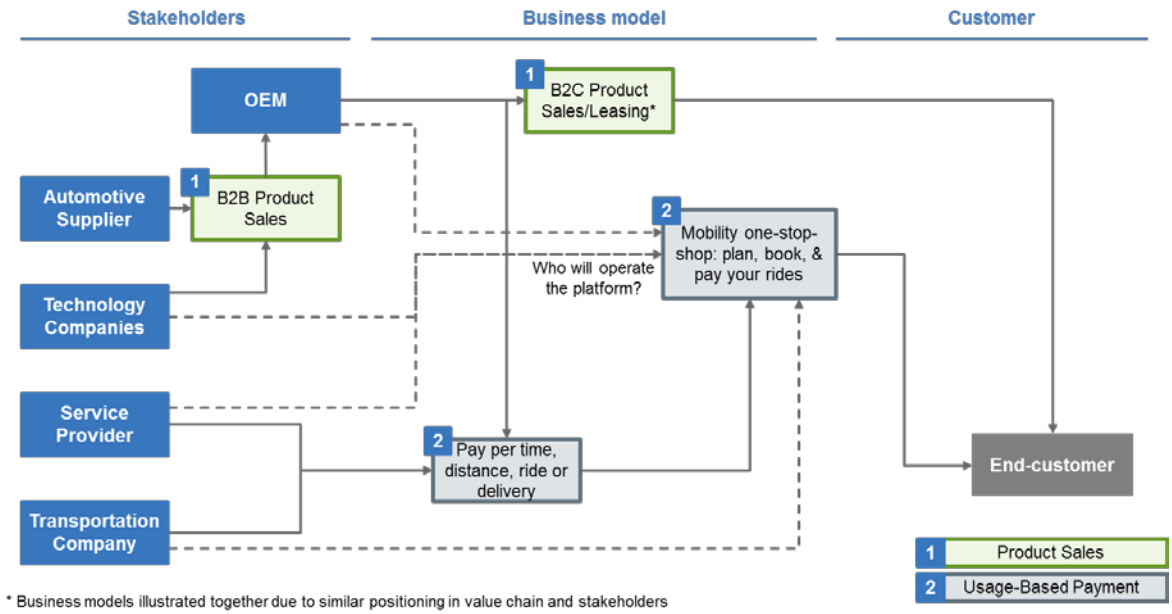


Figure 16 – Value Chain for Innovative Transport towards 2030

Finding Box

(16) The value chain will be transformed in the future through the emergence of new technologies, services and business models.

(17) People are increasingly looking for mobility-on-demand that is accessible all the time instead of owning a car.

(18) The threat for the OEMs is that, with a shift in consumer behaviour away from private car ownership towards the use of services, OEMs would lose some of their direct access to the end-customer.

5. Study interviews indicate that access to finance is particularly challenging for growth-stage companies

The interview sample

As part of this work, a long list of 865 companies active in Innovative Transport was compiled. A representative sample of 38 companies was selected for interview. The geographies, maturity and business model of companies interviewed is shown in Figure 17 below:

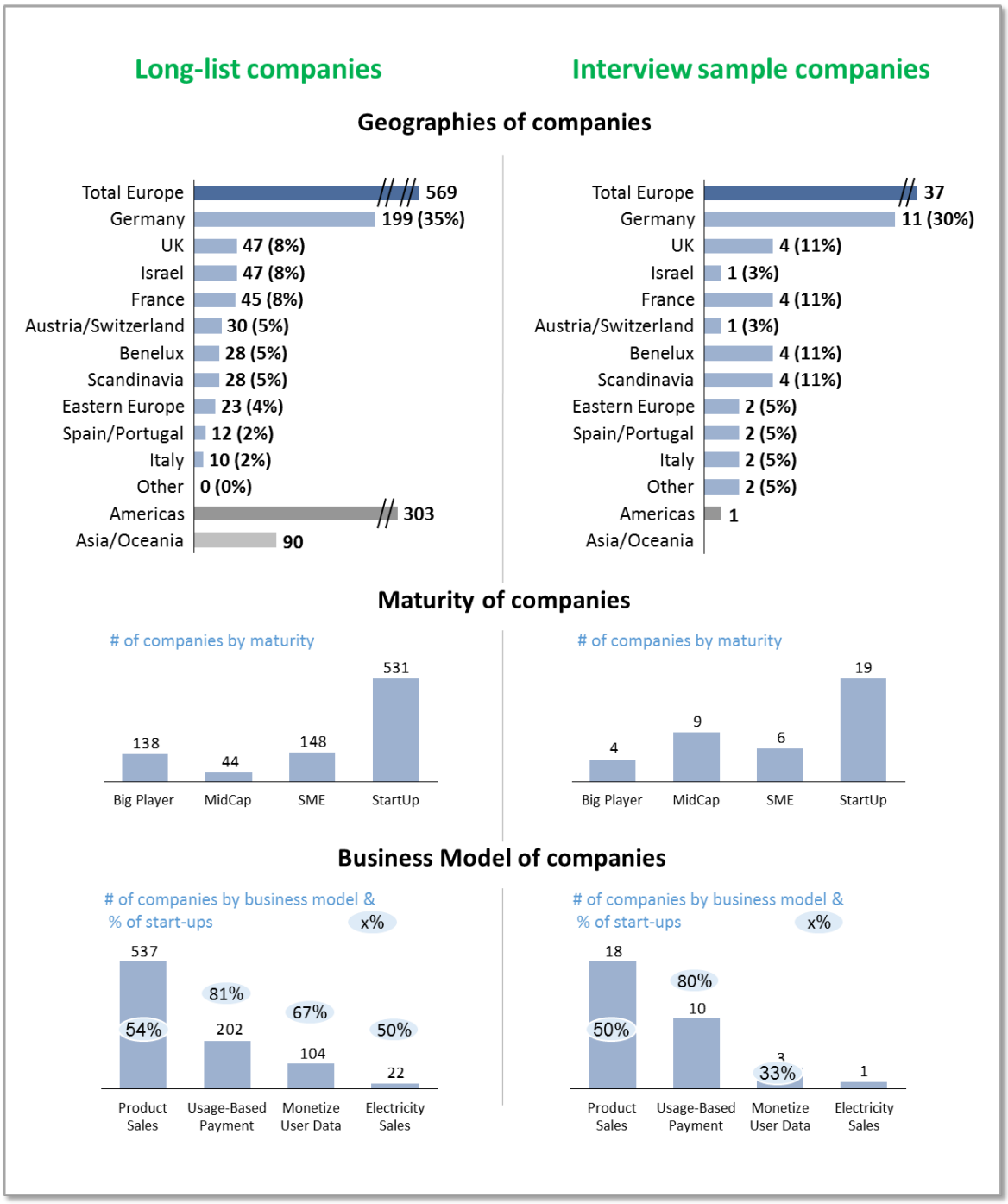


Figure 17 – Geographies, maturity and business models of companies on the demand side long list and the interview sample

Number of employees, revenue size, R&D investment share and policy focus areas are provided for the sample companies interviewed (Figure 18 below):

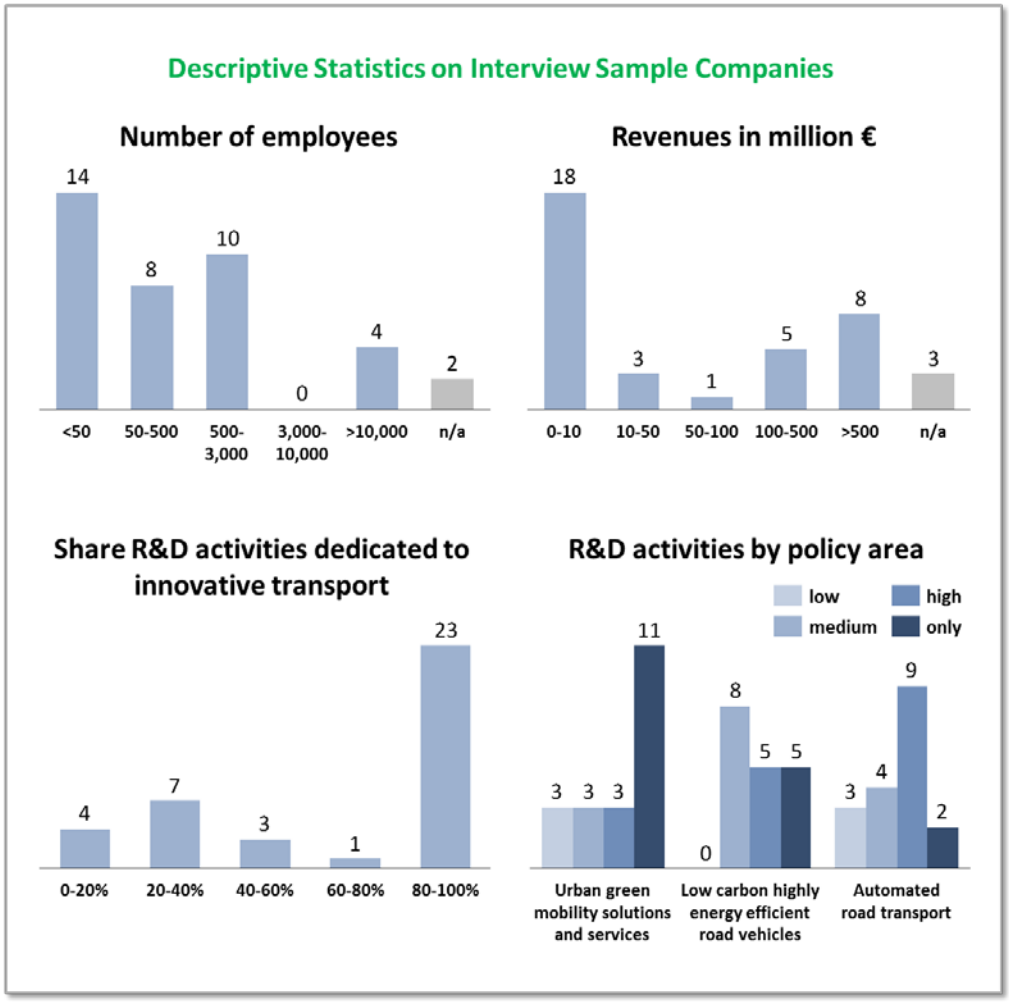


Figure 18 – Descriptive statistics on demand-side interview sample companies

Feedback from the interviews: Product Sales business model

Product Sales is a somewhat mature, well-tested business model. It focuses on new technologies with an uncertain adoption rate but operates within overall generally well-established setup (i.e. designing, manufacturing and selling vehicles and parts).

Most OEMs and automotive suppliers have been operating in this area for a long time. They are being joined by new players with innovative technologies. Funding is typically critical during expansion or enhancement of the product line and on R&D. Asset-heavy business models require heavy CapEx investments (with the exception of software components), and have rather long lead times.

The result is that VC investment is in limited supply under this business model, with only the more established companies managing to finance themselves via their own cash-flow or bank funding. Grants are also important in this segment.

The interviews confirmed that this business model is already rather mature, allowing some of these companies to finance themselves from their own operation or to access bank finance. The start-ups were much more reliant on venture capital (three companies) and grants (six companies).

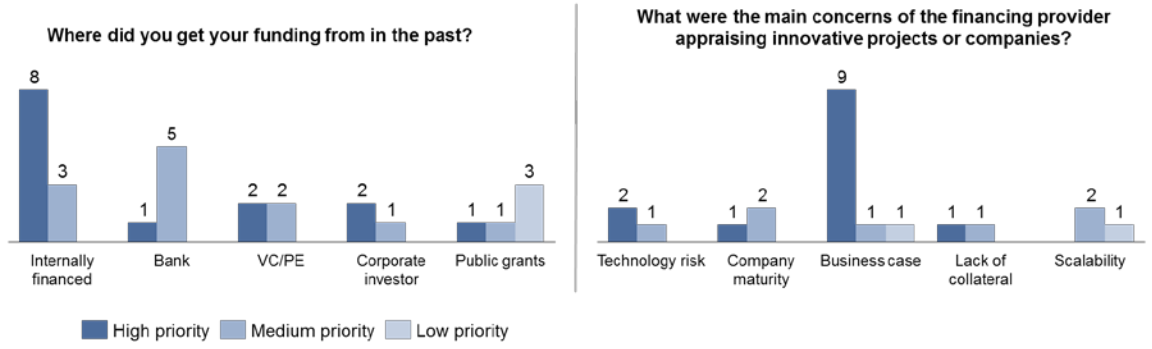


Figure 19 – Product Sales past financing sources and main concerns of financing providers

A compelling business case was by far the greatest priority for the companies' finance providers when appraising Innovative Transport activities.

The interviewees were also asked about their financing plans for the next 18 months. On average, the Product Sales companies in the interview sample secured €13m of financing over the past two years. The range of financing was between €1.3m and €34m. Looking forward, the companies on average aimed at €28m of additional financing, or a 121% raise, compared to the past. The range was between €2m and €80m.

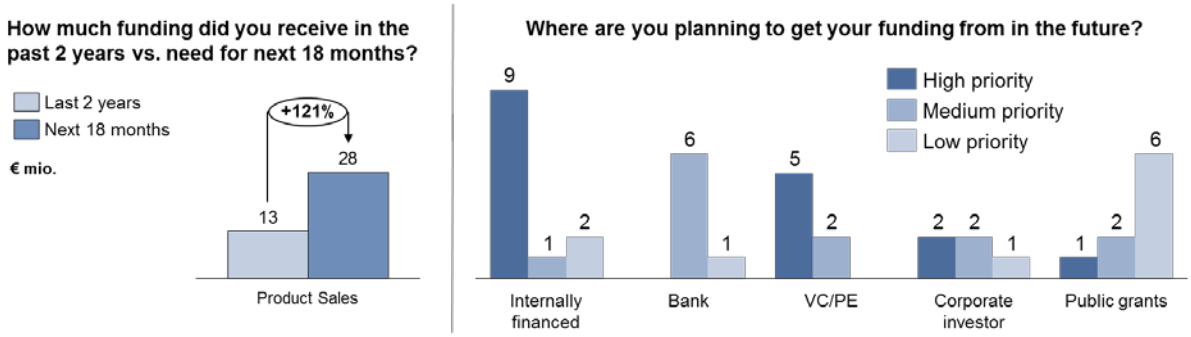


Figure 20 – Product Sales funding received in the past vs planned for the future and the sources of funding

Product Sales companies were planning to use their future financing mainly to invest into R&D activities and also to ramp-up new facilities. Other investments – such as fixed assets, marketing or M&A – were only relevant to a few companies. This shows the high focus of Product Sales companies on long-term investments such as production facilities.

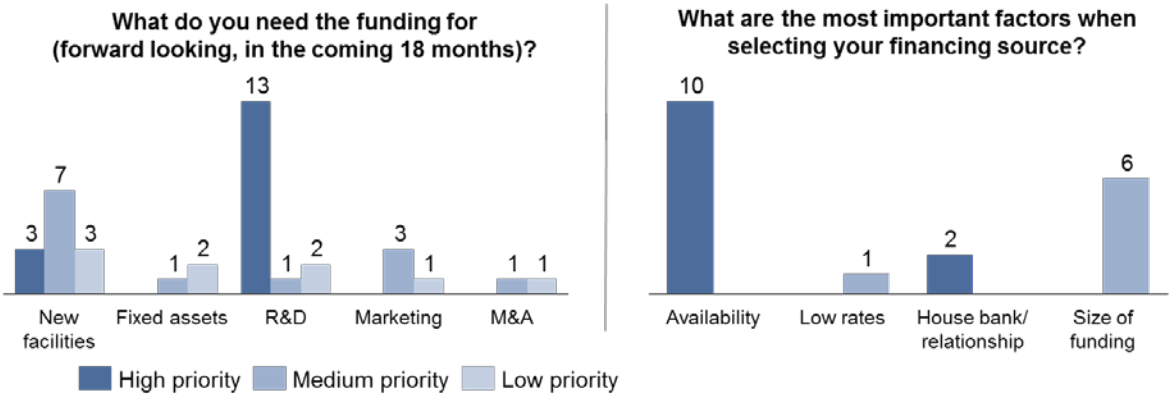


Figure 21 – Product Sales investment needs and factors for selecting the funding source

Finding Box

(19) Most of the Product Sales companies interviewed managed to finance themselves from their own operations or accessed bank financing, thereby confirming the rather mature profile and business model of some of these companies.

(20) The Product Sales companies interviewed received an average of €13m of financing and were aiming for an additional €28m for the next 18 months

(21) The Product Sales companies interviewed plan to focus investments on R&D and capex.

"We are using equity to cover our operating expenses; equity is easy to get. We are using grants to build-up the charging infrastructure, which are hard to get."
CEO Product Sales Company

"Funding of development activities in Innovative Transport is mainly done out of the cash flow."
Head of Strategy Automotive OEM

Feedback from the interviews: Usage-Based Payments business model

Usage-based payments is a less mature business model that focuses on services and depends mostly on third party assets. The most important funding need by far is to acquire and retain customers and market share. Scaling up the business fast is key, as typically only a few champions survive in each sub-segment. Investments are needed to develop platforms and service organisations, as well as to deal with fragmented regulation and legislation in the various markets. Similar to Product Sales, the financing gap is more evident during the growth phase.

Companies such as Uber, Flixbus and BlaBlaCar are the more mature players in the Usage-Based Payments market. Although profitable in some markets and geographies, they see the market potential and invest in further growth, rather than becoming profitable earlier on.

"The business of mobility-as-a-service is a pure scaling game. Whoever secures 100m of funding first will win the market."

CEO of mobility platform start-up

Usage-Based Payment and mobility services are dominated by start-ups and SMEs. Of the ten companies interviewed, nine were SMEs. The focus on equity financing is quite stark: nine companies were using investments from VCs and PEs, with five also being financed by corporate investors. Grants were used less often than with Product Sales companies, indicating their frequent unsuitability to mobility services and the quick growth ambitions of the Usage-Based Payment sector. Not surprisingly, interviews showed that the scalability of Usage-Based Payment businesses represents the main concern for finance providers.

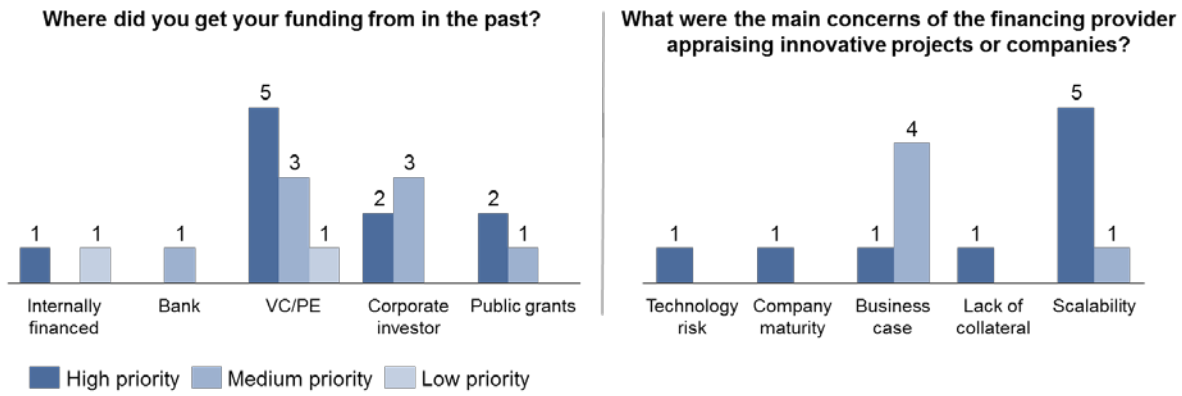


Figure 22 – Usage-Based Payment past financing sources and main concerns of financing provider

Usage-Based Payment companies in the sample received an average of €13m of financing over the past two years. For the next 18 months, they are aiming at an average of €58m. This 363% growth rate is three times that of the Product Sales companies and signals high-growth ambitions. Planned future financing ranges between €2m and €200m.

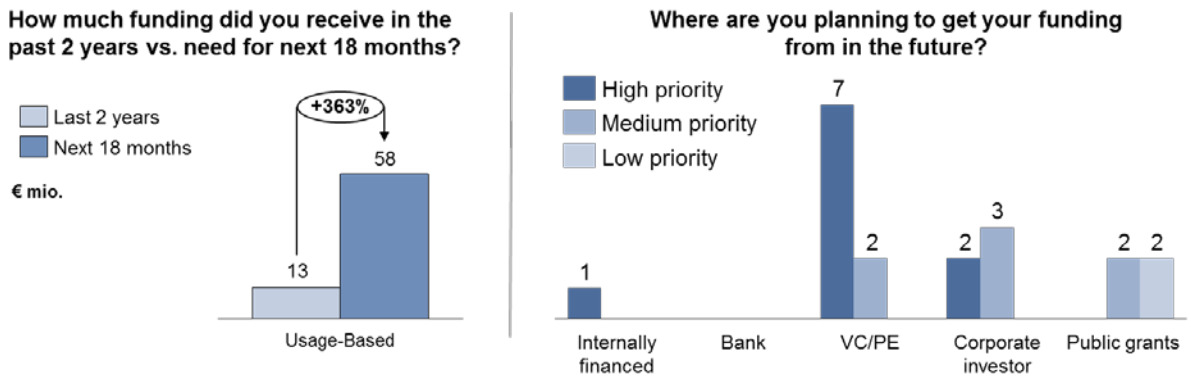


Figure 23 – Usage-Based Payment funding received in the past vs planned in the future and financing sources

The main sources of future financing – mainly needed for R&D and marketing – remain VC/PE and corporate investors. Companies need to strengthen their technology and digital mobility platforms while securing many customers as fast as possible. The high marketing expenditures signal the high growth ambitions of such companies. None plan to invest into facilities or other fixed assets, confirming the asset-light nature of Usage-Based Payment companies.

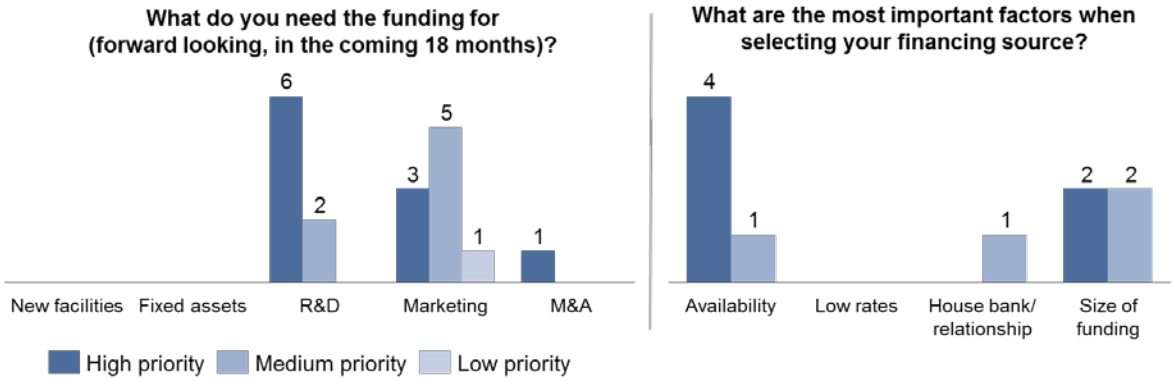


Figure 24 – Usage-Based Payment investment needs and factors for selecting financing sources

The most important factors for selecting the financing sources were the availability and size of funding. Once again, this points at the growth ambition and equity focus of this segment.

"Every VC is looking for the same kind of company: a good business model and quick scale-up. We are trying to attract more equity investments and to support them with grants. This also makes it easier to secure debt in the future."
CFO Mobility Platform Start-up

"VCs are much faster than securing grants. It only takes four to 12 weeks to get money compared to more than half a year. Mobility service start-ups are looking much more at VCs for the initial funding rounds."
CFO Logistics Platform Start-up

"We need up to 100m for the next two years depending on our growth targets. That kind of money can only be raised through VCs."
CEO Mobility Service Start-up

"We consider platform and sharing models as high risk and high reward models. The winner will take it all and there will be lots of losers. It's kind of a betting game for the most successful player."
Head of Strategy Corporate VC

Finding Box

(22) The Usage-Based Payment companies interviewed received their financing mainly from VCs/PEs and corporate investors. As for future funding sources, companies were focusing on the same type of investors.

(23) The Usage-Based Payment companies interviewed received on average €13m of financing and were aiming for an additional €58m for the next 18 months. This represents a higher growth ambition than for Product Sales.

(24) The Usage-Based Payment companies interviewed need future financing mainly for marketing and R&D expenses.

Feedback from the interviews: Electricity Sales business model

Electricity Sales depend strongly on overall market penetration and the adoption of electric vehicles. These in turn are influenced by national policies, standards and incentives. Electricity Sales is a less mature business model than Product Sales and relies on a clearly defined asset (the charging infrastructure) to deliver the service. Demand is understood but not easily predicted.

The majority of funding is allocated to the charging infrastructure assets with longer maturities up to ten years. The financing gap is clearly on the growth phase, where the ability to raise funds for asset deployment is critical to the survival of the venture. This is typically done in the form of a consortium, where, for example, utilities, charging equipment providers, maintenance contractors, OEMs or other stakeholders bid together for a public tender to build up infrastructure or make a joint application for a grant.

The initial investment is typically around €10 000 for a slow charger or €40 000 for a fast charger. These investments are usually supported by public funds of up to 50%[21]. For future super-fast chargers built along highways with over 300 kW, investments greater than €100 000 will be required per charging point. However, there are also high costs in operating and maintaining the infrastructure. In most cases, the operators belong to the same company that provided the infrastructure. These can be utility companies, their subsidiaries and regional energy providers. Demand for electricity currently remains very low in most locations, so that building and operating a charging station is at present highly unprofitable and represents one of the most difficult areas in which to raise financing.

"Every charging point we are building is a strategic investment; the business case is not interesting or positive."

Electricity Sales, Head of Strategy

Feedback from the interviews: Monetisation of User Data business model

This is a business model with medium maturity, characterised by in-place demand and rapid growth. It is anticipated that the majority of funds will be allocated to enhancing platforms, as well as commercial development and marketing. The financing gap persists throughout the phases and increases in the growth phase, as the company builds new services and expands into new technologies. Monetise User Data also factors in to the other business models: data enriches products and services and enables further-improved offerings or the development of new applications.

[21] Source: Interviews with market participants

Finding Box

(25) Financing requirements are a function of technology maturity, business model and company-specific characteristics.

(26) For all business models (with the partial exception of Monetise User Data), the **profitability break-even point is late in the company lifecycle**, usually only after the growth phase (for asset-heavy models this is due to the longer lead time and technology development; for asset-light businesses this is due to efforts in customer acquisition and in rapid scaling-up).

6. Business model risk profiles

This study further considered the risk profile characteristics of each business model across a number of parameters, including demand, competition, regulation and typical investment programme. A summary is provided in the chart below:

RISKS	1 Product Sales	2 Usage-Based Payments	3 Electricity Sales	4 Monetize User Data
Product/ Technology	New products evolving, dependent on charging infrastructure	New services, not stabilised yet; great innovation	New service, not standardised yet; great evolution on efficiency	Tested products, rapidly becoming the norm
Assets	Heavy machinery, platforms, components, end-product	most 3rd party assets; less control and QA	High investment into charging stations that might become outdated before earning money	Asset-light, mostly IP on business intelligence
Demand	Low demand expected to grow rapidly with trust and infrastructure	Good demand for established concepts and players	Demand not easily predicted; OEMs moving in to boost e-vehicle sales	Demand in place, rapidly growing
Competition	Players mostly known with some new disruptors	Highly competitive; major players, many new entrants	Used as competitive advantage by OEMs for e-vehicles	Highly competitive; many new entrants
Regulation	Emission standards dependent; incentives major effect	Highly protected market	Emission standards dependent; incentives major effect	Data privacy central to companies' offerings;
Risk Summary	MEDIUM Established business model but new technologies	HIGH Not fully formed relying on marketing & 3rd parties' assets	MEDIUM-HIGH Evolving with EU/national policy to play a significant role	MEDIUM Evolving in a growing market with tested products

Figure 25 – Business model risk assessment ("traffic light" colour coding – i.e. red is higher risk)

- **Product Sales** is identified as medium risk. The business model itself is very established with a number of big and profitable companies active in the sector. The risk is mostly related to the deployment of new technologies.
- **Usage-Based Payment** is relatively high risk, mainly due to highly competitive and protected market environments. In addition, companies in the sector are mostly young and not yet profitable. Entry barriers into the sector are relatively low due to the asset-light business model. However, scaling up is difficult due to high competition and regulatory challenges.
- **Electricity Sales** is considered as medium to high risk, greatly relying on product sales and respective regulation. The risk is mostly centred on a rapidly evolving technology that is not yet standardised and which increases the risk of investing into assets that might become outdated before returning revenues and profit.

- **Monetisation of User Data** is considered a medium-risk business model, operating within a highly competitive but partly established market. Several companies in the sector are already profitable whilst still growing at a high rate. In addition, companies are increasingly applying this business model as a "transversal activity" to other business models to enhance and better monetise their products and services.

SECTION II – Investment in the Growth Phase of Innovative Transport Companies is Mostly Coming from non-European Sources

In this section the following points are addressed:

- Qualitative identification of financing gaps(s)
- Sub-optimal investment conditions within Innovative Transport

SUMMARY BOX

- We have seen that the four business models differ significantly in regards to their risk profile, maturity, financing requirements and time to profitability
- Usage-based Payment is considered the business model with the highest reliance on venture capital due to the high risk/reward profile and typically asset-light balance sheets. In addition, it is also the business model VCs, corporate investors and PEs are currently most focused on
- Within Europe, the past three years have seen a higher number of financial transactions and sizeable transactions concerning Usage-Based Payment companies than for Product Sales businesses
- All investors in Usage-Based Payment companies were VCs/PEs or corporate investors, most of them non-European

1. The financial instruments offered by the supply side vary by risk profile

For the purposes of mapping the financial instruments to the demand requirements, financial products and support services available from both public bodies and private investors were reviewed. These products and support services have been grouped into four categories with common risk characteristics. They can be split into private instruments including equity, debt and hybrid products, and public instruments, as shown in Figure 26.

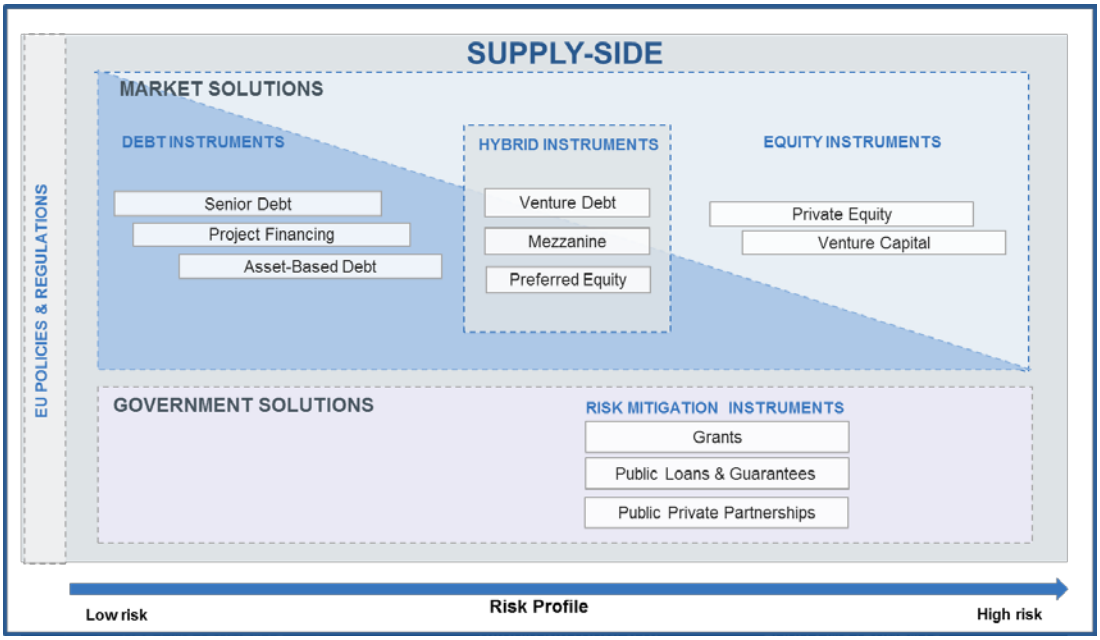


Figure 26 – Financing instruments overview

- **Equity Instruments**: instruments used throughout the life cycle of the company, with venture/growth capital more common at early stages and private equity at the more mature stages.

- **Hybrid Instruments**: instruments that combine both equity and debt characteristics such as mezzanine financing, venture debt, shareholder loans and preferred equity. Hybrid instruments are mainly used in the growth phase, when a company is seeking to access debt and ensure continued growth without further diluting the holdings of the founders and/or current owners.
- **Debt Instruments**: instruments used for financing companies in the late growth and profitability phases, when they have well-tested business models, a healthy balance sheet, recurring revenues and reliable, steady cash flows to cover interest and principal repayments.
- **Risk-Mitigation Instruments**: instruments that aim to help companies grow and access financing – such as grants and public guarantees – which are typically provided by public bodies at national and EU level. They complement private market instruments and enable the companies to advance R&D and growth.

Mapping available financial instruments to business model maturity phases

By examining the financial profiles and the investment requirements of the Innovative Transport sector, combined with qualitative findings from the interviews with market participants, this study identified a significant financing gap for Innovative Transport companies, especially during the growth phase.

As outlined above, the break-even point in many Innovative Transport companies often comes at a late stage. Furthermore, for Innovative Transport start-ups, demand and related revenues often pick up slowly, several years after the products are commercialised. This is more evident when considering each model separately:

- For Product Sales, a long up-front development cycle and time for setting up production lines is required. This can be especially observed in the example of new entrants to the OEM space, which need to develop a vehicle from scratch, hire engineers, set up production facilities and machinery, build a distribution network and establish a supply base before being able to release their product to market and receive any revenue. For example, Tesla was founded in 2003 and is only now, in 2017, on the brink of reaching net profitability[22].
- For Usage-Based Payment business models, the underlying markets are typically characterised by network economics, and high multi-year investments are required to secure a critical level of market share. While investments into assets are much lower than for Product Sales companies, the competitive market and low entry barriers for Usage-Based Payment systems are forcing companies to prioritise growth over profitability and to expand quickly. An example is Uber, which was founded in 2009 and is still not profitable due to having to subsidise rides to compete with other ride-sharing services.
- For Electricity Sales business models, high levels of investment in infrastructure, as well as a dependency on the uptake of electric vehicles to provide a customer base, define financing needs. On the one hand, setting up charging stations requires high up-front investment and necessitates significant recurring costs for operations, maintenance and repairs. On the other hand, there is significant uncertainty as to when a sufficient number of EVs will be on the streets to create the robust demand for charging needed for operators to fulfil their utilisation requirements and become profitable. In addition, technological development in the sector is advancing quickly, and some charging stations installed today might already be obsolete in a couple of years.

The above patterns define a **prolonged "Valley of Death" where companies do not have sufficient revenues yet and require a constant flow of growth capital to finance their operations**. This is a key difference, especially to non-digital industries like consumer products, where entrepreneurs are achieving

[22] http://www.reuters.com/article/us-tesla-results-idUSKCN12Q2QW

better capital efficiency through requiring less funding to achieve significant revenues and build a successful business.[23]

> *"Out of the 120 growth companies we worked with, only one is profitable."*
> **Director of financing marketplace**

Considering the different characteristics of each phase, Figure 27 shows the typical financial instruments used during a company's development cycle.

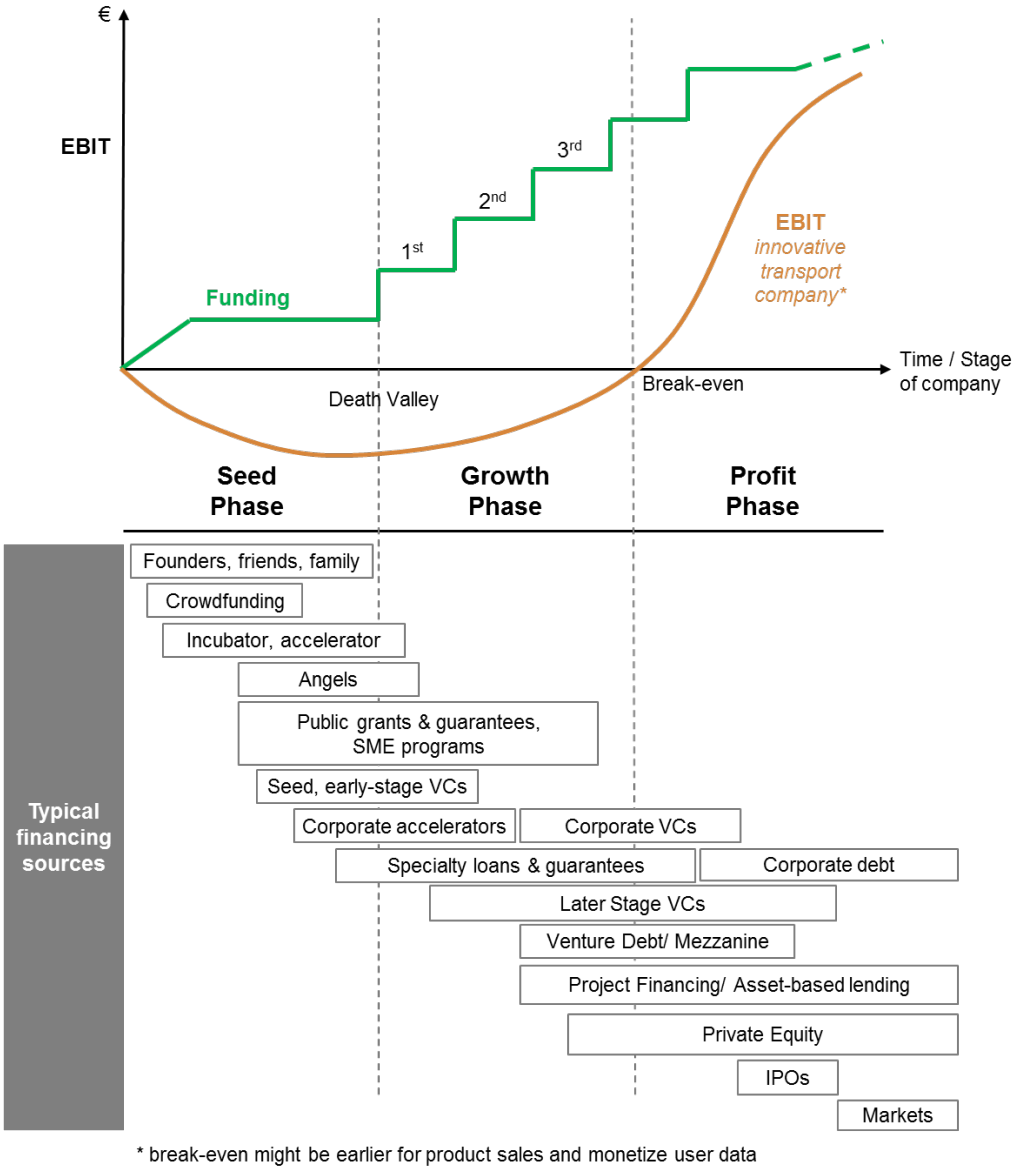


Figure 27 – Financing sources for the maturity phases

[23] https://circleup.com/community/article/why-early-stage-consumer-entrepreneurs-are-having-more-success-fundraising/Vyzf2yYAAL6usF_o/

2. The financial instruments available are of varying value to the different Innovative Transport business models

The study compared financing supply to demand. The outcome of the analysis is presented in Figure 28, where the financial instruments per business model and level of maturity are shown. Some key insights from the analysis include:

- Venture capital works best with Usage-Based Payments and Monetise User Data, where the investment is on average lower and returns higher due to the asset-light nature of these business models. There is also great interest from OEMs, as they invest in strategically aligned start-ups and aim to complement their products and offerings. 50% of the companies interviewed have either used or are planning to use venture capital.
- Internal financing through own cash flow or funds from a parent company is mostly observed in Product Sales and Electricity Sales, especially in asset-heavy, large investments with long tenors. This is on the one hand due to the significant activity of OEMs in this field, and on the other to the mismatch of such investments' risk/reward profiles with the VC investment model.
- Grants and public loans play a key role in enabling the venture to take off and in supporting R&D and development across the models. 66% of the companies interviewed have used or are planning to use grants, especially in the seed phase and, to a slightly lesser degree, also in the growth phase.

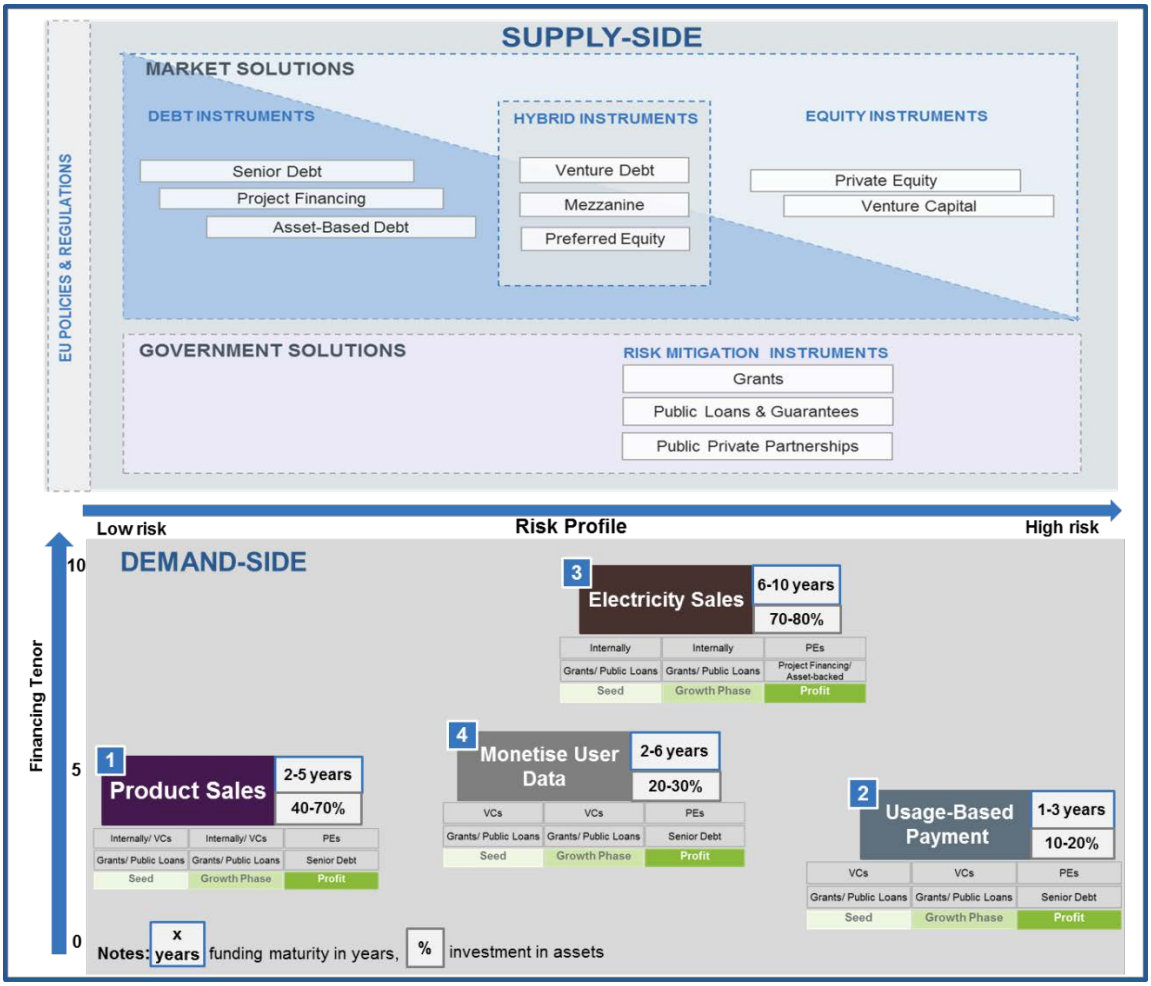


Figure 28 – Bringing the demand-side and supply-side together

Finding Box

(27) The four business models differ significantly with regard to their risk profile, financing tenor, funding maturity and types of assets invested into.

(28) Usage-Based Payment is considered to be the business model with the highest reliance on venture capital due to its high risk/reward profile and asset-light nature.

The table below summarises the risk profiles and financing requirements of the four business models:

Product Sales	Usage-Based Payment
▪ Rather mature, well-tested business model, operating within a known setup and with rather clear roles, despite the new technologies under development ▪ Funding is typically critical during expansion or enhancement of the product facilities and on R&D ▪ Asset-heavy business model, requiring heavy capex investments (with the exception of software components), with rather long lead times ▪ For the reasons outlined above, VC investment is in limited supply under this business model, with only the more established companies managing to finance themselves via their own cash flow or via bank financing ▪ Grants are also important in this segment	▪ Less mature business model, focuses on services and mostly depends on third party assets ▪ The most important funding need by far is to acquire and retain customers and market share: scaling up the business fast is key as there are typically only a few champions that survive in each sub-segment ▪ Investments are typically needed in the service scale-up phase (marketing and R&D) as well as to deal with the fragmented regulatory frameworks ▪ Asset-light business model, more in line with the risk-return profile of VC investors ▪ Clear focus on equity financing via VC and corporate investors, with grants playing a lesser role compared to the Product Sales business model
Operating Alternative Fuel Infrastructure	**Monetisation of User Data**
▪ Less mature business model compared to Product Sales and relies on a clearly defined asset ▪ Heavily depends on the overall market penetration and adoption of electric vehicles; the demand is understood but not easily predicted ▪ The financing gap is clearly on the growth phase, where the ability to raise funds for the asset acquisition and setup is critical to the survival of the venture ▪ Typically funding comes in the form of a consortium, where e.g. utilities, charging equipment providers, maintenance contractors, OEMs or other stakeholders pool funds together ▪ The economics of the venture typically require support from public funds early on before market uptake	▪ Business model with medium maturity, characterised by in-place demand and rapid growth ▪ Asset-light with faster investment pay-back periods ▪ VC focus but strong interest from OEMs ▪ Funds used for enhancing platform services and analytic capabilities as well as for customer acquisition

3. Only one form of public funding is consistently valued by Innovative Transport companies – public grants

A number of public funding instruments are already available and successfully deployed at European level, aiming to support companies at various stages of their development. They can be provided directly to the company (e.g. via the EC or the EIB) or intermediated through local partner banks and VC funds. In addition, financial advisory services are available from public institutions to help companies access funding sources.

Companies in the seed phase are typically supported by public grants and guarantees from the EC or national programmes, or by seed capital and angel investments. Innovative Transport companies are looking at public grants on European (e.g. Horizon 2020), Member State or regional level, although some grant programmes are not perfectly suited to the business profile of service-focused companies[24]. In addition, many accelerators are supported by public funding and are helping companies in the seed phase.

During the development phase, companies are primarily supported by forms of equity, typically via venture capital. Some public grant programmes are also available to companies in the growth phase, although the funds they receive out of these programmes could be considered as supplementary to the companies' financing mix. Venture debt or mezzanine is likewise considered by some companies in the growth phase, due to its non-dilutive properties and flexible structures, but the availability of such instruments remains limited in the market. The fit of mezzanine finance to growth companies largely depends on the structure of the project (e.g. leaning more towards equity or debt characteristics), and the specific characteristics and needs of the company raising capital.[25]

In the profit phase, when business models are established and companies generate recurring, positive operating cash flows, public debt instruments such as intermediated loans, direct loans or project finance become more relevant.

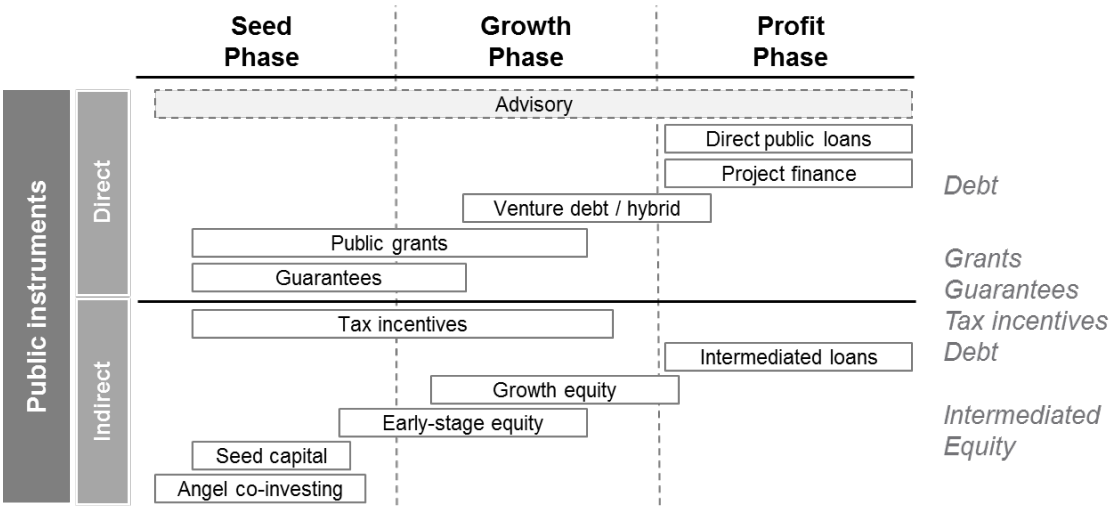


Figure 29 – Available public instruments in the EU-28

Even though a broad range of public financial instruments is available to innovative companies at all stages, companies interviewed in this study only used them sparingly, except for grants (see Figure 30 below), which were widely used across the interview population. However, some interviewees stated that they would regard them as only complementary to their funding mix and as more critically required in larger volumes at seed and early stages. Most companies indicated that grants alone would not be sufficient to scale up a

[24] Source: Interviews with market participants

[25] See "Financing gap for SMEs and the mezzanine capital", Vasilescu, 2010

company and grow. In addition, there seems to be a mismatch between some grant programmes' eligibility criteria and the specific high-growth, fast-paced and asset-light characteristics of mobility service companies.

Furthermore, not all companies were aware of EIB/EIF programmes, with some noting that the process of applying there or for EC grants could be very cumbersome and in itself slow down commercial development. In addition, most companies perceived public institutions only as "neutral" to "somewhat helpful" for their funding.

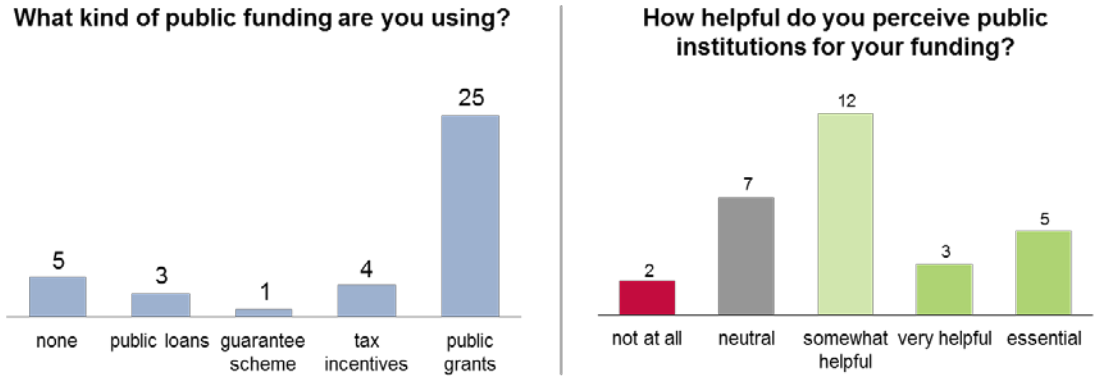


Figure 30 – Interviewees' use of public funding

Finding Box

(29) Grants are by far the most used public funding instrument across the interview sample. Most of the companies are using grants but consider them more as supplementary to their existing financing, rather than as critical to growth. Often grants are used to conduct research projects on new innovative topics that would not have been financed without them.

(30) Although public financial instruments are available at all maturity stages, with the exception of grants, interviewees only occasionally made use of them.

"Grants from the EC help significantly in setting up a company and for networking with the automotive industry. However the grants are not sufficient to scale up and make the next step."
CEO Electric Vehicles Start-up

"Applying for EU grants is very complicated and takes too much time while the chances of success are quite low."
CFO Product Sales Company

"We received a big loan from the EIB that can be considered as high risk. No commercial bank was willing to do that."
CFO Automotive Supplier

"The EIB is very helpful to our funding as they offer much longer tenors than commercial banks."
CFO Public Transport Operator

4. Investment in Innovative Transport companies in the growth phase is shifting to Usage-Based Payment companies through VC funding, but the investors are mostly non-European

In order to further test the assumptions and findings presented in the previous chapters, this section looks at financing transactions that took place over the past three years in the Innovative Transport sector, specifically at the level of the two main business models – Product Sales and Usage-Based Payment. During the analysis, 43 transactions were reviewed as shown on the overview in Figure 31 below.

 # transactions by investor & business model

	Product Sales	Usage-Based	Σ
Bank	3		3
PE	2	4	6
VC	5	16	21
Corporate	4	7	11
Gov./PPP	2		2
Σ	16	27	43

Transaction volume in € millions

	Product Sales	Usage-Based	Σ
Bank	413		413
PE	68	187	255
VC	17	470	487
Corporate	42	637	679
Gov./PPP	17		17
Σ	557	1294	1851

Figure 31 – Financing transactions overview for Product Sales and Usage-Based Payment

There has been very high activity in Usage-Based Payment, especially by VCs, PEs and Corporate Investors, mostly targeting SMEs and start-ups. Banks seem to be looking mostly at the more mature Product Sales business model. However, this cannot be directly inferred from above table, which for bank financing is heavily skewed by one deal (Mobileye, €378m, see Figure 32 below). In addition, most pure bank financing deals without an M&A component have occurred in the private market and are not publicly available. Out of the €1.9bn worth of transactions, non-EU investors were involved in transactions of €1.2bn. Some transactions were performed jointly by different types of investor, e.g. VCs or PEs partnering with corporate investors.

In the two tables below, the ten highest publicly available transactions targeting European companies for Product Sales and Usage-Based Payment are presented.

Product Sales exemplary transactions in European companies								
#	Investors	Investor type	Investor country	Investment type	Investment volume [m€]	Target company	Target company country	Target company size
1	Morgan Stanley, Goldman Sachs	Bank	US	Private Equity	378	Mobileye	Israel	Startup
2	Gilde Equity Management	PE	Netherlands	Acquisition	65	EV-Box	Netherlands	SME
3	Valeo; Keolis and Group8	Corporate/ VC	France, France, Qatar	Series C	30	Navya	France	Startup
4	Ambarella	Corporate	US	Acquisition	28	VisLab	Italy	Startup
5	European Investment Bank	Bank	Luxemburg / EU	Debt	14	Gestamp Tallent	UK	Midcap
6	Innovate UK; EPSRC	Government	UK	Grant	13	Hyperdrive Innovation	UK	SME
7	Earlybird Venture Capital	VC	Germany	Venture Capital	7	Clean Mobile	Germany	Startup
8	SMRT International Pte Ltd; United Technical Services	Corporate	Singapore; UAE	Grant	6	2getthere	Netherlands	SME
9	Bosch VC; Inventure Oy; Day One; Tamares	Corporate/ VC	Germany; Finaland	Equity	6	AdasWorks	Hungary	Startup
10	Advanced Propulsion Center	PPP	UK	Series A	6	AGM Batteries	UK	SME

Figure 32 – Top 10 financial transactions – Product Sales[26]

Usage-Based Payment exemplary transactions in European companies								
#	Investors	Investor type	Investor country	Investment type	Investment volume [m€]	Target company	Target company country	Target company size
1	Volkswagen Group	Corporate	Germany	PE	283	Gett	Israel	SME
2	Insight Venture Partners; Lead Edge Capital	VC	US	Series D	200	BlaBlaCar	France	Midcap
3	Avis Budget Group	Corporate	US	PE	161	Maggiore	Italy	SME
4	Vostok New Ventures	PE	Germany	Series D	142	Gett	Israel	SME
5	Rakuten	Corporate	Japan	Series C	113	Cabify	Spain	Startup
6	DN Capital, DST Global, Mutschler Ventures and Piton Capital	VC	UK; Russia; Germany; UK	Series D	111	AUTO1 Group	Germany	SME
7	Benchmark Capital; Index Ventures; Balderton Capital	VC	US	Series B	38	Citymapper	United Kingdom	Startup
8	Cathay Innovation; Nokia Growth Partners	VC	France, Finland	Series C	31	Drivy	France	Startup
9	Index Ventures	VC	UK	Series A	24	MetaPack	United Kingdom	Startup
10	GEOPOST	Corporate	France	Seed capital	22	Stuart	France	Startup

Figure 33 – Top ten financial transactions – Usage-Based Payment[27]

[26] Source: Crunchbase and CB Insights databases, December 2016

[27] Source: Crunchbase and CB Insights databases, December 2016

Finding Box

(31) VCs, corporate investors and PEs are most focused on investments in Usage-Based Payment companies.

(32) Most of the past financial transactions into European companies have included non-European investors.

(33) The financial transactions for Usage-Based Payment companies were far more numerous and of a higher value than for Product Sales.

(34) Banks are focused on companies with operating profitability and more solid balance sheets.

SECTION III – The Total Financing Gap in European Innovative Transport is Estimated in a Range Between Approximately €5.5bn and €13bn

SUMMARY BOX

- Investments into the sector generally increased over the past three years although the allocation of funding remains very uneven. In particular, European start-ups and companies following the Product Sales business model seem to profit only to a lesser degree
- There is a financing gap for Innovative Transport in the EU, especially during the growth phase
- The financing gap is estimated in the range of approximately €5.5bn to €13bn annually
- The European venture capital market remains less mature and more risk averse, leaving opportunities for US investors to move in
- The financing gap estimation is based on a relative, top down calculation as opposed to a more granular bottom-up estimation. The purpose of the exercise was to identify an order of magnitude to complement the qualitative assessment and the desktop research

1. Study interviews confirm that there is a funding gap for European Innovative Transport companies in the growth phase

In examining the financing alternatives in Europe, this study concludes that there is a financing gap for the Innovative Transport sector during the growth phase and thus affecting mainly start-ups and SMEs, as shown in Figure 34 below. A third (seven out of 21) of all start-ups or SMEs interviewed stated that they find it difficult or very difficult to receive sufficient financing. Three companies were neutral on the topic.

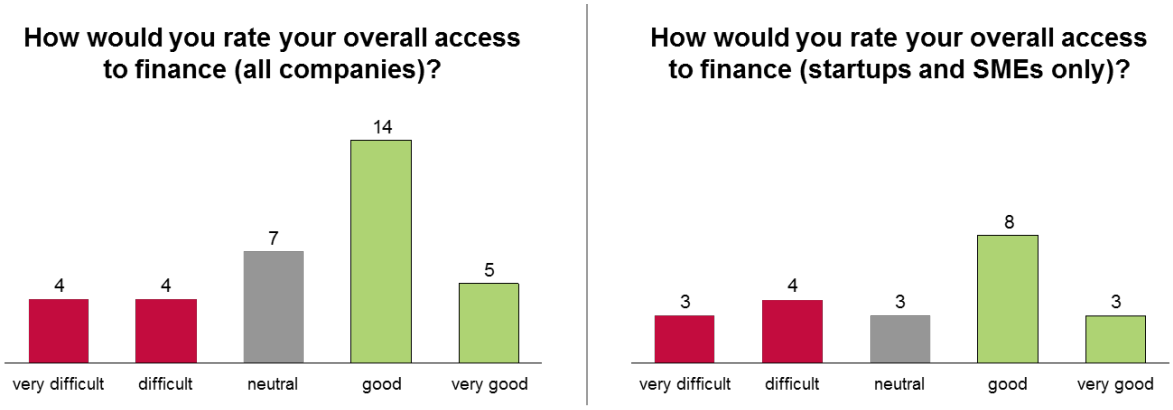


Figure 34 – Interviewees' response on access to finance

However, the study finds that the financing environment today is perceived as having improved compared to three years ago, with further improvement expected (see Figure 35 below).

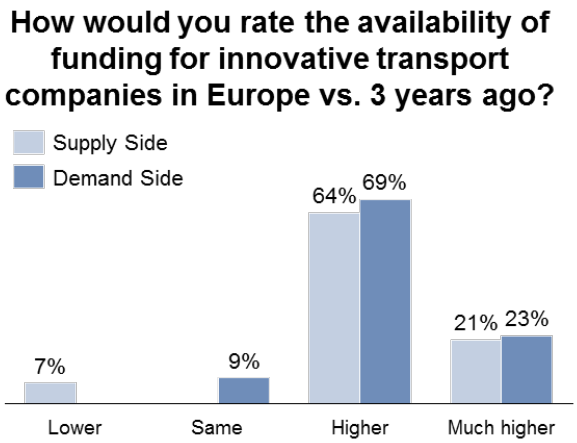


Figure 35 – Interviewees' response on availability of funding in Europe

There are several reasons for the optimistic outlook on the short-term financing environment. The Innovative Transport sector is expected to grow by a significant 15-25% annually, creating many opportunities with new technologies, businesses and services for financial institutions to invest in. In addition, there is increased interest in the sector from equity investors expecting to co-invest incrementally as it matures.

On the other hand, US and Chinese companies can access financing, especially equity, more easily due to the higher available volumes and larger variety of funds. Innovative Transport companies in these markets thus benefit from a competitive advantage over their European peers, as we will see in the following sections. At the same time, US investors have been showing an increasing interest in innovative European ventures: whereas this is good news from a company's financing standpoint, a significant ownership stake held by a non-European investor may at times be accompanied by a shift in headquarters – and in extreme cases operations – abroad.

The amount of overall funds flowing into the sector is illustrated by Figure 36. The equity investments into Innovative Transport companies worldwide have almost doubled annually in recent years. In the past three years, investments rose from $2.2bn in 2013 to $16.3bn in the first half of 2016. Coincidentally, 2013 was also the year when Uber started to raise significant amounts of capital with its first three-digit financing round of $363m. One year later, in 2014, Uber secured $2.6bn through two additional rounds. The years 2013 and 2014 can thus be considered a tipping point in financing of Innovative Transport, where mobility services started to raise significant interest from venture capital investors. As we have seen in the previous sections, overall more than $50bn of financing flowed into the sector between 2011 and the first half of 2016.

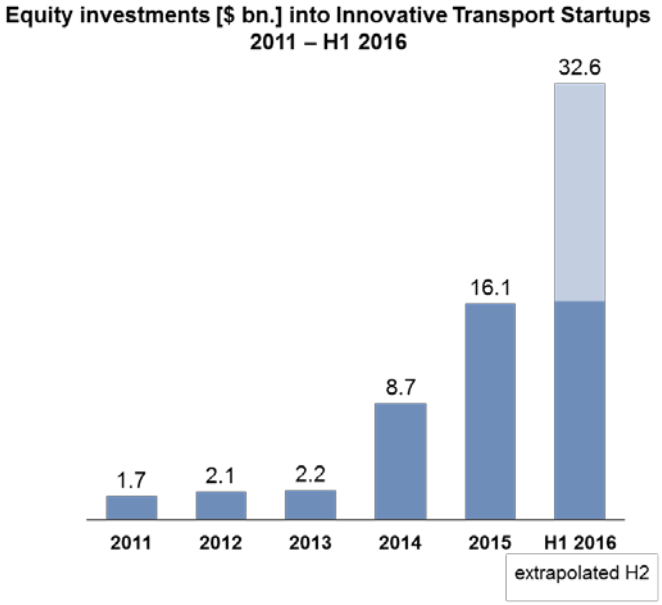


Figure 36 – Global equity investments into Innovative Transport Start-ups[28]

Such volumes could be interpreted as companies in Innovative Transport not facing financing issues. However, a deeper look at the financing available reveals a different picture.

While overall financing in the sector increased over the years, a few select companies in key market segments have profited disproportionally. Figure 37 below gives an overview of the automotive and mobility start-ups that have received the highest amount of investment since 2011. The first seven companies in the list received more than half of the overall $50bn invested in the sector: Uber, Didi Chuxing, Tesla, Lyft, Ola Cabs, Grab and Gett. With the exception of Tesla, all of these companies are mobility services that apply a Usage-Based Payment business model. Moreover, all are from the US or Asia with the exception of the Israeli start-up Gett. The European start-up receiving the most funding over the same period was BlaBlaCar, which received $0.3bn, far less than the first seven companies in the list received individually.

In summary, while the overall financing situation in the sector has improved in recent years, **the distribution of money is highly concentrated on a few individual businesses outside the EU and within specific business models**. European companies following the Product Sales business model especially have profited to a much lesser degree from the boom.

Funding of Automotive and Mobility Startups over the last 5 years			
Startup	**Business Model**	**Geography**	**Funding [$ bn.]**
Uber	Usage-Based Payment	USA	11.6
Didi Chuxing	Usage-Based Payment	China	7.4
Tesla Motors	Product Sales	USA	2.4
Lyft	Usage-Based Payment	USA	2.0
Ola Cabs	Usage-Based Payment	India	1.6
Grab	Usage-Based Payment	Singapore	1.4
Gett	Usage-Based Payment	Israel	0.6
…			
Blablacar	Usage-Based Payment	France	0.3

Figure 37 – Automotive and mobility start-ups receiving the most funding[29]

[28] Source: Oliver Wyman press release January 2017; Crunchbase data from December 2016

Finding Box

(35) Only half of the interview sample considered their own access to finance conditions as “good” or “very good”. Nevertheless, there was a broad agreement across the interviewees that the financing situation in the sector is better than three years ago.

(36) Past transactions show that equity investments into the sector have strongly increased, although the distribution of money is highly concentrated. In particular, European start-ups and companies following the Product Sales business model seem to profit to a lesser degree.

"Today the availability of funding in the sector is much higher than three years ago, but is has started from a low base, so it is still fairly small."
Fund Manager VC

"The sector is very interesting and we are seeing lots of money flowing into it."
Director Commercial Bank

"The whole sector has grown in importance. We see more start-ups today in the mobility sector and also more financing rounds than a couple of years ago."
Partner VC

[29] Source: Crunchbase data from December 2016

2. The financing gap is especially pronounced during the growth stage of Product Sales, Usage-Based Payment and Electricity Sales companies

As shown in Figure 38 below, this study identified that the availability of financing is generally good across all models during the seed phase, with some challenges for Electricity Sales business models due to their asset-heavy nature.

Financing is generally more challenging across the spectrum during the growth phase, which is characterised by high CapEx and OpEx needs, typically no operating profitability yet and high uncertainty of returns on investment. The business model of Monetising User Data is generally more successful in this phase, with companies in this sub-sector usually achieving significant revenues early on.

Companies reaching the profit phase generally face only low to moderate difficulties in securing financing and can be considered as bankable for standard debt instruments.

	1 Product Sales	2 Usage-Based Payments	3 Electricity Sales	4 Monetize User Data	
Seed Phase	+ Grants available, Horizon 2020 well accepted + Financing by OEMs/Tier-1 + Seed VCs for autonomous / connected car – Seed financing for EV	+ Seed VCs very active – Grants often not fitting to service based models	+ Public loans and grants + Large consortiums of OEMs and utilities to set-up network – VCs not interested due to heavy asset investments	+ Seed VCs very active + Financing by OEMs, Tech. companies and other corporate investors + Grants available	Good availability
Growth Phase	+ Grants available, Horizon 2020 well accepted + Financing by OEMs/Tier-1 – Very low revenues in growth phase – Low availability of growth VC financing	+ VC selective interest o Growth VC financing – Low revenues and very high competition – Grants often not fitting to service based models	+ High public support for installation costs + OEM activity in the sector o Potential project financing and asset-backed financing – Low revenues, high assets – VCs not interested	+ Strong VC interest + Moderate early revenues o Growth VC financing	Financing Gaps
Profit Phase	+ Debt for profitable companies + Revenues from initial sales – Risk averse banks for unprofitable companies – Limited exit options	o Late-VC/PE interest o Potential for (venture) debt products	+ Project financing and asset-backed financing available o Potential PE interest – Amortisation of invest uncertain – No grants for operating & maintenance but high costs	+ PE interest + Debt activities	Good for profitable, challenging for unprofitable
	Moderate financing	Moderate financing	Low financing	Good financing	

Figure 38 – Financing heat map by business model (red=gap most acute; green=gap least acute; grey=moderate gap)

Considering the financing situation from a sectoral viewpoint, this provides a similar narrative (Figure 39): while seed financing is available across all sectors, the main financing gap is observed in the growth phase. Particularly within urban green mobility solutions and low carbon highly energy efficient road vehicles, it is challenging for companies to secure sufficient financing to grow and scale up. The situation is not as critical during the growth phase for companies in the automated road sector due to strong interest and funding by corporate investors from the automotive as well as IT & software industries. In the profit phase, financing is generally available for companies that have a balance sheet that can bear a certain amount of financial liabilities.

	Seed Phase	Growth Phase	Profit Phase	
a Urban green mobility solutions and services	+ Seed VCs very active – Grants often not fitting to service based models	+ VC selective interest o Growth VC financing – Low revenues and very high competition – Grants often not fitting to service based models – Some markets already decided	o Late-VC/PE interest o Potential for (venture) debt products o No profitable companies yet; expected only after market consolidation	Relatively low financing available
b Low carbon highly energy efficient road vehicles, e-vehicles, e-vehicle batteries*	+ Grants available on national and EU level + Financing by OEMs/Tier-1 + Strong research & academia – Seed VC financing for EV & battery	+ OEM activity o Grants available but not sufficient for rapid growth – Low revenues in growth phase – Low availability of growth VC – Battery production in EU not cost competitive	+ Debt for profitable companies + Revenues from initial sales – Risk averse banks for unprofitable companies – Limited exit options	Relatively low financing available
c Automated road transport	+ Seed VCs very active + Financing by OEMs, Tech. companies and other corporate investors + Grants available – Lack of software engineers – Tech companies mostly non-EU	+ Strong VC interest + Financing by OEMs, Tech. companies, corporate investors + Moderate early revenues o Growth VC financing – Lack of big EU IT& SW companies and big EU growth VCs	+ VC/PE interest + Debt activities	Moderate-good financing conditions
	Good seed financing opportunities	Growth financing lacking	Good financing for profitable companies, difficult if unprofitable	

Figure 39 – Financing heat map by sector area (red=gap most acute; green=gap least acute; grey=moderate gap)

There is a financing gap in Europe, especially during the growth stage of Product Sales, Usage-Based Payment and Electricity Sales companies. From a sector perspective, the financing gap is especially critical for urban green mobility solutions and services as well as low carbon highly energy efficient road vehicles.

"We have a lack of VCs in Europe because we are lacking the big lighthouse examples of successful billion-dollar exits."
Manager Corporate VC

"There is a funding gap [in Europe] for tickets above 5m, for seed and early-stage financing it's better."
Manager Business Development Mobility Service Start-up

"For usage-based payment we see only very few companies these days being set-up. Most companies in the sector were founded 3-4 years ago and consolidation of the market already took place and is still ongoing. Investors are also afraid of Uber. There is a hesitation to invest in start-ups with business models that could compete with Uber."
Manager Business Development Mobility Service Start-up

"There is a significant funding gap in Europe especially in the growth segment. This means that companies have to either slow down their growth or look for investors from America or Asia. US companies are expanding their market shares in expense of their European competitors. This is especially true for shared mobility services."
Fund Manager VC

"We see a lack of growth funding in Europe for financing rounds above 10m."
Manager Venture Capital Market Matching Platform

3. There is a significant financing difference between Europe and the US, for equity and debt instruments

The previous chapters showed that innovation in the automotive and transportation industry is driven by a high number of start-ups next to the established players such as OEMs and suppliers. We also provided evidence that start-ups and SMEs are highly dependent on VC funding to scale their business quickly to be able to compete.

This study further identified the most acute financing gap across all business models in the growth phase. The growth phase relates to companies that have received seed and Series A financing and are aiming to scale up their business through additional funding rounds. These companies are referred to as "start-ups" in this chapter.

Against this background, the present chapter aims to provide a short overview of the financing situation of European start-ups compared to that of their US competitors. It also takes a quick glance at the funding situation of Asian and Israeli start-ups.

The EU-28 has an almost equal GDP size, a larger population and a larger automotive and transportation sector than the US. Despite that, the number of new automotive start-ups in Europe has lagged far behind that of the US. Only 29% of all new automotive start-ups are based in Europe compared to 52% in the US and 20% in Asia (see Figure 40 below).

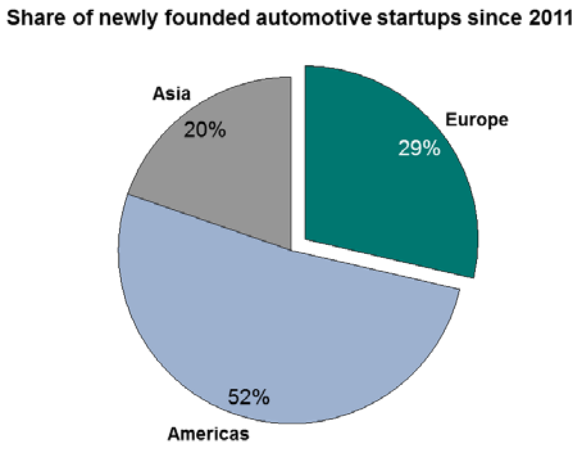


Figure 40 – Geographical distribution of new automotive start-ups[30]

European start-ups are also attracting less funding. Only 12% of global investments are targeting European companies, while those in Asia (30%) and America (59%) are securing far larger amounts (see Figure 41 below). This has significant implications for companies' ability to quickly grow and scale up. As shown in prior sections, most of the investments are going into mobility service companies where quick growth is essential to survive, capture market share and beat the competition. Combined with the legal and regulatory uncertainty in the European mobility services market (e.g. for ride-sharing), these are the main reasons why US and Asian companies have so far outperformed European peers in the mobility service sector.

[30] Source: Oliver Wyman press release January 2017, Crunchbase database 2016

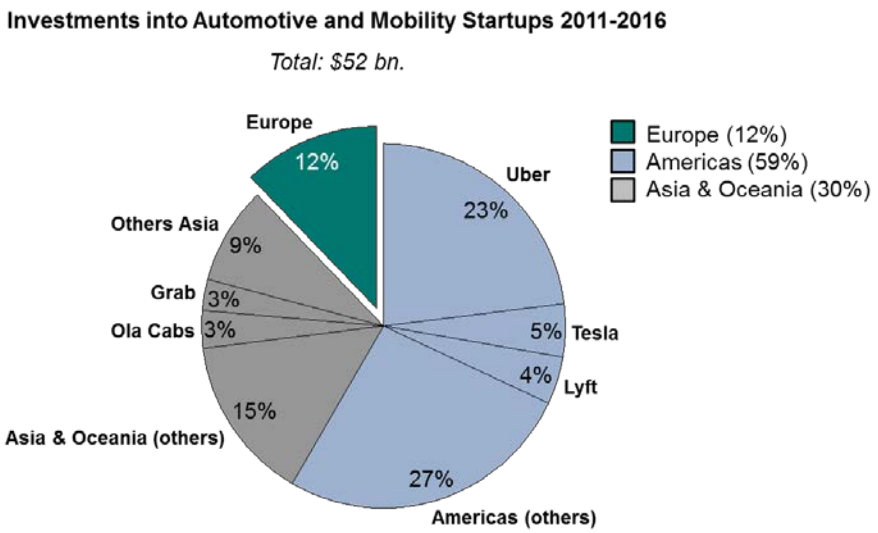


Figure 41 – Worldwide distribution of investments into automotive and mobility start-ups[31]

One of the main reasons for the lesser amount of money invested into European Innovative Transport companies is the less mature European venture capital scene compared to that of the US. This is not specific to Innovative Transport investors but spans across all industries. Total European VC funding was only about a quarter of US VC funding over the period from 2013 to 2015. Chinese VC funding also surpassed European funding in 2014. In addition, the median deal value in Europe is only about half of deal values in the US or China (see Figure 42 below).[32]

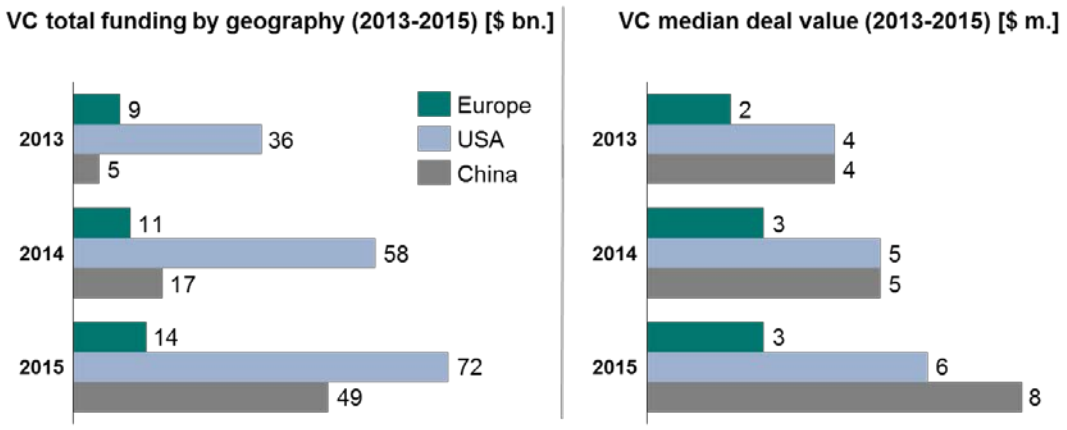


Figure 42 – VC funding and median deal value in Europe, US and China[32]

The considerable difference in the growth and late stage is also illustrated by Figure 43 below. Only 17% of all VC deals in Europe took part in growth stage financing rounds and 4% in the late stage. In the US, the share of growth stage and late stage deals is almost double. On the one hand, this points to a good availability of seed and early stage capital for European companies through several early stage VCs. On the other hand, the high discrepancy in the number of deals for the growth phase in Europe compared to the early stage illustrates the number of companies that are not able to secure growth financing. These

[31] Source: Crunchbase, CB Insights, Oliver Wyman

[32] Source: EY Global Venture Capital Trends 2015

companies either cease to exist or have to scale back their growth ambitions, and need to survive with smaller volumes of funding. In markets with network economics such as Mobility Services, where a first mover position is even more critical to gain and maintain than in standard industries, the difficulty in accessing growth financing severely jeopardises the survival of European companies.

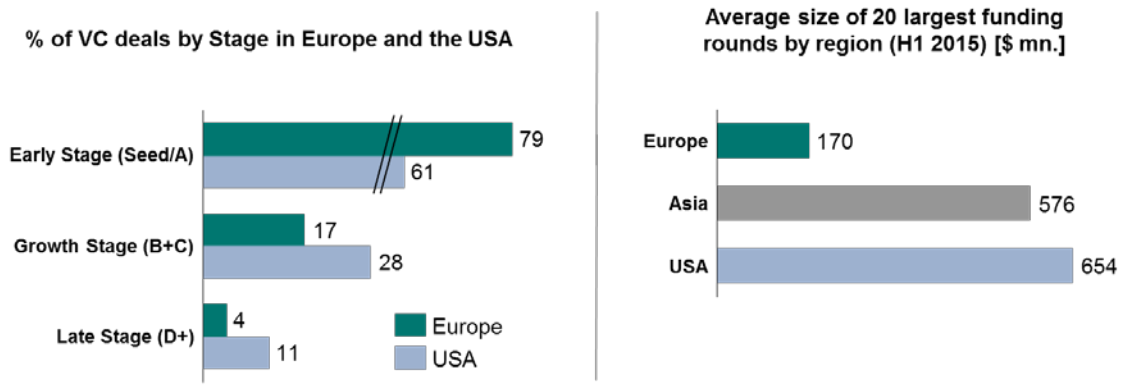


Figure 43 – Percentage of VC deals by stage (EU vs US) and average size of 20 largest funding rounds by region[33]

Another striking finding is that average funding rounds in Europe are far smaller than in other geographies. Analysing the size of the ten largest funding rounds by region reveals that the European average of $170m is only a third or a quarter of Asian or US funding rounds respectively. While these are findings from across all industries, the situation within automotive or Innovative Transport can be considered as the same or worse. As shown above, in Figure 37, the seven automotive start-ups receiving the most funding are all non-European.

With European VCs lagging behind in size and capital available, especially for growth and later stage companies, non-European investors from Asia and the US are increasing their investments into European companies. While European seed and early stage companies were usually able to secure financing from European investors (83%), the picture is completely different for later stage financing rounds. In these cases, 70% of all financing rounds for European companies have included non-European investors. In several cases, US investors that have secured large minority stakes in a company have demanded the companies move their headquarters and part of their operations to the US. For example, across all industries at least 289 Israeli start-ups are based in Manhattan with ride-sharing company Gett being one, as well as a further 100 Israeli start-ups in California.[34]

[33] Source: CB Insights Venture Report; Dow Jones VentureSource, Tech.eu

[34] http://www.officespacesny.com/israeli-tech-companies-nyc/

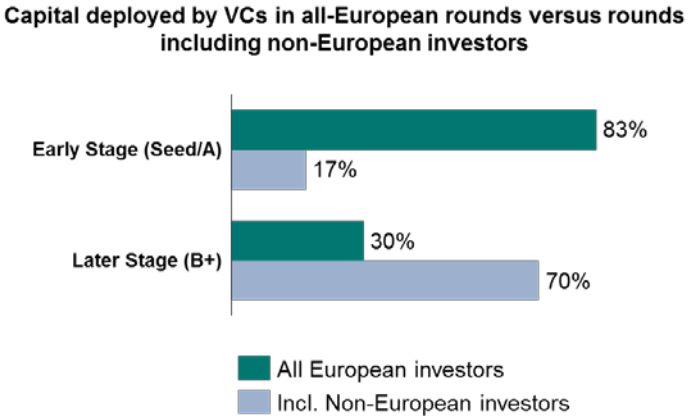


Figure 44 – Funding from European vs non-European investors[35]

The strong venture capital market in the US compared to Europe can also be observed in Figure 45. In the US, VC investments represent 0.33% of GDP. Meanwhile, the percentage of VC investments related to the GDP in European countries ranges from 0.001% (Italy) to 0.05% (Finland). The only exception is Israel (a Horizon 2020 associated country) with 0.38% VC investments in relation to GDP. Another notable point is that VC investments in later stages are higher than in early stages in the US. In almost all European countries except the UK, Sweden and Austria, the situation is reversed. Moreover, the percentage of VC investments related to GDP are below average in Eastern and Southern European countries.

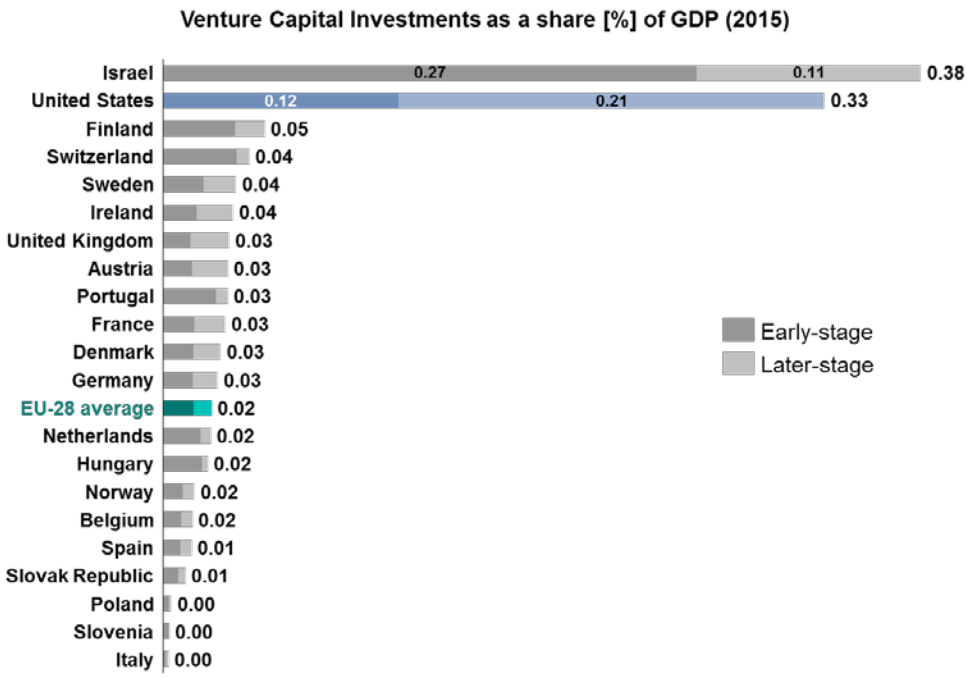


Figure 45 – VC investments as % of the GDP[36]

The difference between funding in Europe and the US – as well as the existence of a financing gap for European start-ups and SMEs – was also thoroughly analysed in a joint study conducted by EDHEC, Tilburg University, VU University Amsterdam and the University of Amsterdam in 2015. The study identified the financing gaps for SMEs across all industries in France, Germany, the Netherlands, Poland, Romania and

[35] Source: Dow Jones VentureSource, Tech.eu

[36] Source: "Entrepreneurship at a glance 2016", OECD

the US. The authors also differentiated between the equity and debt gap in the respective countries. The results in Figure 46 show that the debt financing gap differs greatly between Europe and the US and also between the respective European Member States. Overall, the debt financing gap in Europe is approximately double that of the US.

Startup and SME debt gap					
USA	Germany	France	Netherlands	Poland	Romania
1.1% to 2.3%	2.7% to 6.0%	3.4% to 5.2%	6.0% to 16.3%	5.0% to 14.7%	1.4% to 4.0%

Figure 46 -– Range of the debt financing gap for start-ups and SMEs in Europe and the US as a percentage of GDP[37]

Finding Box

(37) The European automotive sector is lagging behind the US in terms of number of start-ups and early-stage companies, the total financing dedicated to these companies, the size of the average financing rounds, the number and size of VCs, total investments by VCs and the number of deals.

(38) Apart from the equity gap there is also a significant debt financing gap in Europe that is more than double that of the US.

Reasons for the equity financing difference between Europe and the US

Multiple reasons are behind the differences between the European and US VC markets:

1) **Different maturity of VC sectors** – The "modern" venture capital industry started in the US in the 1970s and was helped along by the 1978 "prudent man rule" that enabled corporate pension funds to invest in private equity.[38] The European private equity sector has since lagged behind the US industry and can be considered as less mature.

2) **Different performance of VC markets** – Historically, the average performance of European VC funds has achieved returns of negative 4% versus 16% in the US on average from the beginning of the 1980s to 2003. This has resulted in a slower growth of European VCs[39] and, due to government interventions, differences in the external environments and specific company characteristics.[40]

3) **Different exit options** – Europe does not have as deep and liquid capital markets as the US. Several markets aiming at young companies introduced in Europe over recent decades – such as the German Neuer Markt, the French Nouveau Marche, the British Techmark or the EASDAQ in Brussels – have either shut down or failed to attract significant capital. This has resulted in European companies preferring to seek trade sales over IPOs.[41] Consequently, investors might be more reluctant to invest due to a more restricted choice of plausible exit routes.[42]

[37] "The European Capital Markets Study – Estimating the Financing Gaps of SMEs", EDHEC, Tilburg University, VU University Amsterdam, University of Amsterdam, 2015

[38] "Boom Time in Venture Capital", Taylor, Alexander L., TIME magazine, Aug. 10, 1981

[39] "Assessing the Contribution of Venture Capital to Innovation", Lerner & Kortum

[40] "Venture capital firms in Europe vs. America: The under performers", Iveybusinessjournal.com;

[41] Initial Public Offering

[42] "The Performance and Prospects of European Venture Capital", EIF

4) **Different distribution of available funding** – The average ticket sizes and funding rounds are significantly lower in Europe than in the US. There is evidence that VC-backed firms that receive too little investment perform worse than innovative companies that are trying to grow their business without VC investments.[43]

5) **Different background of European VC managers** – VC managers in the US are often former entrepreneurs while European VC managers typically have a financial rather than a business background. This might mean that they are less able to identify investments with high potential and are less able to understand the needs of an entrepreneur.[44] Moreover, US VCs seem to be specialised by sector or technology more often, making them more sophisticated in their investment selection processes.[45]

6) **Different labour markets** – US universities such as Stanford, MIT and Harvard are much more focused on producing entrepreneurs and support them with seed funding and other instruments. In addition, potential European entrepreneurs might face higher opportunity costs in giving up secure, well-paying jobs and social security systems. Especially in automotive, freshly graduated engineers and software developers in Europe are recruited by the big OEMs and suppliers to pursue a career with them.

7) **Different institutional environment** – The institutional environment in Europe might be less entrepreneur-friendly when looking at barriers to entrepreneurs (delays, fixed costs and labour markets), bankruptcy and taxation regimes.

8) **Different venture capital ecosystem** – Unlike the US and its Silicon Valley, there is no clear start-up hub in Europe where automotive, mobility, technology and finance come together to network. There are a couple of hubs with a strong financial presence (London, the Netherlands) or a strong automotive sector (Southern Germany) but having demand side and supply side in one place is generally rare.

Reasons for the debt financing difference between Europe and the US

Similar to the equity financing difference between Europe and the US, a multitude of reasons are behind the debt financing gap:

1) **Different bank regulatory environments** – European bank regulation is tighter than in the US, especially after the introduction of new rules following the financial crisis in the form of Basel III and the Capital Requirements Directive IV package. Regulation is intended to strengthen bank capital requirements by increasing liquidity and decreasing leverage.[46] This also means that European banks have a limited ability to lend to businesses with a higher risk-reward ratio, such as Innovative Transport start-ups and SMEs.

2) **Different impact of the financial crisis** – The financial crisis following the Lehman collapse is still being felt in the European banking sector. While US banks have generally recovered with strengthened balance sheets, the average equity ratio in the European banking sector fell to 5.4% in 2016. Since the crisis began in 2008, the ten biggest US banks have increased their equity capital by 170%, while European institutes only managed to increase it by 55%.[47] In addition, following the

[43] "The Impact of VC on the Growth of Firms", Clarysse and Heirman, 2007

[44] "What Role of Legal Systems in Financial Intermediation?", Bottazzi, Da Rin and Hellman, 2004

[45] "Venture Capital Performance: The Disparity Between Europe and the United States", Hege, Palomino and Schweinbacher, 2009

[46] "Group of Governors and Heads of Supervision announces higher global minimum capital standards", Basel Committee on Banking Supervision. 12 September 2010

[47] http://www.manager-magazin.de/unternehmen/banken/us-banken-und-europas-banken-im-vergleich-a-1112973.html; Ernst & Young study

euro-crisis, Southern European banks in particular are suffering from non-performing loans that are restricting their capacity to issue fresh loans to the industry.

3) **Different capital market structures** – The European banking sector consists largely of national banks operating primarily within their home countries. In addition, numerous local and regional banks have built established networks with companies close by. Companies in Europe are therefore focusing more on bank lending for their financing, often with long-term partner banks, rather than on capital markets. In Europe, established companies rely much more on banks for their refinancing with about 80% of corporate debt coming from bank lending and 20% from the corporate bonds market. In the US, this ratio is reversed.[48] Across all industry sectors, this results in a shortage of more than $1 trillion in what European companies are raising annually on the bond markets as compared to the US.[48]

4) **Different prevalence of venture debt in the US vs EU** – Venture debt originated in the US in the 1960s and only came to Europe in the late 1990s through the firm European Venture Partners (now Kreos Capital).[49] More recently, the EIB has developed a venture debt instrument under the European Fund for Strategic Investments (EFSI). However, the venture debt market in Europe is significantly less mature and smaller in size than in the US. This means that a financial instrument destined at filling the gap between the first series of equity financing and the profit phase when companies can reasonably start to access standard bank debt was made available late – and is still only available on a small scale – for European companies.

Finding Box

(39) There are several reasons for the lower equity financing in the European Innovative Transport sector compared to the US: different maturity of the VC sector, performance of VC markets, exit options, spread of available funding and background of European VC managers, sources of fundraising, labour markets, institutional environment and venture capital ecosystem.

(40) The reasons for the debt gap originate from differences in the bank regulatory environment, the impact of the financial crisis, market environments, corporate funding structures and the prevalence of venture debt in the US.

[48] http://openmarkets.cmegroup.com/10431/how-u-s-and-eu-capital-markets-are-different

[49] "The rise of venture debt in Europe", bvca, 2013

"It's much easier for American companies to get funding, Europe is very conservative and risk averse."
Head of Strategy Corporate VC

"Financing is much better for US companies. We have just recently seen an American SME that is developing electric buses receiving 140m. In Germany we see lots of good companies not receiving sufficient funding."
Partner VC

"Europe's VC landscape is scattered with small VCs and only a few bigger ones. The small VCs can't risk investing in more than one deep-tech company duet or portfolio diversification. Growth financing with ticket sizes above 2m is hard to secure in Europe. If there is no digital business model, many VCs are restricted in their investment."
Head of Europe at an American Mobility Start-up

"In Europe it's much harder to get financing. For the seed phase it is not that big of a problem but it is really hard to receive enough money to grow and scale up."
Head of Europe of an American Mobility Start-up

"It would be much easier to get money in the USA. Within a short time we could collect more money over there than in Europe or Italy specifically in ten years."
Manager Venture Capital Market Matching Platform

"For our last big financing round we were unable to find any investors from Europe, they just weren't interested. Some told us that we would need to move away from our home country. We ended up getting financing from a Chinese investor."
CFO Electric Vehicle Start-up

4. The total financing gap in European Innovative Transport is estimated in the range of approximately €5.5bn to €13bn

Placing the Innovative Road Transport market in context

In order to understand the funding gap for players in the Innovative Transport market it is important to put any gap in the context of the size of the total Transport Market, valued at €4 258bn in 2016.

Within the total Transport Market, Innovative Transport was valued at €490bn in 2016 and received some €32bn of equity investment globally (see Figure 36). This represents a ~6-7% investment rate globally, which would be at the lower end of investment rates for high-tech markets. Compared to the 4% investment rate on revenues in the traditional transport markets, there is a step change in funding demand for Innovative Transport companies.

Over the next 13 years (to 2030), the Innovative Transport market is expected to grow to a volume of €3 460bn (Figure 47) and investments will likely hold at the current level of a high single digit share of market value. By 2030, we can anticipate investment demand of around €240bn in a much faster-moving environment[50].

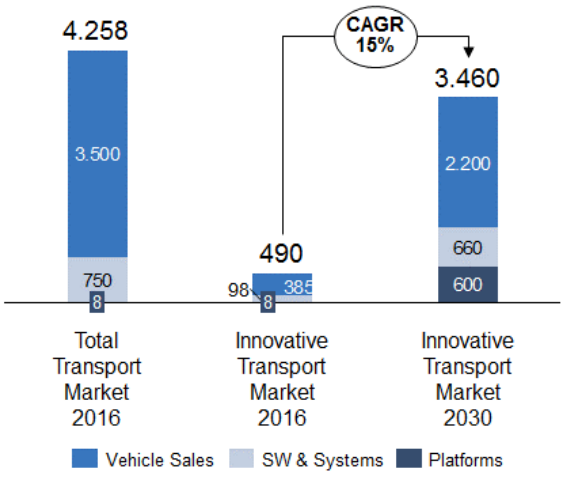


Figure 47 – Placing the Innovative Road Transport market in context

This triggers two questions:

- What is the current funding gap?
- What is the future funding gap for supporting the growth of Innovative Transport businesses at world-class level in Europe?

Methodology

The concept of a "funding gap" will inevitably be open to interpretation across the different stakeholders. The methodology adopted for this study is therefore to address the two critical questions above directly. For the purposes of this study, the first question is critical for the access-to-finance challenges currently facing Innovative Transport companies. However, the authors urge the European institutions to consider the issues presented by the second question in order to make sure that Europe provides the most attractive environment possible for Innovative Transport companies.

However, the figures presented below remain rough estimates meant to provide further insights into the sector and guide future policymaking. The rapid growth in the sector and the variety of available funding mechanisms means that it is difficult to establish an accurate estimate and a number of proxy measurements are therefore used.

Methodology – What is the current funding gap?

Based on the qualitative response from Innovative Transport companies in the report's survey, there is clearly demand for funding that is currently not being met by the existing market. In order to quantify the gap

[50] Assumes a 7% investment rate, which would be low for a high-technology industry

between supply and demand in the EU, it is difficult to place a value on the "absolute" funding gap – this would require a more extensive, bottom-up statistical analysis of Innovative Transport companies to understand their business plans, funding needs and what instruments they were able to access in the market.[51] Instead, in order to provide an approximation, this study looks at the "relative" funding gap – the difference between what the current EU funding market provides compared to a more attractive market, in this case the US. For simplicity, the study refers to this relative gap as the **direct funding gap**.

To quantify the direct funding gap, this study used the financing that is dedicated to US Innovative Transport start-ups and SMEs as a baseline for both equity and debt financing. The financing gap in European Innovative Transport is multi-faceted and consists of an equity component ("equity gap") and several sub-components as well as a debt component ("debt gap"). For the equity gap, two sub-components are considered (see Figure 48 below):

1) Financing rounds in European Innovative Transport are on average less than half US volumes
2) IPO exits are less attractive in Europe as there are twice as many in the US, with a 48% higher valuation on average

In addition, previous studies[37] point to a debt gap in Europe that is more than double that in the US economy.

One could also argue for an additional gap component as the number of new automotive start-ups since 2000 is significantly lower in the EU (462 companies) than in the US (1 118 companies)[52] even though the GDP of both geographies is comparable and the automotive industry in the EU is larger than in the US. However, this seems to be due to multiple structural reasons (environment, education, labour market, entrepreneurial spirit, start-up ecosystem and opportunity costs) and cannot be causally linked to a lack of financing in the automotive start-up sector. Thus, in the context of this study the lesser number of start-ups is considered as a "soft gap" that will neither be quantified nor added to the overall gap.

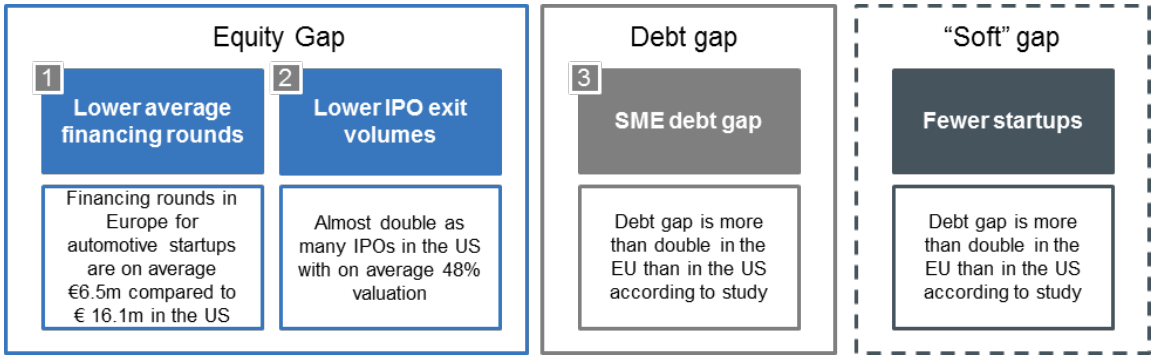


Figure 48 – Approach to calculating the financing gap in European Innovative Transport[53]

Quantifying the equity financing gap

The range of the total equity financing gap in European Innovative Transport is derived by combining the two sub-components of the gap and comparing them to the financing dedicated to US start-ups and SMEs. For the purpose of the estimations, the most recent figures available for the automotive or Innovative Transport

[51] An example of such bottom-up estimation in the Innovative Transport sector is provided in "Clean Power for Transport Infrastructure Deployment", 14 March 2017, by EC DG for Mobility and Transport and Steer Davies Gleave, where previous research by the EC analysed the investments needed on the TEN-T and its urban nodes for charging, and found an estimated CAPEX investment need for all types of energy (electricity, gas and hydrogen) of an additional €1.7bn.

[52] Source: Crunchbase and CB Insights databases, Oliver Wyman press release (2017)

[53] Source: IMF, EC, selectUSA, ACEA, EDHEC, PwC, OW, EY, PA Consulting

sector have been applied while also looking at previous years to avoid misinterpreting potential one-time effects. Figure 49 below gives an overview on the approach and results for each equity gap sub-component. Overall, this study estimates the equity financing gap in European Innovative Transport at €2.1bn to €4.9bn annually.

Quantifying the direct equity gap

Gap sub-component	Description	Approach to quantify	Resulting annual gap range [€ billion]
1 Lower average financing rounds	Financing rounds in Europe for automotive start-ups are on average €6.5m compared to €16.1m in the US (median €2.5m vs €6m)	Multiplying the number of European automotive startups (462) with the difference in median (€3.5m) / average (€9.6m) funding	1.6 – 4.4
2 Lower IPO exit volumes	Total IPO volumes across all industries in the US (€23.9bn) much higher than in the EU (€7.9bn 2013-2015)	Assumption that 3.5% of the GDP in the US is dedicated to automotive and 4% in the EU and that the IPO volumes are proportionate results in €0.8bn automotive IPOs in the US vs €0.3bn in the EU	0.5
		Sum	2.1 – 4.9

Figure 49 – Quantifying the equity gap

Commentary on the lower average financing rounds

European start-ups are particularly disadvantaged with regard to financing rounds, attracting significantly less funding than US competitors, as is clear from the median and average funding provided (median in US €6m vs €2.5m in EU; average in US €16.1m vs €6.5m in EU). The large difference between median and average values can be attributed to the exceptionally large funding rounds at the top-end for companies such as Uber and Blablacar vs a long tail of much smaller funding rounds. The difference in median funding (€3.5m) between EU and US funding rounds and the difference in average funding (€9.6m) indicates a significant addressable demand from EU Innovative Transport companies that is not being satisfied (on the assumption that European companies are of equivalent value in their innovation). There are, approximately, 462 innovative European automotive start-ups created every year. If those companies were to attract only the median funding in each financing round, they would be funded by €3.5m less than US equivalents or €1.6bn annually. If they attracted the average funding in each financing round, they would be funded €9.6m less than US equivalents or €4.4bn annually. This gives a shortfall of equity funding of €1.6bn – €4.4bn annually – in comparison to US equivalents.

Commentary on the lower IPO exit volumes

The value of IPOs (Initial Public Offerings) in the US is significantly higher than in the EU. This study considers that the attractiveness of the US market for investors puts the EU market at a disadvantage and consequently provides less access to funding for EU companies. At the macro level, total IPO volumes across all industries in the US are €23.9bn annually, which is significantly higher than in the EU (€7.9bn annually). The study assumes that 3.5% of GDP in the US is dedicated to automotive and 4% in the EU. That means that €0.8bn of IPO funding flows to US automotive companies annually whilst €0.3bn flows to EU automotive companies annually, which suggests a gap of €0.5bn.

Quantifying the debt financing gap

To quantify the debt financing gap, this study followed the approach and results of the "European Capital Markets Study"[54] that was based on a methodology applied by a previous EIB study[55]. The European Capital Markets Study focused on quantifying the debt and equity financing gaps of SMEs in the US, France, Germany, the Netherlands, Poland and Romania (see Figure 46). The methodology of the study for calculating the debt gap can be briefly summarised as combining the supply and demand for debt:

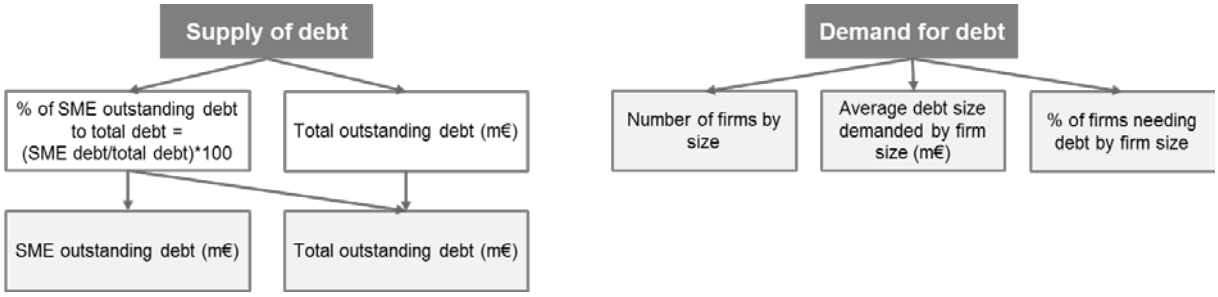


Figure 50 – Methodology for calculating the debt gap[37]

The calculation of the debt gap in the European Capital Market Study includes data on different sizes of obtained compared to desired debt funding. In addition, the study estimated the debt demand of those firms that applied for but were rejected for debt. For more details on the sources of data and methodology for calculating the debt gap please consult the European Capital Markets Study.

For the purposes of this calculation, as about half of the European automotive industry is based in Germany and to get a more conservative estimate of the debt gap, the range of the estimated debt gap in Germany was applied to the whole EU. This gap is still more than double that in the US. As the figures from the European Capital Markets Study covered all industries, this study broke them down to the automotive and more specifically to the Innovative Transport sector. Please refer to the table below for more details on the calculations.

[54] "The European Capital Markets Study – Estimating the Financing Gaps of SMEs", EDHEC, Tilburg University, VU University Amsterdam, University of Amsterdam, 2015

[55] "Private Sector Financing and the Role of Risk-Bearing Instruments", European Investment Bank (EIB), 2013

Quantifying the debt gap			
Gap sub-component	**Description**	**Approach to quantify**	**Resulting annual gap range [€ billion]**
5 SME debt gap	Debt gap is more than double as high in the US according to the "European Capital Markets Study". As Germany is responsible for about half of the European automotive industry, German debt gap figures of 2.7% to 6.0% of GDP are applied and broken down to the automotive and then innovative transport sector and compared to the US debt gap.	Assumption that 3.5% of the GDP in the US is dedicated to automotive and 4% in the EU and that the debt gaps correlate with that. A further assumption is made that 35% of the automotive gap is related to innovative transport. This results in a range of €5.7bn to €12.7bn for the innovative transport debt gap in the EU vs a range of €2.2bn to €4.6bn in the USA.	3.5 – 8.1
		Sum	3.5 – 8.1

Figure 51 – Quantifying the debt gap

Finding Box

(41) The equity gap is estimated in an approximate range of €2.1bn to €4.9bn annually and constitutes two main elements: lower average financing rounds and lower IPO exit volumes.

(42) The debt gap is estimated in an approximate range of €3.5bn to €8.1bn annually for start-ups and SMEs.

(43) The annual financing gap in European Innovative Transport is **estimated in a range between €5.5bn and €13bn.**

Breaking this gap down to the three sectors of Innovative Transport is not easily done due to the lack of more granular data and information. However, combining this estimate with the qualitative assessment of Figure 39, the majority of the financing gap seems to be attributable to urban green mobility solutions and services as well as to low carbon highly energy efficient road vehicles.

For urban mobility solutions, this is evidenced through the investments observed into such companies outside of Europe. American and Asian start-ups Uber, Lyft, Didi Chuxing, Ola and Grab alone received almost half of all the investments dedicated to Innovative Transport start-ups globally.

For low carbon highly energy efficient road vehicles, this is evidenced by the high amount of incentives and grants for the Chinese electric vehicle sector as well as much higher sales volumes of EVs outside Europe. The battery market is also clearly dominated by Asian companies and Tesla. The distribution of charging infrastructure in Europe is lagging behind the US, with the market leader in the charging segment – US-based Chargepoint – having collected about $250m of funding (also from European OEMs).

For automated road transport, the financing gap is considered not to be as significant with European automotive players, IT & software companies as well as VCs investing heavily in this space. In Europe, this sub-sector is rather held back by policy, legal and regulatory uncertainty rather than financing.

Case study – funding required for Electric Vehicle charging points

Based on a recent Transport for London (TfL) report, London needs to provide 700 rapid charging points by 2020. London is currently estimated to have 10% of all the current Ultra-Low Emission Vehicles (ULEV) in the UK – this corresponds to 10 000 cars at present, projected to grow to 40 000 by 2020 and 150 000 by 2025 (mid-case).[56] Extrapolating the number of electric vehicles in London to across the UK provides estimates of 400 000 by 2020 and 1.5m by 2025. The number of charging points probably does not scale directly, so 22 000 by 2020 and 33 000 by 2025 can be assumed.

The TfL study provides an estimated cost of £200 – £500 for each on-street EV charging point. OLEV provides funding for up to £7 500 at 75% funding, meaning that funding for £10 000 is available for each charging point. The range of £500 – £10 000 is too large to be useful, and so the study assumes a mid-point of £5 000 per charging point, noting that there will be economy of scale if the charging points are treated as a single infrastructure project, rather than being installed one at a time.

The number of cars in the UK is currently 32m, and across the EU is 256m. On the assumption that the number of charging points does scale with the number of cars as in the UK, then the number of charging points required in the EU is estimated to be 176 000 by 2020 and 264 000 by 2025. At £5 000 (€5,600) per charging point, this provides an estimated total investment of €986m to install the required 176 000 additional charging points by 2025, or €140m per year for the next seven years.

[56] The Office for Low Emission Vehicles (OLEV) provides a similar benchmark of 100 000 electric cars in the UK, with 11 000 EV charging points

SECTION IV –Nine Key Recommendations are Proposed to Address the Gaps Identified

As a result of the analysis and market consultation carried out as part of this study, a set of recommendations were developed to address the financing gap and further barriers to innovation and access to finance in European Innovative Transport. Recommendations 1 to 6 are aimed directly at the respective sub-segments of the Innovative Transport sector while Recommendations 7, 8 and 9 apply across the board.

SUMMARY BOX

1. In the field of urban green mobility solutions and services

Mobility solutions and services are today mostly dominated by non-European start-ups. This is mainly due to: 1) better access to equity financing for non-European companies (see Uber, Lyft, Didi) and 2) more difficulties in scaling up in Europe due to heterogeneous markets with regards to policies, legislation and regulation. As we have seen in the previous section, the sector attracts the selective interest of VC. Grants would be helpful but are available only to a lesser extent due to the service-based nature of most of these businesses.

1.1. RECOMMENDATION 1: Incentivise Public Transport Operators (PTO/As) to open up to third party digital mobility platforms

1.2. RECOMMENDATION 2: Introduce clear and standardized EU-wide definition and regulation of mobility services

1.3. RECOMMENDATION 3: Tailor grants for fast growing service companies

2. In the field of low carbon highly energy efficient road vehicles

The aim of the following two recommendations is to increase the uptake of alternative fuel vehicles in public and private fleets by improving the economics of a segment where the access to finance challenge is most acute and where the social and economic impact is arguably most relevant.

2.1. RECOMMENDATION 4: Support the build-up of charging infrastructure through blending grants with flexible (soft) debt financing

2.2. RECOMMENDATION 5: Provide financial support to the uptake of alternative fuels in public fleets and the related value chain

3. In the field of automated road transport

Within automated road transport, this study found that uncertainty with regard to policies, regulation and liability are the key challenges for companies developing such technologies, rather than access to financing.

3.1. RECOMMENDATION 6: Align and amend European policies and legislation on autonomous driving and push for a technology friendly testing environment

Across the three sectors:

4. RECOMMENDATION 7: Support and enhance ecosystems of existing and emerging mobility hubs
5. RECOMMENDATION 8: Address the growth phase financing gap by supporting dedicated Innovative Transport or multi-corporate funds
6. RECOMMENDATION 9: Raise awareness on existing EC-EIB financing instruments

Figure 52 below maps the recommendations across the criteria of cost, time and ease of implementation vs potential impact. The upper right part of the matrix thus points out the recommendations that are by comparison expected to be easier in effort and more cost-effective to implement, while the bottom left part

includes recommendations that need to be implemented over a longer period of time with substantial effort and related costs.

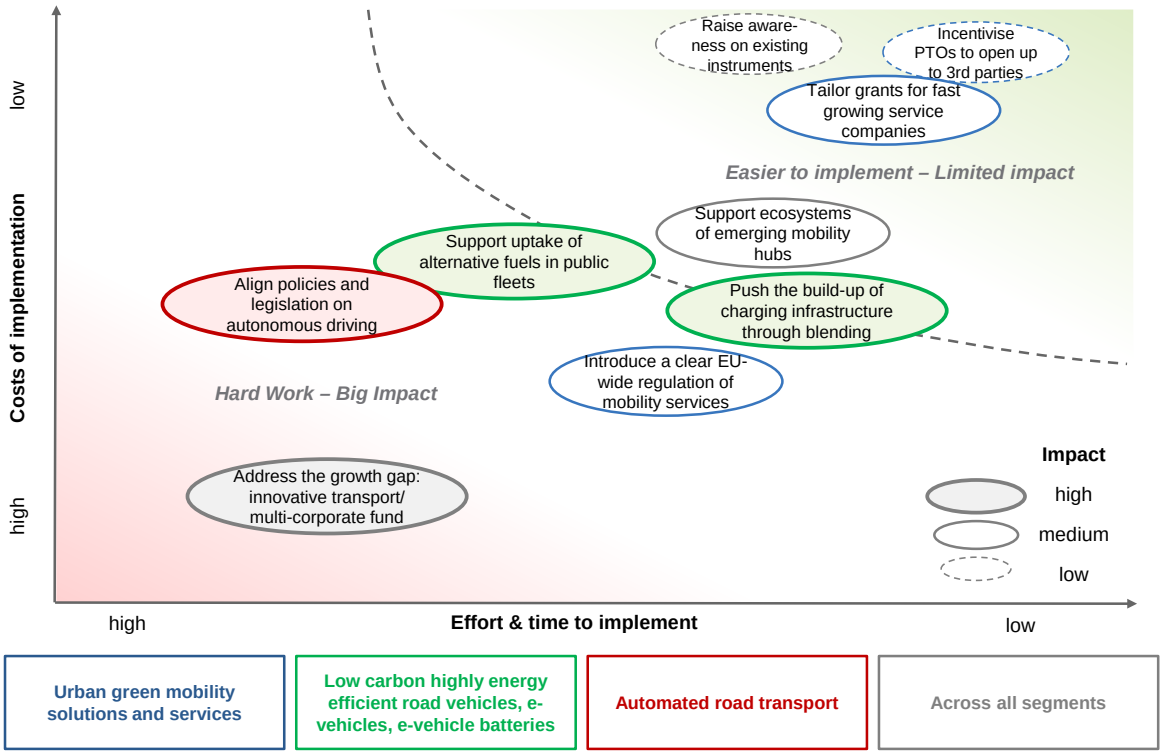
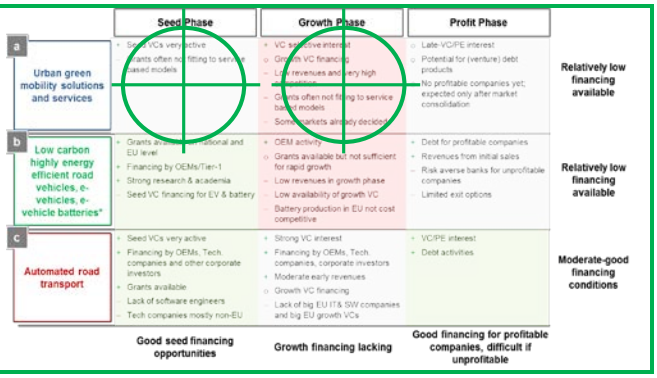


Figure 52 – Assessment of costs, ease and time of implementation vs potential impact of recommendations

Considering the ambition of supporting the acceleration and take-up of clean and sustainable transport solutions and technologies, the proposed actions should not be seen in isolation, but rather complementary and synergetic when designing an implementation plan. The guiding principle behind the recommendations is that European Institutions are well-placed to facilitate the transition to sustainable mobility, by designing or refocusing financing instruments and by promoting a friendly regulatory and policy environment, particularly in areas where European companies could have a competitive edge. Considering the challenge ahead, priority should be given to the most impactful actions, which could, however, be piloted in specific technology areas or geographies.

RECOMMENDATION 1: Incentivise Public Transport Operators (PTOs) and Authorities (PTAs) to open up to third party digital mobility platforms

- ➔ *This is a policy recommendation strongly affecting the viability of a specific business model and therefore with strong financial implications*
- ➔ *Targeting the (seed and) growth phase of a specific mobility solution business model, where Europe could have a distinct competitive edge*



Rationale: In theory, **Europe has a global advantage compared to other geographies when it comes to alternative mobility to private car ownership**. Almost every mid-size to large European city has a comprehensive and dense public transport network that is mostly operated by local PTOs. This is a key prerequisite for having mobility available everywhere and at all times without owning a car. Integrating existing public transport offers with alternative means such as bike, car or ride-sharing would enable users to access mobility on demand. By integrating means of transport into one journey planning and booking platform that may also offer mobility flat-rates, people would have an incentive to switch away from private car ownership. Some examples of such mobility platforms and concepts are Whim, UbiGo and Quixxit.

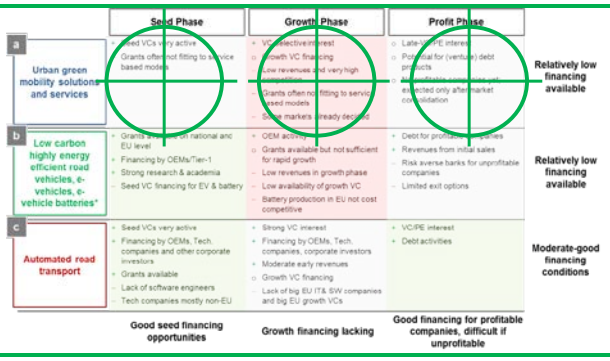
In practice, such multimodal platforms are facing a challenge in Europe when it comes to integrating public transportation on a European, national or even municipal level. This is because PTO/As are generally not willing to open up to third party mobility platforms that are trying to integrate journey planning and booking across several modes of transport.

Recommendation: The introduction of new mobility concepts integrating different means of transport to replace private car ownership requires the full determination of municipal, national and European governments. The European Commission should work with national governments and strive **to harmonise laws and regulations covering different means of transportation and to ensure that the public transportation companies are opening up to new mobility concepts**. Open data access and standardised interfaces (APIs) for public and private mobility offerings are a necessary prerequisite to integrating different means of transport as well as public transportation. This would be convenient for the user as well as easily scalable for digital mobility platforms. Data access would need to include not only schedules and real-time location data but also access to payment systems.

Examples: Some best practice examples already exist, e.g. in **Helsinki where laws are adapted to the need of mobility platforms and public and private transport providers are cooperating to integrate all means of transport.** Another example would be Transport for London (TfL) opening up its data interfaces to third parties, although access to booking systems is not yet permitted.

RECOMMENDATION 2: Introduce a clear and standardised EU-wide definition and regulation of mobility services

➔ *Policy recommendation with strong financial implications affecting the whole market of mobility services and the growth potential of companies operating therein*



Rationale: Mobility services such as ride-sharing are a relatively new trend and, as such, **a European-wide definition and regulation is not yet in place**. Moreover, the current state of ride-sharing differs widely between the European Member States and regulation of such services is subject to controversial discussion. While some Member States such as Estonia, the Netherlands and other markets like Warsaw are welcoming ride-sharing as a business model and alternative mobility option, the service is banned or restricted in most European countries such as France, Spain and Germany. Bans and restrictions often followed strong protests from incumbent taxi operators (e.g. in Madrid, London, Paris, Barcelona, Berlin…) that felt threatened by the new competition through ride-sharing companies.

One of the controversies around ride-sharing at the moment is whether it should be considered as a transportation company or as a digital service that connects demand and supply. Similar issues apply to other mobility services. This has a significant impact on how companies offering these services would be treated legally in the EU. As a digital service, ride-sharing would "benefit from the freedom of establishment for service providers and the free movement of services as provided for in the Services Directive 2006/123/EC and the TFEU". As a transportation company it would be regulated at Member State level.

Other disputes revolve around, for example, whether using a smartphone to track the journey and set fares is equal to operating a meter (London); if ride-sharing drivers are employees or self-employed partners (Germany); if the minimum wage is applicable to ride-sharing drivers; and if a company should be allowed to run services locally while channelling tax payments elsewhere. Another important point that requires a clear definition is the difference between short-distance ride-sharing such as Uber and long-distance ride-pooling such as Blablacar (Uber drivers drive as a profession to make a profit, Blablacar rides are offered on a cost-sharing basis, which is why they can operate without major restrictions).

> *"We have a high level of regulatory fragmentation in Europe. This means a high level of effort for companies looking to expand. We really see the need for a Europe-wide definition and legal framework for car-sharing and car-pooling."*
> **CEO Mobility Start-up**

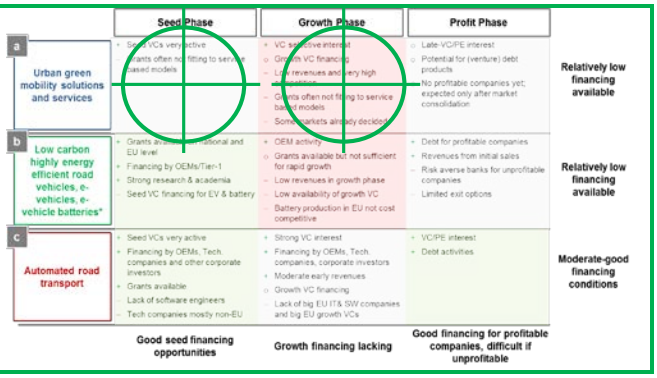
Recommendation: **As a first step, a clear Europe-wide definition of the different mobility services such as ride-sharing, ride-pooling, car-sharing and others is necessary**. Even within ride-sharing, several different variations can be observed in the market as illustrated by the many services Uber is offering: UberX, UberXL, UberSelect, UberPop, UberPool, UberBlack. **A common definition** would be a good baseline to further discuss how these services should be treated from a regulatory standpoint. The European Commission has already initiated several discussions around mobility and other shared services such as the "European Agenda for the Collaborative economy" where it states that the "absolute bans and quantitative restrictions should only be used as a measure of last resort".

Examples: **A Europe-wide regulation could be introduced similar to the Estonian law on ride-sharing** where digital platforms are required to meet certain standards on transparency and safety while also lowering barriers for incumbent taxi operators to allow for fair competition. In addition, taxes on the rides would be automatically paid through an electronic tax system by the drivers.

Other mobility services could also be supported in their growth through removing regulatory barriers**. A good example for this is the car-sharing law in Germany that allows municipalities to offer free parking to shared vehicles or to declare dedicated parking areas**. This would significantly lower operating costs for car-sharing companies and allow for faster growth of the services. In addition, it could also be combined in the future with requirements obliging car-sharing fleets to introduce more alternative fuel vehicles or incentivising car-sharing companies to offer more cars around important transport nodes to better integrate with other modes of transport.

RECOMMENDATION 3: Tailor grants for fast growing service companies

➔ *Financial recommendation targeting the fast growing segment of mobility services*



Rationale: The selection criteria for (European and national) public support and grant programmes are often not geared towards development of services but rather more focused on physical products and technologies. Furthermore, such programmes are often inflexible vis-à-vis the ambitious growth and regularly changing business models of mobility service companies.

This is also supported by the fact that only 50% of the Usage-Based Payment companies in the interview sample use grants compared to 83% of the Product Sales companies.

"We avoid taking part in EU or Horizon 2020 projects because they are too slow and not flexible enough. They do not fit with our rapid growth ambitions."
CFO Mobility Service Start-up

"EU programmes and grants are focused on technology and products. It's hard to get funding as a mobility service company."
Head of Research Network

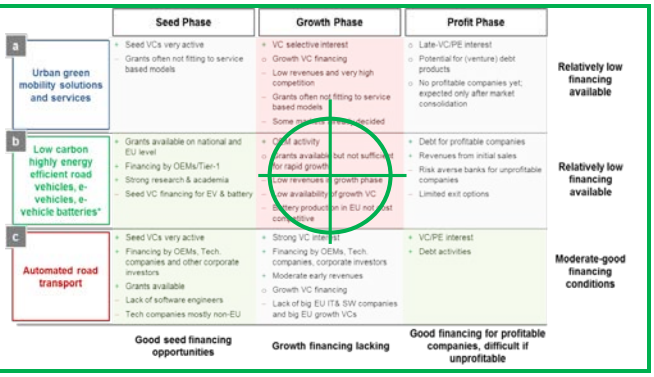
Recommendation: Mobility service companies should be supported in their early stages of development through **grant programmes that are focused on services rather than products or technology**. It is understood that in the context of the European Innovation Council, existing restrictions on the grant allocation process of H2020's SME Instrument will be removed, which is a welcome development. It is also critical that the grants are designed on **flexible terms with regards to the outcome of the project**. Mobility service companies in particular are operating in an ever-changing and dynamic environment and often need to modify and adapt their business models or mode of operation accordingly and within a short period of time to react to market feedback and competition.

Furthermore, considering the dynamism of this segment, grants targeting such service companies could be structured as a **contingent convertible instrument, allowing the grant provider to benefit from the upside in case of success** (the grant would be converted into common equity if an agreed milestone were successfully achieved).

Examples: Contingent public grants have been successfully implemented outside of Europe, e.g. in Israel since the early 1990s or in the US Small Business Administration.

RECOMMENDATION 4: Support the build-up of charging infrastructure through blending grants with flexible (soft) debt financing

- ➔ *Financial recommendation targeting the uptake of alternative fuels via a set of support actions towards infrastructure operators*
- ➔ *Based on this study, this is the area where the access-to-finance challenge is most acute and where arguably the highest societal and environmental impact is potentially achieved*



Rationale: Of the technologies and solutions in scope of this study, **alternative fuel infrastructure was identified as one of the areas needing the most financing support**. A combination of uncertainty about the adoption of alternative fuel vehicles and poor economics in the early years of operation is holding back investment in this area. As the uptake of alternative fuel vehicles is closely related to the availability of charging stations, more support is needed to ramp up the infrastructure.

This can be observed when considering the density of the alternative fuel charging infrastructure in Europe. Although the build-up of charging infrastructure for alternative fuels (electric, hydrogen, CNG, LNG) in Europe is growing, it is doing so from a relatively low level. Many initiatives at Member State level are under way to further increase the uptake of the charging network. However, the distribution and density of the network varies greatly between the Member States.

Data from openchargemap.org analysed as part of the EC study "Clean Power for Transport Infrastructure Deployment" further illustrates this situation. In 2016, a little more than 1 700 electric charging stations above 40 kW were in operation across Europe. However, most of them were concentrated in a few Member States such as the UK (633 stations), Germany (281) and Sweden (156).[57] In addition, the charging stations in place today are often not yet suited to the needs of high power charging in excess of 250 kW in order to reduce charging times to an acceptable level. They are also mostly deployed in urban areas following a fragmented, locally or regionally driven approach instead of being positioned along highways connecting important European-wide transport routes like the TEN-T corridors.[58]

For CNG, the majority of the 3 060 public stations at present are based in Italy (1 071) and Germany (851), with the other markets having only a very limited network.[59] Compared to this, the network for hydrogen in Europe is at an even earlier stage with fewer than 100 stations in operation.[60]

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[57] Source: "Clean Power for Infrastructure Deployment", European Commission, 2016

[58] https://ec.europa.eu/transport/themes/infrastructure/ten-t-guidelines/corridors_en

[59] Source: metanauto.com

As the uptake of alternative fuel vehicles is closely related to the availability of charging stations, more support is needed to ramp up the infrastructure. During the interviews conducted, it was often stated that the business case for installing and operating the infrastructure would be negative despite public grants and programmes that typically supply about 50% of the installation costs. In addition, some charging stations have already been shut down due to revenues from selling electricity being even lower than the operating and maintenance costs of the station. Interviewees also stated that the uncertainty concerning the adoption of alternative fuel vehicles in the future and concerning the growth of the market were holding back investments.

Recommendation: Charging station operators should receive more **incentives to accelerate the ramp-up of the charging infrastructure**, especially for high power charging along European cross-border transport corridors. **The EU could build on existing instruments to develop a set of incentives for this purpose – a combination of guarantees, grants and debt on flexible terms** (the CEF "Blending Call", combining grants with third party financing, is a positive development is this direction). Such setup may require substantial structural preparatory work, therefore targeted advisory support should be considered (indeed, in the context of the CEF Blending Call, support from the European Investment Advisory Hub is being put in place).

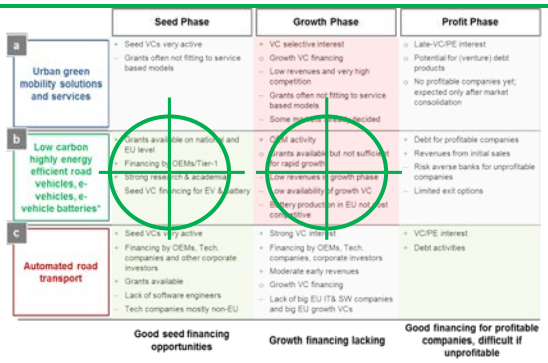
Due to the typically poor economics of such ventures in the early years of operations, grants should in such a scenario not only cover the initial installation costs of the infrastructure but also parts of the operating costs in the following years. (Soft) debt could be blended with the grants to increase the financing further. Such debt could be triggered at specific inflection points of the venture. Further uncertainty about the market uptake could be mitigated by introducing uptake guarantees, longer grace periods and more flexible conditions until a certain milestone is achieved. Eventually, the debt portion could also be structured as a convertible instrument in order to reduce the burden on the recipient in the event of slower-than-expected uptake.

In order to achieve the highest impact, such actions should be **prioritised towards select technologies** instead of following a technology-agnostic approach and spreading the funding too thinly across the various alternative fuels technologies. This would give more certainty and planning security to the whole industry.

Examples: Such an approach is, for example, followed by Japan with the aim of becoming the leading market for hydrogen fuel cell technology or by China for battery electric vehicles.

RECOMMENDATION 5: Provide financial support to the uptake of alternative fuels in public fleets and the related value chain

➔ *Financial and policy recommendations targeting the public market of alternative fuel technologies*



Rationale: PTO/As are currently mainly using diesel buses in their fleets and are only starting to experiment with battery electric and fuel cell hydrogen buses. While purchase prices for battery electric or fuel cell

[60] Source: h2stations.org

hydrogen buses are still above the purchase price of, for example, a diesel hybrid bus, the gap has closed significantly over the last five years and is now at about 40-80%. The gap is expected to shrink further with prices possibly becoming break-even with diesel hybrid buses over the next five years.[61] However, for tendering for new buses a TCO (total cost of ownership) view including operating and fuel costs, mileage, charging infrastructure, repair and maintenance is necessary.

There are several bus OEMs in Europe of different sizes with a significant number of them already having the technology in place for battery electric or fuel cell hydrogen buses. **In order to reach economies of scale and incentives to further invest into technology development, they are now at a point where they would need high volumes** instead of the typically small orders they receive from each municipality. The same applies for the upstream value chain of technology and component suppliers.

Meanwhile, China is leading the market for public electric buses and already selling more than 100 000 per year. By the end of 2015, 98% of the electric buses worldwide were driving in China.[62] The threat for the European industry is that the local markets are taking too long to develop, while Chinese bus OEMs keep expanding to Europe and taking advantage of the scale of their production to offer lower prices.

In addition, public transport authorities wield significant procurement power through multi-annual bids for the provision of transportation services. Smaller, younger companies with innovative mobility solutions face the additional hurdle of having to overcome the perception of elevated levels of implementation and financing risk compared to more traditional, potentially less innovative providers. By perceiving public entities as consumers, policy action can help to lower those hurdles and encourage cities/PTAs to actively include small companies and start-ups in the bidding.

Recommendations: A number of actions should be considered:

- European PTO/As should be supported through **grants and incentives to mitigate the higher purchase price of alternative fuel buses** compared to combustion engine buses (the grant would cover the price difference).
- **Innovative financing solutions** could be developed **to support the leasing and purchasing of zero-emission fleets and services** (e.g. zero-emission transport bonds and obligations backed by zero-emission fleet leasing and lending contracts, potentially supported by a public guarantee or asymmetric return schemes).
- Any (semi-)public financing for PTO/As should be **linked more explicitly to the upgrade of fleets with alternative fuel vehicles**, excluding the expansion or replacement of public bus fleets featuring conventional diesel buses.
- **Bus OEMs need to be put in a position to achieve economies of scale** in development and production and thus be able to offer more competitive prices. This could be achieved by **organising and coordinating joint procurement initiatives** for alternative fuel buses. The European Commission should push in this direction, building on the PROCURA and COMPRO joint procurement initiatives. A more ambitious option would be to launch a European procurement platform for public fleets, to obtain critical mass and economies of scale with the requirement of buying from European-resident or/and European-based IP technologies and services. The contract awards could be combined with readily available financing solutions to speed up the manufacturing.
- Policies requiring PTO/As to make their fleets greener by, for example, requiring public fleets to have a certain share of alternative fuel vehicles within a defined time frame, should also be introduced either at municipal, national or European level. Once again, the European Commission should lead the way.
- Regarding public procurement, public transport authorities can join forces with national and European-level development/promotional banks to facilitate the bidding of young and innovative companies in public tenders. This facilitation can take various forms, e.g. privileged and facilitated

[61] Source: Interviews with market participants

[62] Source: https://cleantechnica.com/2017/02/03/china-100-electric-bus-sales-grew-115700-2016/

access to bank due diligence in the event of a successful bid; availability of more, faster and smaller-scale contract financing options (including lease financing) for young/small transport and mobility services providers; double-staged appraisals by public transport authorities that provide the winners of bids with privileged access to national or European level promotional/development banks.

Examples: On price mitigation measures, good examples are the Fuel Cells and Hydrogen Joint Undertaking (FCH JU)[63] for fuel cell-powered buses with incentives around €100 000 per bus or the British Green Bus Fund.[64]

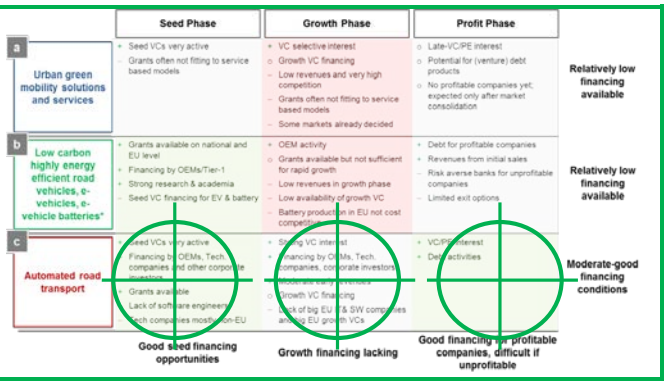
The London Taxi Company and the Department for Transport are jointly aiming to electrify the black cab fleet in London over the coming years. To achieve this, £64m of subsidies are being made available.

In total in Europe, 19 public transport operators and authorities covering around 25 European cities, have published an e-bus strategy for 2020 and more so for 2025, according to an UITP report (ZeEUS eBus Report, January 2017). As an example, by 2025, RATP of Paris has committed to rolling out a 100% eco-friendly bus fleet, including electric and biogas buses, in the Île-de-France region.

On joint procurement initiatives, recent examples would be the JIVE and MEHRLIN projects that were launched in the UK to purchase 144 hydrogen fuel cell buses and seven hydrogen refuelling stations.[65]

RECOMMENDATION 6: Align and amend European policies and legislation on autonomous driving and push for a technology friendly testing environment

➔ *Policy recommendation targeting automated transport technologies*



Rationale: **Within automated road transport, this study found that uncertainty with regard to policies, regulation and liability are the key challenges for companies, rather than access to financing**. VC funds, OEMs, suppliers and technology companies are investing large sums into the development of autonomous driving technology with one example being the recent takeover of Israeli autonomous-driving software company Mobileye by Intel for $15bn.

Most automotive, transportation and mobility companies are testing their autonomous technology and vehicles in the USA due to easier access to test licenses. While some test tracks are also available in Europe (e.g. on the German A9 highway), discussion in the USA has already reached the next level:

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[63] http://www.fch.europa.eu/

[64] https://www.gov.uk/government/collections/background-to-the-green-bus-fund

[65] http://www.element-energy.co.uk/wordpress/wp-content/uploads/2017/01/JIVE-MEHRLIN-Project-Launch-Press-Release-25012017.pdf

allowing test drives without a human driver as a backup solution required at all times (e.g. in California[66] and Michigan[67]).

Further concerns by the interviewees of this study surrounded a European-wide certification of autonomous technology and vehicles, the liability aspects for accidents, IT security, modernising the infrastructure with V2X technology as well as data privacy and ownership.

"Clear and standardised EU-wide rules can make a big difference in creating a predictable, consistent and certain environment for business, thus supporting rapid development through-out EU."
VC Partner

"Mobility and related policies (e.g. for liability in autonomous driving) need to be handled on a European rather than a national level. This would make it a lot easier for companies to plan their business."
CFO Transportation Company

"Regulation is a much bigger hurdle to enabling autonomous driving than technology."
CEO Autonomous Driving Start-up

Recommendation: Develop a coherent and joint **strategy for connected and autonomous driving** between the European Commission, Member States and stakeholders in the transport industry. This strategy should cover a broad range of topics:

- Coordinate legislation regarding autonomous driving on a Member State level and facilitate the exchange of data and best practices through a central, commonly accessible data platform.
- Link with existing European platforms such as C-ITS, C-Roads, Gear 2030 and the Round Table on Connected and Automated Driving[68] as well as national platforms such as Drive Sweden, the Round Table Automated Driving in Germany or the Autonomous Vehicle Plan in France.[69]
- Clarify ownership of data and data privacy while also enabling data-sharing for real-time traffic, accident, hazards and maintenance information.
- Develop a roadmap for the implementation of standards for V2V and V2X communication. New cars should also be obliged to include the necessary hardware and software for such technologies, which are a prerequisite to autonomous driving.
- Support identification and certification of dedicated test tracks for connected and autonomous driving with a special focus on cross-border initiatives. Testing should also include truck platooning and automated urban mobility scenarios.
- Facilitate the adaptation of the Vienna and Geneva conventions to consider all levels of autonomous driving and push for coherent implementation in Member State law.
- Alignment with existing EU policies interacting with automated vehicles, making amendments where needed. Policies would include Directive 2007/46/EC on vehicle approval, the EU Roadworthiness Directive/2014/45/EU, and others.[70]

[66] https://www.theguardian.com/us-news/2016/oct/01/california-self-driving-cars-licensed-drivers

[67] http://www.cnbc.com/2016/12/10/michigan-lets-self-driving-cars-on-roads-without-human-drivers.html

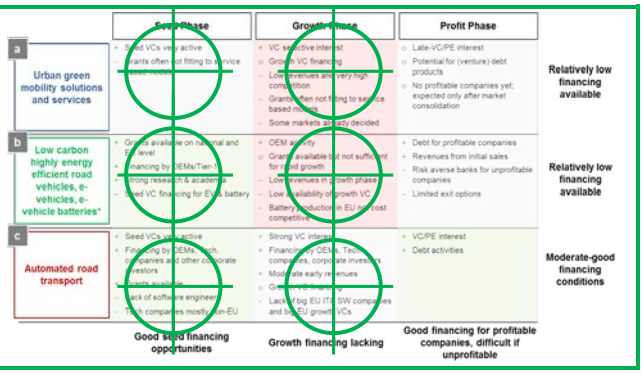
[68] https://english.eu2016.nl/documents/publications/2016/04/14/declaration-of-amsterdam

[69] "Automated Driving Roadmap", ERTRAC, 2015

[70] Source: "Self piloted cars: the future of road transport?", European Parliament, 2016

RECOMMENDATION 7: Support and enhance ecosystems of existing and emerging mobility hubs

➔ *Recommendation aimed at the seed and growth phase of companies in all three segments of Innovative Transport*



Rationale: There is no equivalent of Silicon Valley equivalent in Europe. There is no similarly powerful and geographically-focused aggregation of capital, a strong academic and labour market, governmental support, successful flagship companies and strong industry presence. However, several smaller hubs in Europe are emerging with some of them also focusing on the Innovative Transport sector. Equally important are those cities and municipalities that are testing new transport models and championing the transition to more sustainable mobility. They deserve attention and support.

Recommendation: The EU Institutions should jointly identify and support potential mobility hub hotspots as well as existing and emerging initiatives. There are already some interesting hotspots in Europe that have several of the required start-up ecosystem components in place:

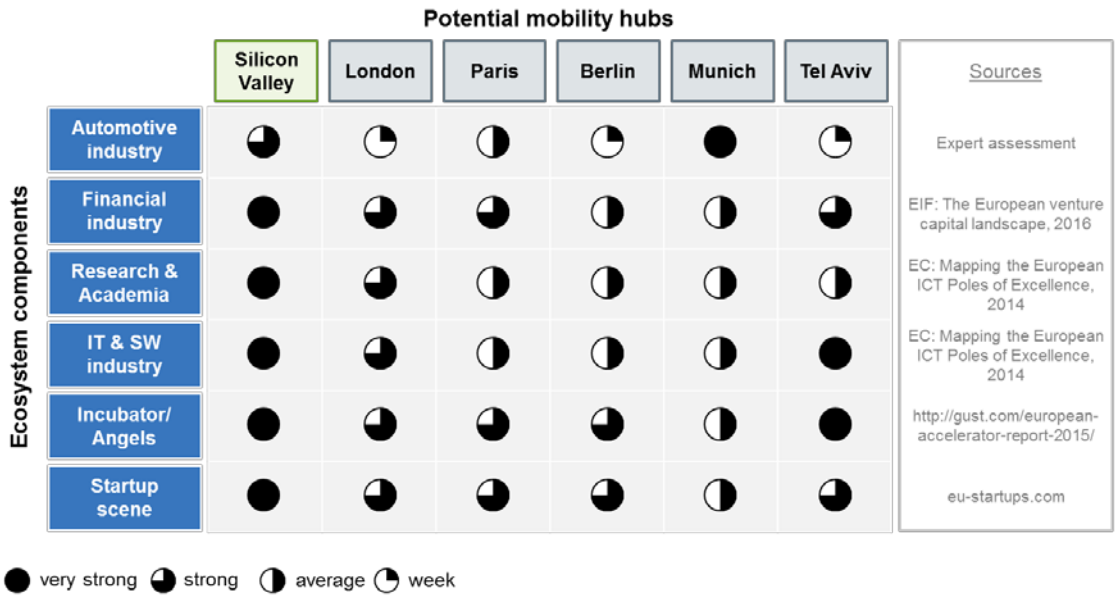


Figure 53 – Evaluation of potential mobility hubs and start-up ecosystems

Some interesting networking and accelerator initiatives aiming at bringing together academia, the automotive industry and governmental bodies are already under way at a European (Start-up Europe project), national (e.g. Drive Sweden, Transport Systems Catapult UK) and regional level (e.g. Start-up Autobahn in Stuttgart, Digital Hub Mobility in Munich). These initiatives are typically funded through a combination of Member State and EU-level (Horizon 2020) support as well as from industry sponsors.

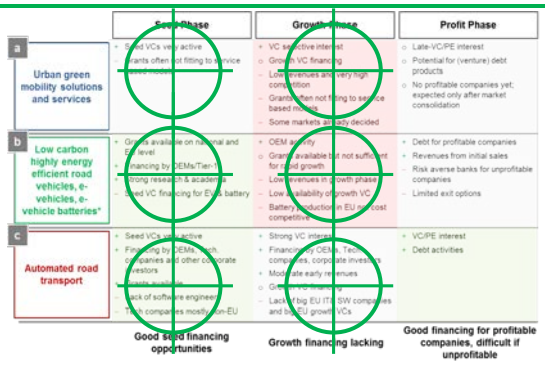
Moreover, a recent JRC study[71] found that "co-funding accelerators appears to be a cost-efficient no-regrets policy option to complement financial instruments. In terms of specific instrument design, evaluation results indicate that schemes which combine funding with coaching and networking support are the most effective, and should ideally involve regular performance evaluation of beneficiary companies to assess their ability to translate the support received into sustained growth."

The role of European Institutions could be to identify mobility clusters with high growth potential and to support them through a combination of grants, further EIB financial and advisory support, as well as networking and coaching activities. Having local representatives of the European institutions in place as dedicated points of contact for innovative start-ups and SMEs would also help raise awareness on existing instruments. This would also help entrepreneurs to quickly get advice and answers on policy and regulation topics around their businesses and the mobility sector.

Equally important would be to foster demonstration pilots and roll-outs in urban areas in and beyond the hubs listed above. The presence of investors, accelerators and start-ups is critical but market take-up is equally relevant and urban mobility champions such as Copenhagen or Amsterdam/Rotterdam could lead the way and act as a showcase, with further support from the European Institutions.

RECOMMENDATION 8: Address the growth phase financing gap by supporting dedicated Innovative Transport or multi-corporate investment funds

➔ *Recommendation aimed at the seed and growth phase of companies in all three segments of Innovative Transport*



Rationale: OEMs, technology companies and knowledge intensive services companies (KIS) are investing heavily in the Innovative Transport sector at an increasing rate. Numerous corporates such as Daimler, Jaguar, BMW, Intel and others have set up venture arms to directly invest into innovative start-ups. On the one hand, corporate investors bring with them a mix of financing and field expertise, both invaluable for a young, innovative company. On the other hand, partnering up with an OEM could restrict the company's development opportunities. Furthermore, some of the VCs interviewed stated that they would prefer not to invest into companies where an OEM or other corporate has already invested due to potential conflicts of interest.

The picture below illustrates some of the recent investments by OEMs into mobility start-ups.

[71] "Improving access to finance: which schemes best support the emergence of high-growth innovative enterprises?", JRC Science for Policy Report

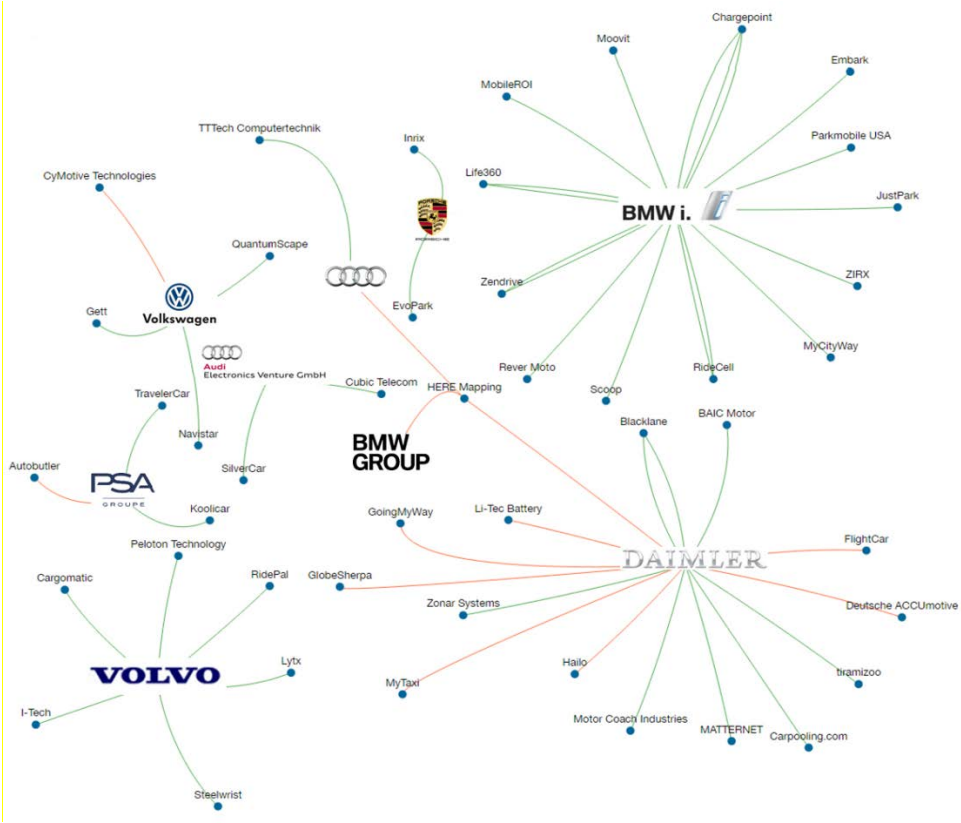


Figure 54 – Investments (green lines) and acquisitions (red lines) of European OEMs into automotive and mobility start-ups 2011-2016[72]

Another trend observed in this study is an **increasing willingness of OEMs to cooperate for important strategic topics** that require large investments and would benefit from standardisation and economies of scale. Some examples are:

- The take-over of Nokia Here through a consortium of Daimler, BMW and Audi that was later further opened up to investments from Intel, Tencent, NavInfo and GIC.
- The Hubject joint venture by BMW, Bosch, Daimler, EnBW, Siemens, Innogy and Volkswagen to facilitate e-roaming and the interoperability of charging stations.
- The joint initiative of Ford, BMW, Daimler and Volkswagen to set up a fast charger network along highways.
- Joint investments from Daimler and BMW into the US charging station start-up Chargepoint.
- Daimler's Start-up Autobahn accelerator in Stuttgart opening up to further partner firms Bosch, HP, ZF and Porsche.

This is an important indicator that the automotive industry is becoming more open-minded towards partnering up with each other and with non-traditional automotive actors in order to realise projects where they could profit from external expertise as well as shared costs and risks.

Recommendation: Such recent developments could offer opportunities for European Institutions to **address the growth financing gap** by leveraging public support and the networks of the OEMs and KIS to increase access to financing for Innovative Transport companies.

The EU could facilitate and support the establishment of **(a) dedicated investment vehicle(s) (potentially deploying both equity and high-risk debt) focusing on supporting the scale-up phase of fast growing companies active either in the general Innovative Transport sector or one of its sub-segments**.

[72] Source: CB Insights database, December 2016

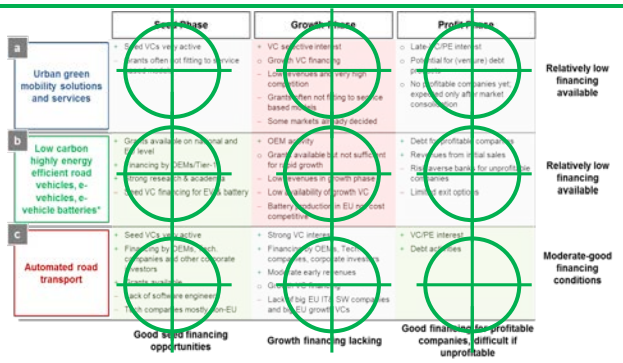
Support from the EU could come through the provision of bedrock equity for the fund and/or the acceptance of asymmetric returns in order to maximise the catalytic effect on private sector participation (similar structures are being considered in the context of the InnovFin programme and the Connecting Europe Facility). Co-investments with transport/OEM funds that are already active, using existing financing instruments (e.g. the ones developed under the European Fund for Strategic Investments – EFSI) could also provide additional firepower.

A more interesting but potentially more challenging option would be to set up the fund in the form of a multi-OEM/KIS or multi-corporate investor vehicle. Such a construct would **leverage the common interests of corporate investors in the sector along with their financial capabilities** while also mitigating the concerns of start-ups being dependent on a single OEM. This option should be first vetted via a target consultation amongst OEMs to i) identify areas of common interest to verify alignment with policy objectives and build the investment strategy around and ii) willingness to invest, at what terms and under what type of structure. Anti-trust considerations for such multi-OEM investment vehicles need to be taken into account.

Examples: An example for such a multi-corporate investor fund is e.g. Ecomobility Ventures in France as a joint investment platform into mobility companies by SNCF, Total, Orange, Air Liquide and Michelin.[73] The accelerator Start-up Autobahn also brings together multiple corporates interested in the sector although the platform does not make equity investments into start-ups, but rather supports them through joint projects, networking and mentoring. Moreover, the new multi-corporate fund Icebreaker Ventures is aiming to raise money from strategic corporations to invest into Innovative Transport solutions.[74]

RECOMMENDATION 9: Raise awareness on existing EC-EIB financing instruments

➔ *Recommendation aimed at all companies in all three segments of Innovative Transport*



Rationale: The interviews carried out as part of this study showed only limited awareness of existing financial instruments from the EIB Group or EC. Moreover, half of the supply side interviewees either had no detailed knowledge of how the EIB instruments could support their portfolio companies or did not think that EIB instruments would be suitable for their business. Responding to the question "*What could the EC or EIB do to promote access to finance and to overcome existing barriers*?" around half of the sample answered "*Raise awareness on available instruments*".

[73] https://www.crunchbase.com/organization/ecomobilit-ventures#/entity

[74] https://pitchbook.com/newsletter/new-firm-icebreaker-ventures-launches-raising-funds

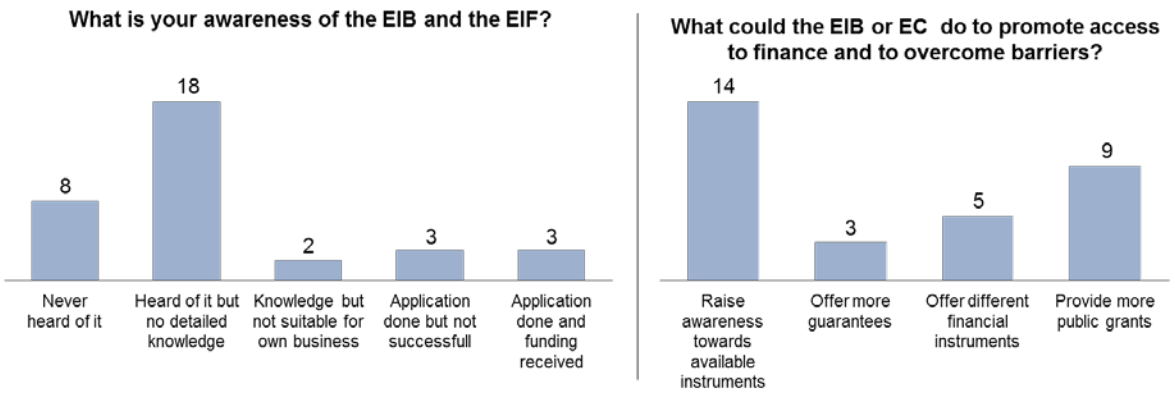


Figure 55 – Awareness of demand side interviewees regarding existing EIB instruments

"We hired an external consultant to help us find financing sources. They already had experience with the EIB and thus approaching the EIB went smoothly."
CFO Automotive Supplier

"There are just too many facilities [at the EIB] and if you do not fit 100% to their profile they will send you to the next one. Entering the EIB channels is horrible."
CEO Commercial Vehicle OEM

Recommendation: the EIB Group and EC should raise the awareness of existing financing instruments in the Innovative Transport sector, especially with start-ups and SMEs. This could happen through multiple channels (partially already in existence/activated, particularly via the European Investment Advisory Hub - EIAH):

- Participation in industry conferences and start-up networks;
- Regular EU-sponsored series of Innovative Transport conferences and workshops;
- Cooperating with incubators and accelerators;
- Partnering with local/regional agencies (public and private) to coach young companies on the public funding available and how to access it;
- Active engagement with EU-funded VC funds that can act as a multiplier in marketing public funding instruments to young entrepreneurs (within or outside their own investment portfolio);
- Mass market advertising of EU funding instruments in relevant blogs and magazines;
- Introducing standard requirements for beneficiaries of EU funding to explicitly list the support received in the provision of products and services.

The recommendation is therefore to both expand the scope of activity as well as to improve the coordination across EU actors and EC services in the organisation and attendance of relevant awareness-raising initiatives.

CONCLUSION

This study highlighted how Innovative Transport technologies and services are disrupting the traditional automotive and road transport sector. New stakeholders are emerging from the start-up and IT & software sectors and are competing with the incumbent OEMs, transportation companies and automotive suppliers.

Particularly for mobility services and alternative fuel vehicles, many non-European start-ups are driving this change. This is due to the existence of a financing gap for European mobility, transportation and automotive companies, especially during the growth phase.

To address this financing gap, several recommendations have been outlined in this study. Some of these recommendations are aimed specifically at one of the three sectors of Innovative Transport that were defined as urban green mobility solutions, low carbon highly energy efficient road vehicles and automated road transport.

Out of these three sectors, this study identified low carbon highly energy efficient road vehicles and the adjacent charging infrastructure as having the most challenging access to finance. Consequently, the recommendations for this sector aimed specifically at introducing new or enhancing existing financing instruments. This would include promoting the uptake of alternative fuel vehicles in public fleets as well as additional support for building the charging infrastructure.

For the sectors of urban mobility solutions and automated road transport, recommendations aimed at mitigating regulatory and policy challenges as well as at adapting grants programmes towards high-growth service-focused companies.

Supplementary recommendations were developed targeting all sectors of Innovative Transport. These included addressing the growth gap through backing dedicated Innovative Transport or multi-corporate funds. Other opportunities for European institutions would include the support of emerging ecosystems of Innovative Transport and awareness-raising regarding existing financing instruments.

Appendices

Appendix A – Glossary

Term	Definition
B2B	Business-to-business commercial relationship
B2C	Business-to-customer commercial relationship
BEV	Battery electric vehicle that uses energy stored in batteries for propulsion
Car-sharing	Short-term car rentals within urban areas
CNG	Compressed natural gas (methane stored at high pressure) is a fuel that can be used to replace gasoline or diesel
EV	Electric vehicle that uses an electric motor instead of internal combustion engines
Horizon 2020	An European financial instrument, part of the EU Research and Innovation Programme, which provides €80bn of financing over several years (2014 to 2020).
Innovative Transport	Sector of road transport solutions around mobility services, low carbon highly energy efficient road vehicles and automated road transport
IT & SW company	Information Technology and Software company
LNG	Liquefied natural gas (methane mixed with ethane) is natural gas that has been processed into liquid form
M&A	Mergers and acquisitions are financial transactions where the ownership of companies or operating units is combined or transferred
Multimodal platform	Platform or app that offers journey planning covering multiple means of transport
PHEV	Plug-in hybrid electric vehicle that uses both electric motors and internal combustion engines
Platooning	A group of vehicles being able to drive very closely together through autonomous features, thus reducing fuel consumption
Private Equity	Capital that is not listed on a public exchange but rather composed of funds and investors that directly invest in private companies, or that engage in buyouts of public companies
PTO/A	A Public Transport Operator operates public transport services such as buses, metros or trams A Public Transport Authority is the authority that oversees the operation of public transport
Ride-pooling	Long-distance ride-sharing of vehicles with a private driver
Ride-sharing	Short-distance ride-sharing and booking with commercial drivers
Service Provider	Company focused on passenger transport services
Tier-1	A tier-1 supplier is a manufacturer of parts or components that delivers directly to a company without a middleman or other manufacturers
Venture Capital	Start-up or growth equity capital that is provided by private investors or specialised financial institutions

Appendix B – Stakeholders engaged through interviews and workshop

Demand Side	
Stuart	TfGM
Spring Innovation / Wepod consortium	BlaBlaCar
Hymove	MaaS Global
Freighthub	Fraunhofer
Voltia	Efacec
Octo Telematics	Daimler
EAM	Manz
Drivy	Drover
Uniti	Mobicap/Spacetec
Drive Sweden	Hubject
Luxoft	Addison Lee
Continental	Transport for London
Dreamchip	Tiramizoo
Rimac	INTRASME/EBN/University of Coventry
UbiGo	Ride Cell
New Motion	Irizar
Toll Collect	IFEVS
Easymile	AMG
Ebusco	FCH Ju
Vayyar	

Supply Side	
Continental	Intel Capital
BGF	BMW iVentures
DN Capital	Green Investment Bank
Deutsche Börse	Northzone
Holtzbrinck	Carlyle
UnternehmerTUM	Daimler
Cabiedes	Commerzbank

In traditional automotive development and manufacturing, a car consists of powertrain, exterior, interior, chassis and electronics segments. New developments and trends in Innovative Transport have already begun to shift the focus between and within the different segments. For example, the emergence of electric cars massively impacts traditional powertrain components like the combustion engine, transmission and drive shaft, that are replaced with electric motors and batteries. Another key driver is the connected car, which requires a much stronger electronics architecture and additional parts and software.

Electric motor and battery

Electric motors are used in electric vehicles as a replacement for traditional combustion engines. They are technically less complex than diesel or fuel engines, meaning they only need about 10% of the development and production effort. Those currently in use are mainly asynchronous machines and permanently excited synchronous machines.

The battery is one of the key components of an electric vehicle and one of the main cost drivers. Today, most electric vehicles use lithium-ion batteries that are also believed to be the key technology for at least the next five years. The industry, especially in Asia and the US, is investing heavily in battery technology in order to increase the density of the cells and to bring prices down. While costs per kWh were around $500-$800, in 2012 they had already reached around $160-$190 in 2016 (see Figure 56). The aim of the industry is to reach a price of around $100 per kWh over the next two years to become cost-competitive with diesel and petrol cars.

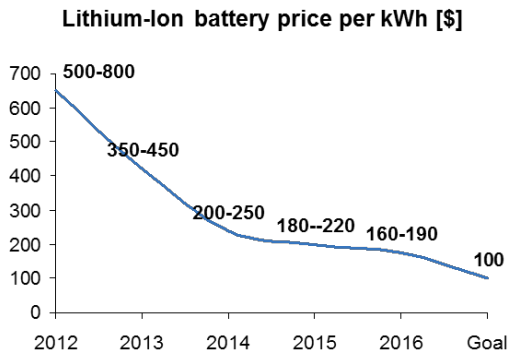


Figure 56 – Development of battery price per kWh[75]

Fuel cell

Next to battery electric cars, fuel cells are another type of zero-emissions vehicle. Fuel cells generate energy to power the motor by using oxygen and compressed hydrogen. However, there is only one series production car on the market at the moment in form of the Toyota Mirai. Further market penetration is uncertain due to high cost of the technology, which far exceeds the costs for internal combustion vehicles. Another restriction is the very scarce availability of charging infrastructure. Fuel cells could also be used in, for example, buses, trucks or other commercial vehicles.

Advance Driver Assistance Systems (ADAS)

ADAS include technology supports drivers with security features, e.g. lane change assistant, brake assistant, lane departure warning, road sign detection and many others. These systems are incrementally improving and are already enabling semi-autonomous driving in some car models. Figure 57 below illustrates the roadmap of ADAS features and their impact on driving safety.

[75] Source: visualcapitalist.com

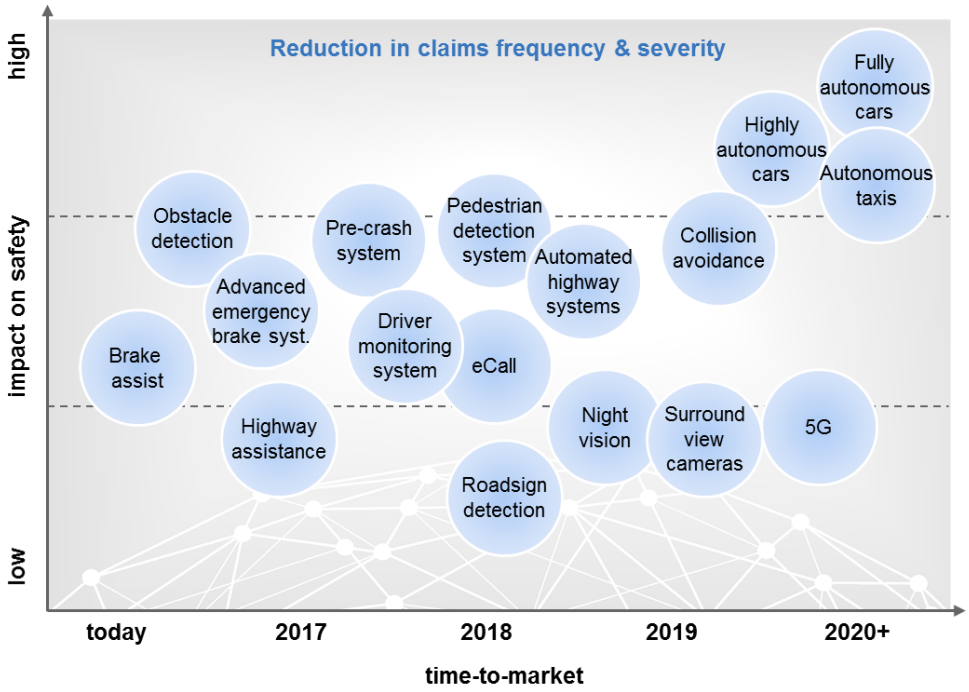


Figure 57 – Roadmap of Advanced Driver Assistance Systems (ADAS)[76]

Sensors, lidars and cameras

These are key hardware components for ADAS and (semi-)autonomous vehicles to support the detection and visualisation of the car's environment and to detect obstacles in time.

Connectivity and telematics

One key trend is that all cars will have an online connection in the future. This allows for new services, e.g. over the air software updates, real-time traffic information, infotainment and entertainment options. The emergence of fast data connections everywhere and the introduction of 5G networks over the coming years are also key requirements for the viability of autonomous driving.

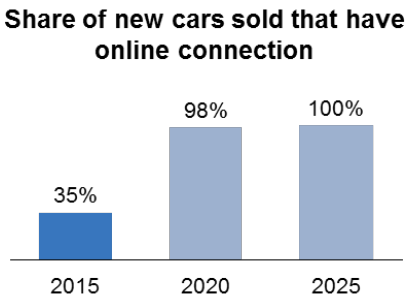


Figure 58 – Share of new cars sold that are connected[77]

Car-to-X communication

Autonomous driving will also require car-to-x communication in the future. This means that vehicles are communicating and sharing information and safety warnings with each other and also with infrastructure components, e.g. traffic lights.

[76] Source: PA Consulting

[77] Source: Statista

Car operating systems

The emergence of software and the use of mobile apps and smartphones require standardised interfaces and operating systems in cars. Increasingly, these are also used as entertainment and connectivity hubs for the driver and passengers. Technology companies like Apple, Google and Microsoft are developing solutions and are cooperating with OEMs to integrate their software into cars. They are also aiming to access driver and driving data.

On-board entertainment

Entertainment options are becoming more important. Customers expect an easy to use interface and the ability to connect their portable devices to the on-board system. Developments toward autonomous driving will further push the need for entertainment options. OEMs are putting a strong emphasis on this as they regard on-board entertainment as a differentiator from their competitors. In addition, it opens up new opportunities for monetising user data and offering tailored services.

Navigation and maps

Navigation systems and real-time traffic information are already available in many of today's cars. In the future, they will become even more important in the context of autonomous driving which requires high definition maps of the environment. Navigation and maps are also a good platform for offering location-based services and collecting user data as further revenue streams.

Augmented and virtual reality

Augmented reality could be used both in cars and outside cars. In cars, it offers additional information to the driver or passengers by displaying information such as traffic, navigation, driving data and warnings on a head-up display (HUD). Outside car, it can also be used to ease assembly, manufacturing or repair processes.

Artificial intelligence, software, algorithms and security

The whole ecosystem around software, algorithms, security and artificial intelligence is growing strongly and becoming increasingly important for car development processes. Software is everywhere in modern cars. Trends such as connected vehicles, ADAS and autonomous driving demand huge software development capabilities that most OEMs and automotive suppliers are do not have in-house. Consequently, many technology companies are active in this area and are selling their products to automotive companies or are also engaging in joint development activities.

Vehicles

Several different types of vehicle are within the scope of Innovative Transport. These include electric and fuel cell vehicles, connected vehicles as well as autonomous vehicles as a future application. However, these vehicles types should not be seen isolated from each other but rather as complementing each other. The car of the future could very well be battery powered, highly connected and autonomously driven.

Electric vehicles

For electric vehicles (EVs), we distinguish between battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs) and hybrid electric vehicles (HEVs), as described in Figure 1. BEVs are fully electric vehicles that have no other form of propulsion than their battery. They are charged with a plug at public or private electric charging stations. PHEVs and HEVs use a combination of an internal combustion engine that runs on gasoline or diesel and an electric motor with a small battery. The difference between the two is that PHEVs can also be plugged in and can thus run for a small distance using the electric motor and battery.

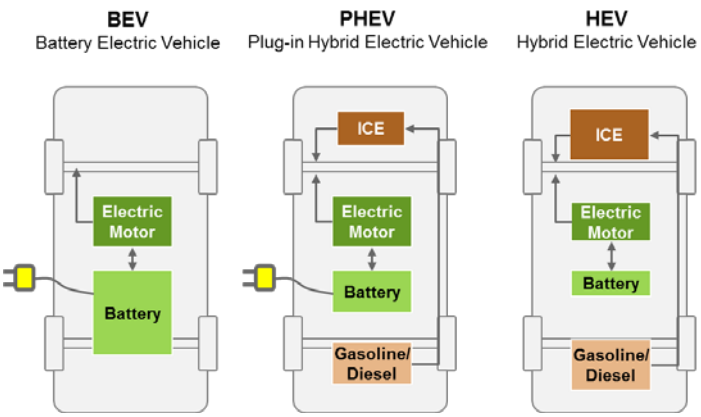


Figure 59 – Electric vehicle types

The electric vehicles market segment is seeing strong growth. The number of European electric cars grew from 43 000 units in 2012 to 191 000 in 2015 with a Compound Annual Growth Rate (CAGR) of 64.7%. The worldwide number of electric vehicles in use is expected to increase to 7.3m by 2020.[78]

When looking at different geographies, China is currently the clearly lead market for electric vehicle sales (see Figure 60). In 2016, there were already more than half a million passenger cars and commercial vehicles sold. Out of the top 20 most-sold EV models in China, only one was produced by a non-Chinese OEM: Tesla. The Chinese carmaker BYD, for example, was the leader in global sales of plug-in electric vehicles in the first ten months of 2015 with 43 070 units.[79] The worldwide number of available car models is expected to increase from 60 models now to over 220 models by 2020 with about 108 models coming from China.[80]

This shows that the significant attention paid by the Chinese government via a mixture of regulatory push and financial pull through grants is baring results. Another good example for this is that 115 000 electric buses are already active in public transport in Chinese municipalities. Despite the success story of electric mobility in China, the number of 500 000 electric vehicles is still low compared to total Chinese vehicle sales of more than 28m units annually.

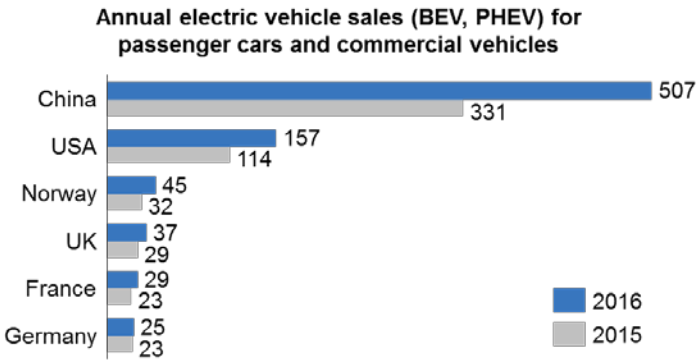


Figure 60 – Annual electric vehicle sales[81]

[78] Statista, PA Analyse

[79] Statista

[80] Frost & Sullivan

[81] Source: Center Automotive Management (CAM), 2017

Country		GNI [€] per capita 2015	Share of premium cars	Direct PEV incentive/ grant [€]	Indirect PEV incentives	PEV % of new cars 2015
	Switzerland	84,180	32%	0€	Tax incentives in some Cantons	2.1%
	Germany	45,790	33%	3,000-4,000€	No circulation tax	0.7%
	Sweden	57,810	39%	4,200€	No circulation tax; tax reduction company cars	2.6%
	UK	43,340	28%	>6,000€	No circulation tax; tax reduction company cars	1.1%
	Spain	28,520	18%	2,700-6,000€	Reduced circulation tax	0.2%
	Italy	32,790	18%	0€	No circulation tax in many regions	0.1%
	Ireland	46,680	13%	2,500-5,000€	No VRT up to 5.000€; Reduced road tax	0.5%
	France	40,580	14%	6,300€	No registration tax, tax reduction company cars	1.2%
	Denmark	58,590	n/a	0€	No registration tax (worth >15.000€), Phased-out by 2020	2.3%
	Netherlands	48,940	19%	0€	Reduced tax; free parking & charging in Amst.	9.7%
	Norway	93,280	27%	0€	No fees, taxes, tolls & VAT (worth >15.000€)	22.4%

Figure 61 – Electric vehicle adoption rate and incentives in the EU[82]

The table above gives an overview of key EV lead markets within the EU. In 2015, Norway (22.4%) and the Netherlands (9.7%) had by far the highest share of EVs on new vehicle registrations. High EV shares are mostly related to countries with a high GNI in combination with generous direct or indirect financial incentives to buy EVs, as is the case in Norway, for example.

The share of battery electric cars, plug-in hybrids and hybrid vehicles will likely emerge by 2020, as a result of European emission regulations. OEMs are expected to meet the new requirements by marketing electric drivetrains.

	BMW i3 (BEV) Facelift	BMW i3 (PEV) Facelift	Renault ZOE	GM Chevrolet Bolt / Ampera-e	Tesla X	Tesla S	Nissan Leaf
Motor	PMSM		FESM	PMSM	ASM		PMSM
Concept	BEV, FWD, 1 AC synchronous motor	PEV, FWD, 1 AC SM (2 Cyl. Otto)	BEV, FWD, 1 asynch. motor	BEV, FWD, 1 AC synchronous motor	BEV, 4WD, 2 asynch. motor	BEV/RWD/4WD, 1 o. 2 asynch. motor.	BEV, FWD, 1 Permanentm.-SM
Power	125 kW	125 kW (28 kW)	65 kW	150 kW	245 – 568 kW	193 – 568 kW	80 kW
Torque	250 Nm	250 Nm	222 Nm	360 Nm	600 – 967 Nm	440 – 967 Nm	254 Nm
Vmax	150 km/h	150 km/h	135 km/h	145 km/h	210 – 250 km/h	210 – 250 km/h	145 km/h
Battery Capacity (Li-ion)	33 kWh	33 kWh	41 kWh	60 kWh	60 – 100 kWh	60 – 100 kWh	24 kWh
Range (NEDC)	300 km	300 / 450 km	400 km	500 km	355 – 542 km	400 – 613 km	250 km
Charging time (fast/normal)	40 min / 6 h	40 min / 7,5 h	30 min / 6-9 h	30 min / 9,5 h	40 min / >9 h	40 min / >9 h	30 min / 8 h
Price	36,150 €	41,150 €	22,100 € (excl. 69-119€ leasing costs battery)	37,495 €	98,900 €	76,600 €	23,365 €

Figure 62 -– Selected electric cars and technical details

As illustrated in Figure 62, most electric cars in the market offer a range of 400 km for selling prices from €23 000 up to €99 000. The range is expected to increase in the future with the introduction of new e-car platforms and increasing efficiency in batteries.

[82] PA Research, World Bank, EU Pocketbook, Jato, ACEA

Case Study Product Sales: Tesla Motors

TESLA

- Tesla was founded in 2003 with the mission to "accelerate the advent of sustainable transport by bringing compelling mass market electric cars to the market as soon as possible"
- The first released model was the Tesla Roadster in 2008, a fully battery electric car, followed by the Model S and the Model X
- Since then, Tesla has seen rapid growth while raising more than $2 billion in funding
- Tesla has a unique approach by combining several business models and by a high level of vertical integration that is unusual for OEMs

What makes Tesla's business model so unique:

1. Market approach – Tesla focused on premium and sports cars to enter the market and build up brand and technology; the mass market will follow with the Model 3
2. Technology – Tesla invests heavily in battery technology and is currently building the largest factory ("Gigafactory") to also do the battery packing by itself
3. Service – Tesla's cars are all connected and can be updated over-the-air. The connectivity also allows for additional services to it's customers
4. Integration – Tesla covers most of the value chain from battery packing and car production up to direct customer sales in it's own shops. In addition Tesla now offers solar panels for home charging solutions through Solarcity
5. Business Model combination – Tesla combines **B2C Product Sales & Leasing** with **B2B Product Sales** of drivetrain components to other OEMs. In addition, Tesla is active in **Electricity Sales** by building up a super charger network and cross-subsidizing it by the vehicle price
6. Sales of emission credits – additional revenue stream of selling emission credits to conventional car manufacturers

Starting from battery packing, Tesla integrated the whole value chain

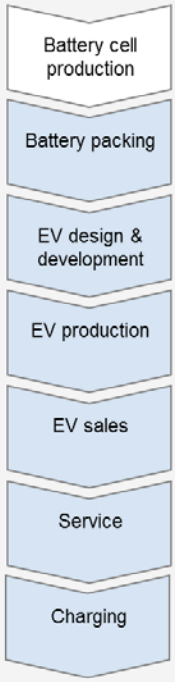


Figure 63 – Case Study Tesla Motors

Hydrogen fuel cell vehicles

Fuel cell vehicles are powered by a fuel cell or by a fuel cell in combination with a battery (see Figure 64). They use oxygen from the air and compressed hydrogen and thus run mostly emission-free. The only available series production cars in the market are currently the Toyota Mirai and the Hyundai ix35 FCEV. Fuel cells are also used in commercial vehicles like buses, trucks and forklifts. The adoption of fuel cell vehicles is currently held back by the lack of charging infrastructure and the high prices of the vehicles.

FCV
Fuel Cell Vehicle

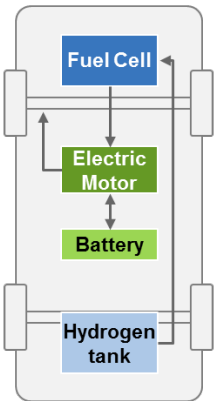


Figure 64 – Fuel cell vehicle concept

Connected vehicle

The term connected vehicle or connected car applies to vehicles that have an online connection and are thus able to receive and send information on an ongoing basis. Being connected is an important enabler for many services and applications in- and outside the car. This includes services such as real-time traffic information, navigation, on-board entertainment options, driver assistance systems such as road sign detection and car2car or car2infrastructure communication.

Autonomous vehicles

Autonomous vehicles have the potential to disrupt the automotive and transportation sector in the future. Several players from inside and outside the industry are developing solutions to make autonomous driving possible.

This study distinguishes between different levels of automation by using the taxonomy and definitions provided by SAE International's J3016 standard in Figure 65 below.

Level	Name	Definition	Steer/ Accelerate	Monitor environment	Fall-back performance	Driving Modes
Human driver monitors the environment						
0	No Automation	Full-time performance by the human driver of all aspects of driving, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	Driving mode-specific execution by a driver assistance system of either steering or acceleration with the driver performing all remaining aspects of driving	Human driver and System	Human driver	Human driver	Some driving modes
2	Partial Automation	Driving mode-specific execution by a driver assistance systems of both steering and acceleration with the driver performing all remaining aspects of the dynamic driving task	System	Human driver	Human driver	Some driving modes
Automated driving system monitors the driving environment						
3	Conditional Automation	Driving mode-specific performance by an automated driving system of all aspects of driving; the driver will respond appropriately to a request to intervene	System	System	Human driver	Some driving modes
4	High Automation	Driving mode-specific performance by an automated driving system of all aspects of driving, even if a driver does not respond appropriately to a request to intervene	System	System	System	Most driving modes
5	Full Automation	Full-time performance by an automated driving system of all aspects of driving under all roadway and environmental conditions that can be managed by a human driver	System	System	System	All driving modes

Figure 65 – Levels of autonomous driving[83]

Today's cars are at level 2 – "partial automation" – which means that they are able to go autonomous in some driving modes, for example on highways where they switch lanes and accelerate while the human driver is still required to supervise the car and to intervene in critical situations. Research on levels 3 to 5 is ongoing all across the world but as well as the technological challenges, this would also require the adoption of regulations and legal restrictions.

There are several different approaches to reaching the full automation level as can be seen in Figure 66. Traditional OEMs are applying a step-by-step approach by improving their advanced driver assistance systems with every new car model and thus introducing an increasing number of automation features into cars. Tesla is following a subsumption architecture model, which means that every movement of Tesla cars is uploaded to a data cloud and then shared with other Tesla cars. This means that the Tesla Autopilot is gradually learning more about driving behaviour and the environment and is improving over time. Google, on the other hand, is using a full world map model where cars require a very detailed map of the environment and masses of data to be able to drive autonomously.

[83] Source: SAE International J3016 standard

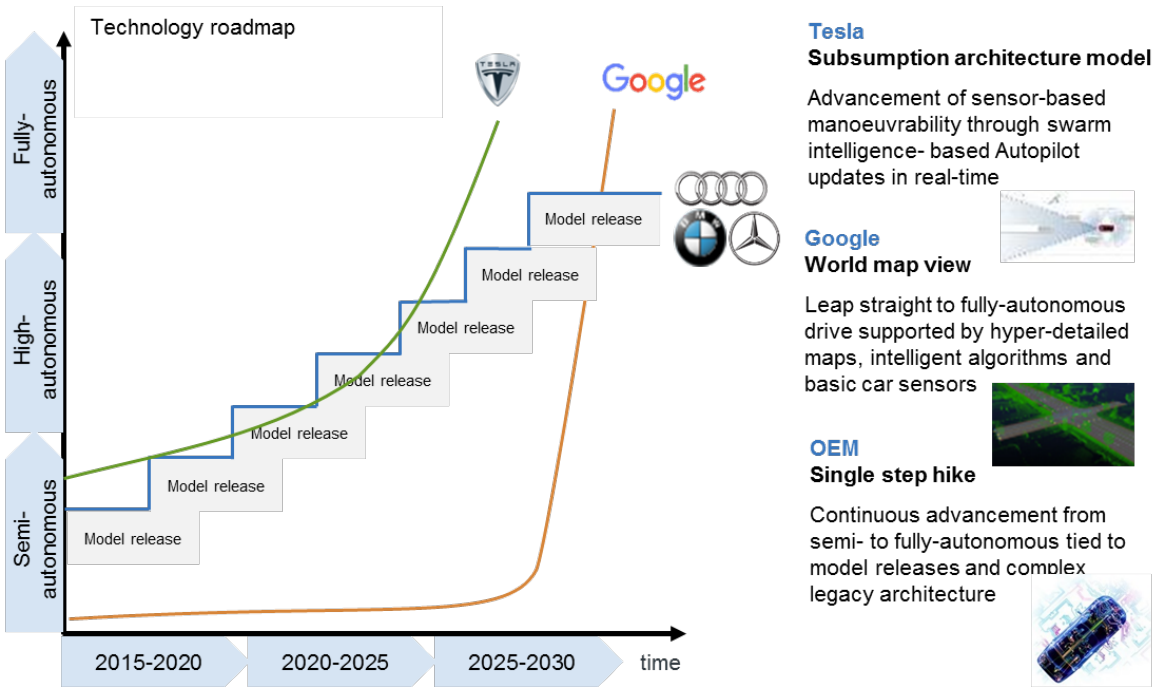


Figure 66 – Strategies to achieve full automation drive technology

There are still many hurdles in place, e.g. the Vienna Convention on Road Traffic, to permitting the use of autonomous cars. One fundamental requirement for self-driving cars is to fulfil the EU ECE regulations. ECE regulation 79 contains requirements for steering configuration that are problematic for automated cars. According to the paragraph on Advanced Driver Assistance Steering Systems, these systems are only permitted as long as the driver is able to control the vehicle at all times. There is a lot of work currently ongoing at EU and Member State level to adapt these policies and regulations to autonomous vehicles.

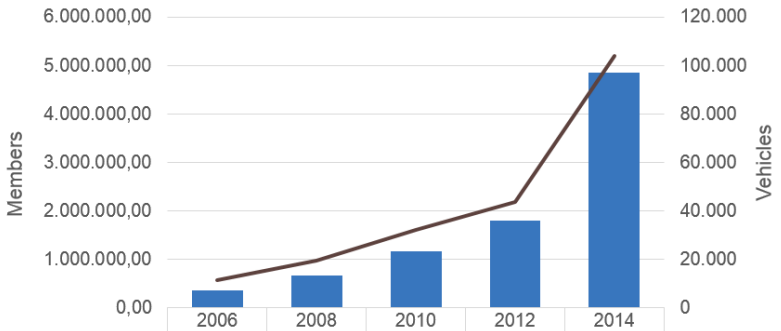
Mobility services

The emergence of new technologies, connected cars and smartphones enables new types of mobility services that are often accessible on demand and bookable trough an app to move people or goods from A to B.

Car-sharing

Car-sharing is a model of short-term car rental where people have on-demand access to a fleet of cars in their surroundings. Typically, they rent the cars by the minute or by the hour by booking with their smartphone. Global car-sharing service revenues in 2015 totalled at about €1bn[84] with strong annual growth rates. The global car-sharing market has grown by over 65% from 2012 to reach 4.8m users in 2014 (see Figure 67).

[84] Source: Navigant Research



	2006	2008	2010	2012	2014
Members	346.610	670.822	1.163.645	1.788.027	4.842.616
Membership Growth Rate		39%	32%	24%	65%
Vehicles	11.501	19.403	31.967	43.554	104.125
Fleet Growth Rate		30%	28%	17%	55%
Membership-Vehicle Ratio	30,1	34,6	36,4	41,1	46,5

Figure 67 – Global development of car-sharing users

Car-sharing initially started with stationary services that were often introduced by some local providers or start-ups. Corporate players such as Deutsche Bahn (Flinkster) then entered the market and created national players. OEMs (e.g. Daimler's car2go, BMW's DriveNow) followed using a free-floating system and are growing their services into a worldwide network.

Car-sharing companies are mainly focusing on larger cities with a high population density to achieve a higher utilisation rate for the cars. Nevertheless, even in larger cities, the free-floating model is mostly not yet profitable. The strategy of OEMs is currently to secure market share and to use car-sharing to promote their cars and increase sales. OEMs such as Daimler and BMW are often cooperating in joint ventures with car-rental companies such as Europcar or Sixt to profit from their fleet management expertise and to expand car-sharing services.

End-users mostly pay according to usage. The fee is based on minutes or km driven or a combination of both. In most cases there is no monthly subscription fee for customers, although some companies do charge extra fees for special destinations, e.g. airports.

The recent trend is also that private car users are offering their own cars in sharing-pools for everybody to use whenever they do not need them (peer-to-peer car-sharing). The sharing platforms are often provided by OEMs (e.g. Daimler and Opel) or start-ups that receive a commission fee for their service.

Bike-sharing

Similar to car-sharing, bike-sharing offers individuals on-demand rentals from a large fleet of bikes within a city. There are station based concepts where users can take bikes from dedicated stations and have to return them a station, as well as concepts where the bikes can be found all over the city and do not have to be returned to a specific location. Users typically pay by time, e.g. per minute or hour. In recent years, bike-sharing has become increasingly popular, especially in Europe and Asia. More than 1 000 bicycle programmes are already in place worldwide with the number of bikes available rising from 1.3m in 2015 to 2.3m in 2016.[85]

Typically, bicycle programmes are set up by municipalities, PTO/As, transportation companies such as Deutsche Bahn or start-ups. They are financed by usage fees, sponsoring and public support.

In recent years, there has also been a trend to introduce pedelecs to bicycle fleets and also to offer scooter-sharing with electric scooters.

[85] www.bikesharingmap.com

Ride-sharing

For ride-sharing we distinguish between long-distance social ride-sharing offered by private drivers through a platform such as BlaBlaCar and urban ride-sharing offered by companies including Uber, Lyft and Gett. In the context of this study, we consider long-distance social ride-sharing as “ride-pooling” while Uber, Lyft and others are considered as “ride-sharing”.

Ride-sharing is dominated by American start-ups such as those mentioned above, as well as some local champions such as Didi Chuxing in China and Ola Cabs in India. The global market leader, Uber, recently achieved 2bn trips and offers an average of 1m trips a day to its 8m users.[86]

The ride-sharing business model can be explained by looking at Uber. To offer the service, Uber simply provides the platform and app to connect passengers and drivers. Fares are set by Uber, which receives 20% of the fares while 80% goes to the drivers. There are premium fares during rush hour and also flat rates for off-peak hours. Passengers pay by credit card. Anyone with a driver’s license, car and smartphone can become a driver. Passengers have to download an app and call an Uber taxi via the app.

Ride-sharing is facing highly controversial regulatory and legal discussions in many locations. For example, Uber is banned in some countries such as France and Germany as there are specific requirements that are necessary for professional drivers. There have also been many protests by taxi companies, e.g. in New York and other American cities.

Nevertheless, the ride-sharing market segment is l growing strongly and has already taken away most traditional taxi business in some locations such as California and New York.

Ride-pooling is a very popular concept, especially in Europe. The clear market leader is BlaBlaCar, with more than 25m members (see Figure 0 below). Ride-pooling is a peer-to-peer sharing concept where private drivers offer free seats to other private individuals that are going the same direction. In contrast to ride-sharing, drivers are not aiming to make a living by offering the rides, but the goal is rather to share costs for fuel and the car during a joint drive. Platform providers therefore often cap the fees a driver can charge to passengers.

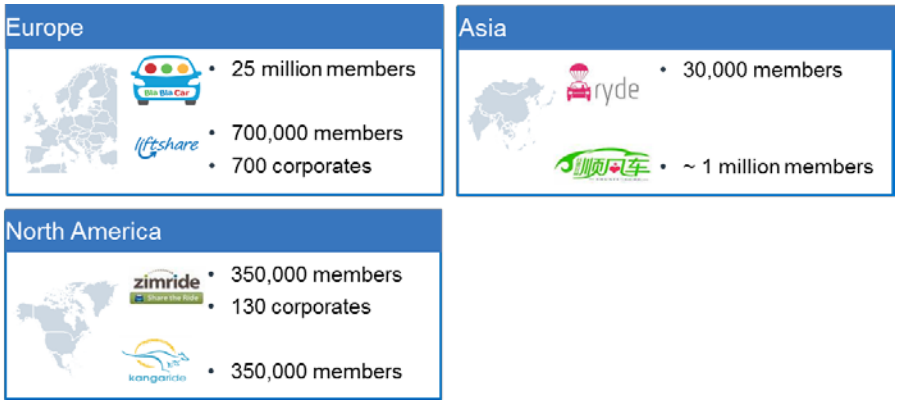


Figure 68 – Ride-pooling members worldwide[87]

[86] http://expandedramblings.com/index.php/Uber-statistics/

[87] Source: Frost & Sullivan

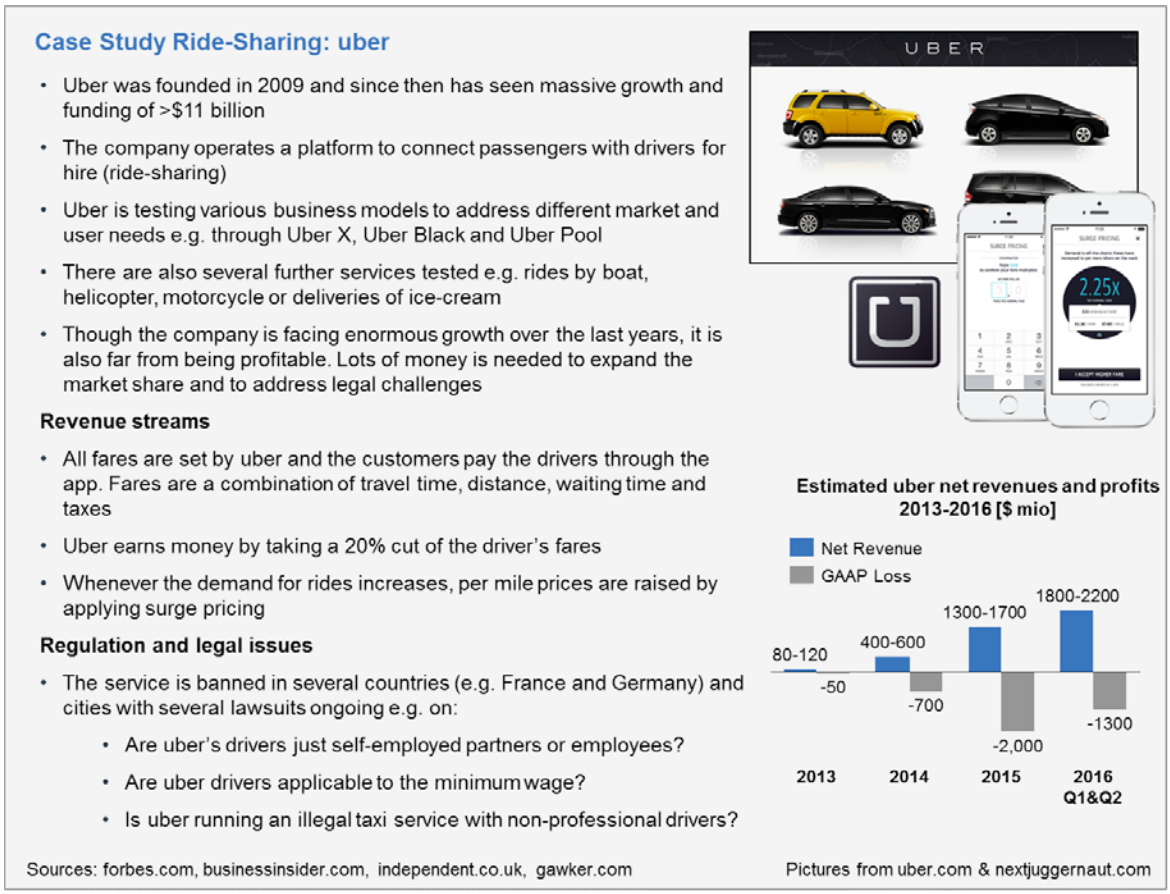


Figure 69 – Case Study Uber

Multimodal transport

Multimodal transport refers to the transportation of passengers under one single contract or ticket but using at least two different means of transport. The target is to offer end-to-end transportation that is as convenient and fast as possible. Thus, people or freight would not need to pay for each means of transport separately. Deutsche Bahn is trying to establish such a model by offering their trains, car-sharing and bike-sharing under one app (Qixxit) and also cooperating with Daimler's car2go. Users can select their rides through the app and Qixxit receives a commission fee. In most of these multimodal apps, it is not yet possible to book and pay for each means of transportation. The user would need to go to each transport provider separately to purchase tickets.

Several start-ups are trying to offer similar services but are finding it difficult to include booking options for the different means of transportation. Local public transport companies also offer multimodal transport apps but often only on a regional/local basis. Some of these local companies are also cooperating with car- and bike-sharing companies to expand their services.

Case Study Multimodal Transport: moovel

- Moovel is a mobility integration platform that is part of Daimler
- The user can plan his journey from A to B through the app by using a combination of various means of transportation
- The journey can be booked and paid through the platform, moovel is receiving a commission fee from the journey operators
- The app today focuses on the German market and offers train rides, car sharing, taxi hailing and local public transport (in Stuttgart and Hamburg)

moovel - Integrated Multimodal Mobility Platform		
Journey Planning	**Booking**	**Payment & Reconciliation**
• Multimodal planning of journeys via smartphone or web platform	• Direct booking of means of transport or referral to third parties	• Payment services for transportation providers
• Car-sharing (car2go, Flinkster) • Taxi hailing (mytaxi)	• Long-distance trains (Deutsche Bahn) • Public Transport (Stuttgart & Hamburg)	
Integrated means of transport		

Figure 70 – Case Study moovel

One issue is that users still have to pay each means of transport separately. The new Finnish start-up Whim is trying to include booking and payment options for each means of transport as well by also offering mobility packages.

Case Study Multimodal Transport: Whim

- Whim is developed by the Finnish Start-up MaaS Global and aims at offering Mobility as a Service including booking and payment of all means of transport
- The app is in the early stages and just starting in Helsinki; car-sharing, long-distance buses and trains are not included, yet

There are different pricing options available to the user:

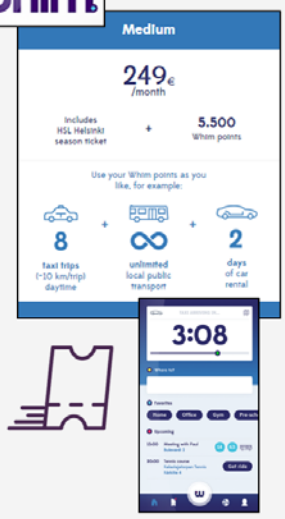
- *Pay as you go*: Pay only what you use – book and pay through the app
- *Mobility packages*: The medium package for 249€ includes unlimited local public transport and a budget of 5.500 whim points for a monthly fee (249€). Whim points can be used e.g. for taxi drives, bike rentals or a rental car for the weekend
- *Enterprise packages*: Aims at corporations and includes a fleet of rental cars, taxi budget, airport lounge access and food deliveries

Key advantages compared to other multimodal apps:

- Only one registration to use all means of transport
- Mobility ready to go at all times, no need to look for the best tariff and buy a ticket
- Booking and payment included in app

Regulatory push:

- Finnish government introduces new regulation by mid 2018: all mobility providers have to open their API-interfaces for digital ticketing



Pictures from whimapp.com

Figure 71 – Case Study Whim

Parking

In recent years, several start-ups emerged that are aiming to facilitate looking for available parking spaces, especially in urban areas. The user can look for a parking space through an app and, in some instances, make a reservation.

Capacity-as-a-service, logistics platforms and last mile deliveries

Capacity as a service refers to a business model where capacity for transporting goods is sold instead of containers or trucks. The customers of this concept are today's trucks users, e.g. logistics and transportation companies such as DB Schenker or Kühne + Nagel and parcel services like UPS or DHL as well as new players, such as Amazon. There might also be intermediaries between the capacity provider and the customer that act as agents. For example, some commercial vehicle OEMs are considering business models where they do not just produce and sell their trucks to third parties (logistics and transportation companies, parcel services) but instead offer capacity for everyone to book through their own platform. The OEMs would than manage a fleet of trucks and vans that provide capacity. In such a scenario, high utilisation and intelligent routing would be the key to success.

Platform providers would earn money through commission fees. Companies such as commercial vehicle OEMs could also cover the upstream value chain by providing the hardware. The technology is based on an online platform that brings together the demand side and the supply side for capacity.

Autonomous taxis and shuttles

These are future mobility concepts and thus there are no market data yet, as the technology of autonomous cars is still under development. Many companies conducting doing research in this area, especially established and emerging OEMs, service providers (e.g. Uber in the US, Easymile and navya in France) and technology companies (e.g. Google and Baidu). The first self-driving taxi service in the world was launched in August 2016 as a pilot project by the start-up NuTonomy in Singapore. Uber is also experimenting with Robo-Taxis in Pittsburgh.

The fleets of autonomous cars are available for everyone, primarily in city centres. The concept is similar to regular taxis but without a driver. The end-users pay per distance or time travelled to the destination or a combination of both.

A distinction must be made between the business models of companies which provide the hardware (the self-driving cars) and companies which provide the service (offer the ride). The service providers receive money from the end-users from the rides taken. The providers of the rides have to pay the hardware providers for the cars. Some OEMs might also aim at providing both the hardware and the platform.

Online service platforms offer to book rides via smartphone. Self-driving taxis could differ from privately owned autonomous cars by adapting more to use cases in the city, e.g. shuttle buses with more space for luggage or a lower maximum speed.

Figure 72 – Autonomous shuttle concept by navya[88]

[88] Source: navya.tech

Platooning

Platooning refers to a concept where several connected trucks communicate with each other and thus make it possible to drive in a "platoon" on highways. This means that the distances between the trucks can be reduced to 15 metres,[89] which then leads to significant fuel savings of around 12%.[90] In the future, it would also enable a concept where only the lead truck is driven by a human driver while the following connected cars are driven by an autonomous driving system.

Figure 73 – Platooning concept[91]

Enabling services

By "enabling services" we understand services that are important enablers for Innovative Transport technologies and products to really gain traction in the market. A good example is the availability of charging infrastructure as one of the most important prerequisites for customers to buy electric vehicles.

Operating charging stations

In recent years, there have already been massive investments into public and private charging infrastructure for electric vehicles in Europe. However, there are still charging gaps, especially in rural areas. In addition, in order to charge vehicles more quickly (e.g. in less than one hour), there is a need for fast chargers with more than 100 kW. Figure 74 below illustrates global charging station deployment and forecast for the next few years. Today 2m-3m charging stations are available but that number is expected to quickly rise in the coming years.

Charging stations are mostly operated by big utilities and several regional or local energy providers in a very fragmented market. Another upcoming trend is OEMs such as Tesla setting up and operating their own charging network.

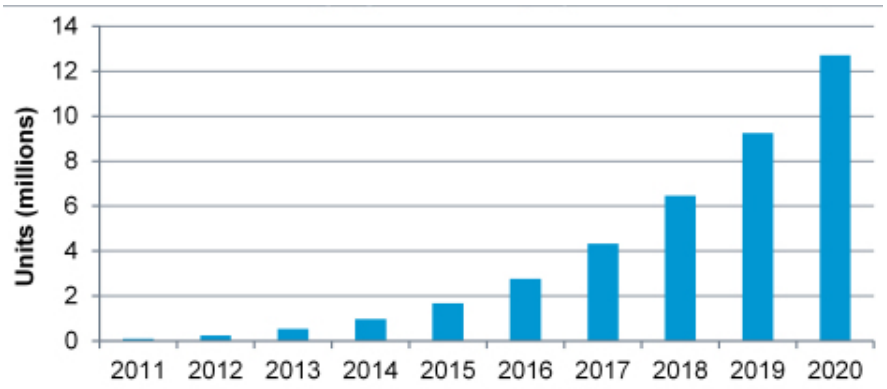


Figure 74 – Global charging station deployment and forecast[92]

[89] Source: daimler.com

[90] Source: man.com

[91] Source: Scania.com

The adoption rate of electric vehicles is also strongly correlated with the availability of charging infrastructure. Figure 75 below shows that, in general, the higher the density of charging infrastructure, the higher the share of electric vehicles on the streets.

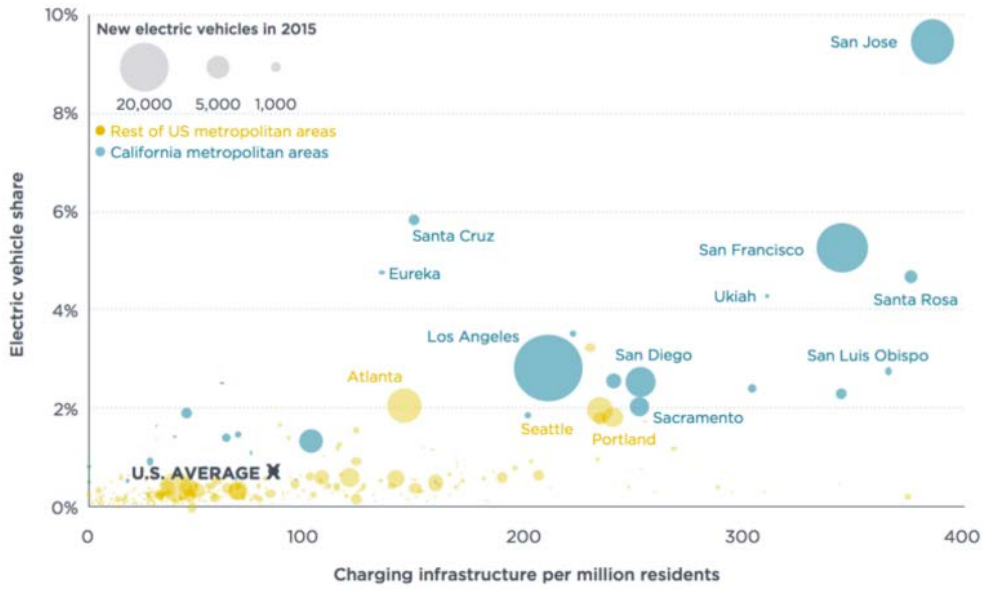


Figure 75 – Relation of electric vehicle share to charging infrastructure deployment in the US[93]

Charging apps and payment

Several companies and apps are aiming at becoming the go-to application for users to locate charging points and to pay for charging. The emergence of e-roaming over the last years driven by companies like Hubject is also a huge step forward to make charging and payments easier for users by removing the need to register with all the different charging operators separately.

[92] Source: IHS Automotive

[93] Source: IHS Automotive

Appendix D – Exemplary investment and cooperation activities of OEMs and suppliers

Product Sales			
Investor type	**Investor**	**Target / Partner**	**Investment type / Coop-model**
OEMs	GM	Cruise Automation	Take-over
	Ford Volvo Daimler Audi Renault Jaguar Land Rover	Livio Peloton Matternet, Starship, Quanergy TTTech Devialet, Chronocam Cloudcar	Minority Stake
	Audi BMW BMW VW GM Daimler Seat Toyota	Nvidia Intel, Mobileye Microsoft Mobileye Mobileye Qualcomm, Argus, Vayyar Samsung, SAP Microsoft	Cooperation
Suppliers	ZF Delphi Continental Harman Bosch Valeo	TRW Ottomatika ASC, Elektrobit Aha, S1nn, Symphony ProSyst Pelker	Take-over
	Delphi Bosch	Quanergy AdasWorks	Minority Stake
	Valeo	Mobileye, Safran	Cooperation

Figure 76 – OEM and supplier investments and cooperation in Product Sales

Usage-Based Payment			
Investor type	**Investor**	**Target / Partner**	**Investment type / Coop-model**
OEM	Daimler Daimler Daimler PSA GM	RideScout Hailo MyTaxi Autobutler Sidecar	Take-over
	GM VW Toyota BMW Daimler Audi Ford Peugeot	Lyft Gett Uber JustPark, Moovit, Zirx, Scoop, Tiramizoo Flixbus, Blacklane,… Silvercar, nuTonomy CarJump	Minority Stake
	Toyota BMW Daimler	Uber Sixt Europcar	Cooperation
Suppliers	Harman	Aditi	Take-over
	Bosch	ParkTAG	Minority Stake
	Bosch	TomTom	Cooperation

Figure 77 – OEM and supplier investments and cooperation in Usage-Based Payment

Monetize User Data			
Investor type	**Investor**	**Target / Partner**	**Investment type / Coop-model**
OEM	Audi, BMW, Daimler VW	Nokia Here PayByPhone, Sunhill	Take-over
	BMW Audi	Life360, Zendrive Cubic Telecom	Minority Stake
	BMW Audi, BMW, Daimler BMW Daimler	Baidu Intel, Tencent Microsoft Otonomo	Cooperation

Figure 78 – OEM and supplier investments and cooperation in Monetise User Data

Electricity Sales			
Investor type	**Investor**	**Target / Partner**	**Investment type / Coop-model**
OEM	BMW, Daimler, VW BMW, Daimler, VW, Ford	Hubject Charging Network	Joint Venture
	BMW	Chargepoint, Chargemaster	Minority Stake

Figure 79 – OEM and supplier investments and cooperation in Electricity Sales

Appendix E – Description of supply and demand side interview populations

Summary of the supply side interview population

Several interviews with financial counterparties were conducted in order to understand the financing gap and test a series of hypotheses. The outcome of the interviews informed the analysis and helped crystallise recommendations on potential approaches. This section gives a short introduction of the financial institutions interviewed on the supply side.

According to the demand side sample, which is primarily start-up and SME driven, the analysis of the supply side focused on equity investors. Consequently, of the financial actors interviewed, five were VC funds, four were corporate investors (three from automotive, one from technology) and two were PE funds. In addition, two banks and one financial marketplace for start-up equity financing were included in the supply side interview scope.

The demand side analysis showed that half of the European Innovative Transport market consisted of German companies. Consequently, the geographic focus of the supply side analysis was shifted predominantly onto financial institutions that were based in Germany. As the Venture Capital market in Europe is strongly dominated by the UK (34% of all European VC activity[94]), it was decided to add the UK as the second geographical focus of the analysis.

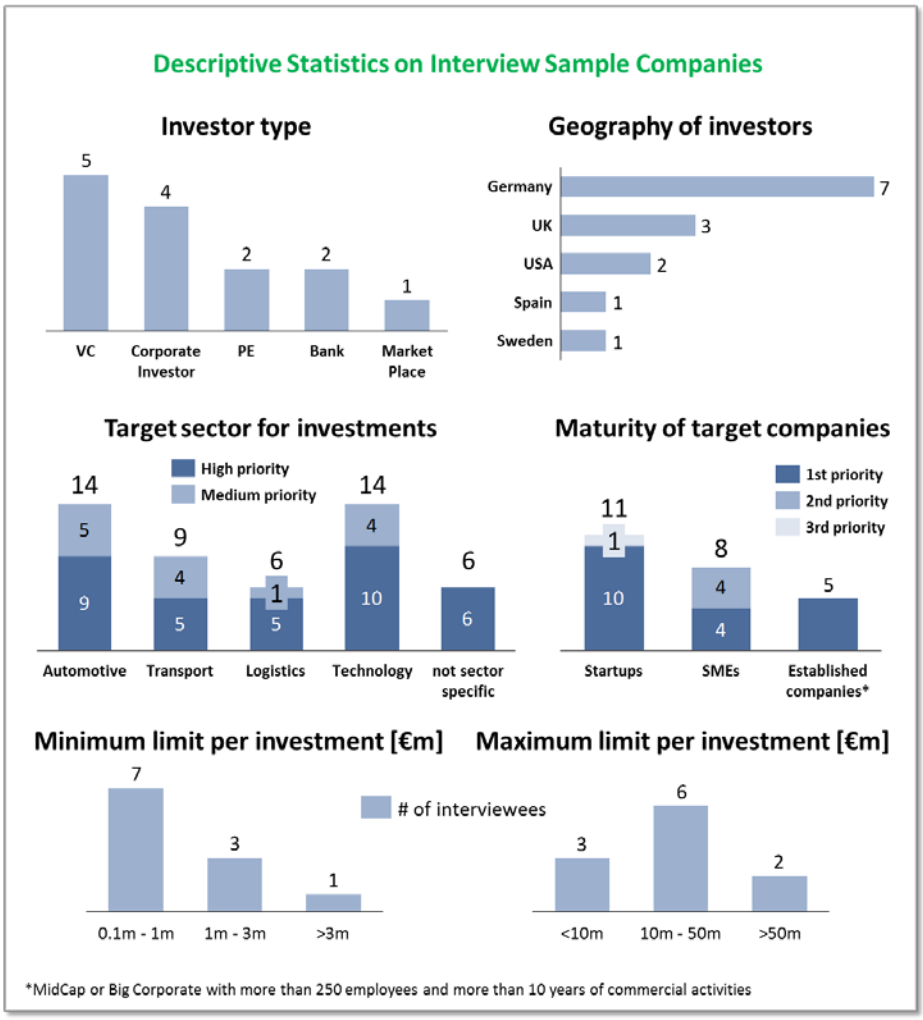


Figure 80 – Descriptive statistics on supply side interview sample companies

[94] Source: Dow Jones Venture

Summary of the demand side interview population

The aim for the interview process was to compose a representative sample of companies within the overall Innovative Transport landscape. A long-list of 865 companies was compiled from all geographies that are active within Innovative Transport. Looking at the maturity of the companies on the long-list already hints at the strong relevance of start-ups in the sector, with start-ups accounting for 531 or 61% of all companies. Another point of note was that Product Sales is still the most used business model by far with 537 companies, 54% of them start-ups. The start-ups are more active in the B2B than in the B2C Product Sales business models. Usage-Based Payments is the second most sought after business model with 202 companies, most of them start-ups (81%). Monetise User Data and Electricity Sales are the main business model of 104 and 22 companies respectively.

Compared to the long-list, the interview sample of 38 companies had similar characteristics. Start-ups represent the biggest group with 14 companies (37%), followed by 11 (29%) SMEs. The sample is also representative from the business model angle: 18 of the 38 companies are following Product Sales as their primary business model with 44% of them start-ups. Usage-Based Payment is the second biggest group with ten companies, seven of them start-ups.

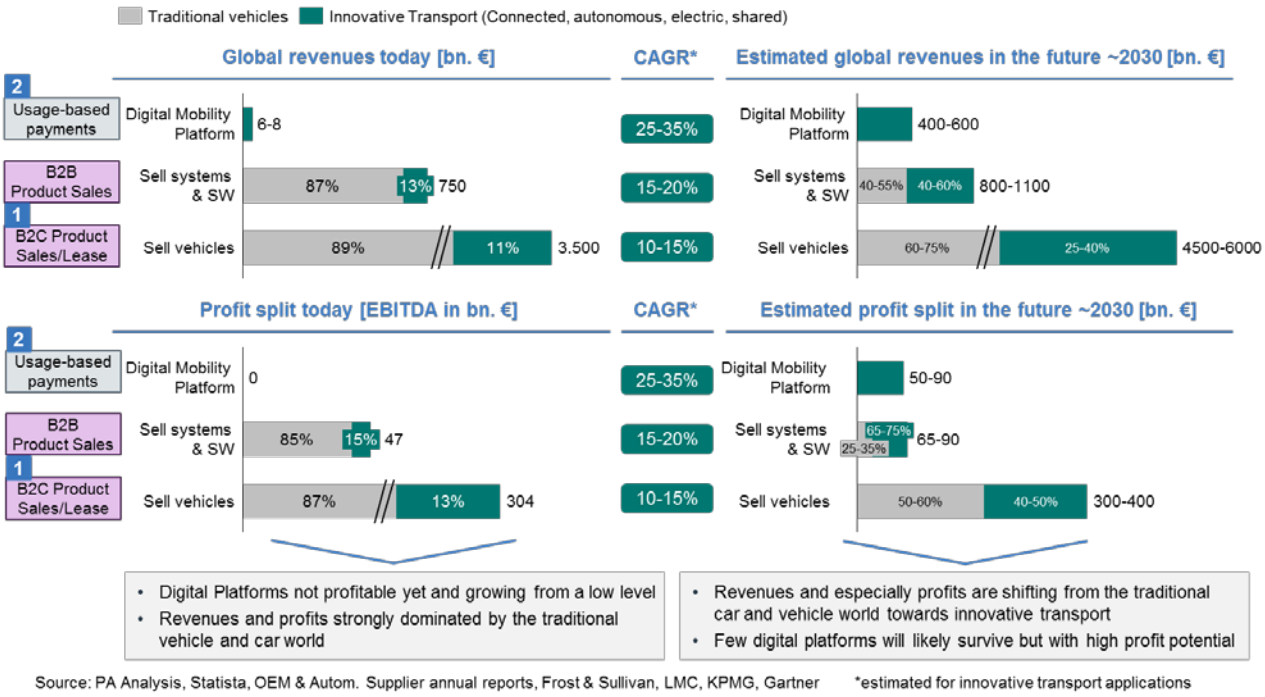
The geographic split of the general long-list landscape reveals that Innovative Transport in Europe is very reliant on German companies (199 or 35% of the 569 identified European companies). Further countries with a high representation are the UK, Israel and France, with 45 to 47 companies. The interview sample reflects this geographical distribution.

Appendix F Commentary on Calculations and Assumptions on Values Used

This section provides further commentary detail on the assumptions made about critical values and the calculations to support some of the values provided in the report.

Core Revenue and Profit Pools for Transport and Innovative Transport Markets

The following chart represents an amalgamation from a number of sources analysed by PA, including Statista, supplier annual reports, Frost & Sullivan, LMC, KPMG and Gartner.



Source: PA Analysis, Statista, OEM & Autom. Supplier annual reports, Frost & Sullivan, LMC, KPMG, Gartner *estimated for innovative transport applications

Assumptions

The report makes the following assumptions to drive some of the underpinning financial conclusions.

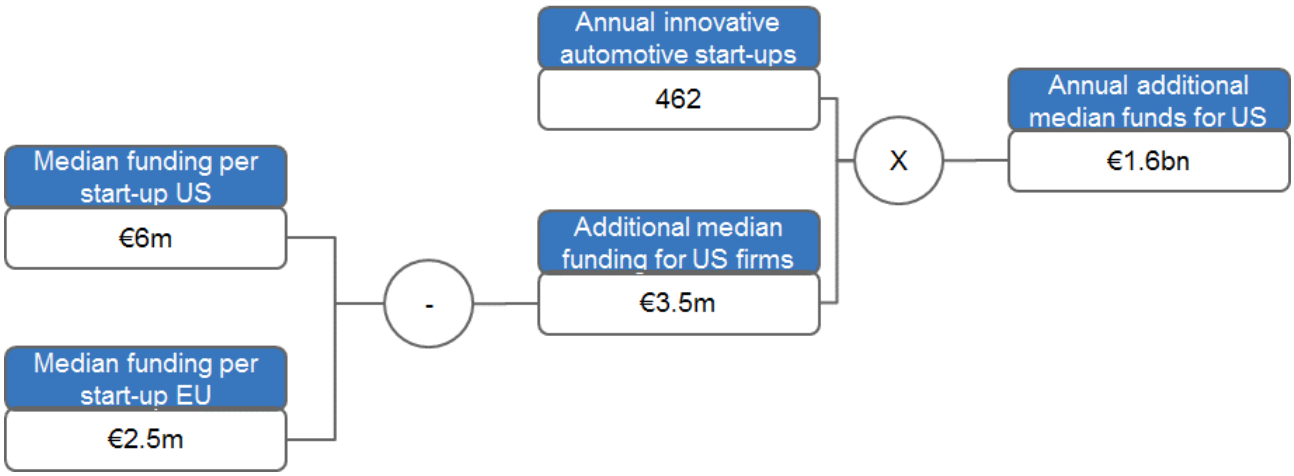
Assumption	Rationale
The Innovative Transport market grows at 15-25% CAGR between 2016 and 2030	We looked at two data sources for this. The Strategy& report "Connected Car Study 2015" quotes growth from a market size of €40.3bn in 2016 to €122.6bn in 2021. This represents a CAGR of 25%. The McKinsey report "Automotive revolution – perspective towards 2030" looks at a "recurring revenue" market of $30bn in 2016 growing to $1 500bn in 2030. This represents a CAGR of 32%. We consider both measures to be representative of the Innovative Transport market and suggest a more conservative 15-25% range for this report
The size of the total, global Transport Market is €4 258bn in 2016	Based on the diagram above, the total revenues today of digital mobility platforms, sales of systems and software and sales of vehicles total €8bn + €750bn + €3 500bn = €4 258bn in 2016
The size of the global Innovative Transport Market is €490bn in 2016	Based on the diagram above, the total revenues today of digital mobility platforms, sales of systems and software and sales of vehicles for the Innovative Transport Market total €7bn + €98bn (13% of €750bn) + €385bn (11% of €3 500bn) = €490bn
35% of the debt funding in the Transport Market is in Innovative Transport	We consider that the future revenues in 2030 are a better lead indicator of overall debt funding than the current revenue streams, as investors are likely to look at future revenue streams rather than current. On this basis, estimated global revenues in Innovative Transport (using mid-points from the diagram above) would be €2,705bn out of a total of €6,700, 40% of the total transport market. We consider therefore that 35% is a more appropriate, conservative estimate for debt funding in the Innovative Transport market.

Calculations

Equity gap – Lower average funding rounds

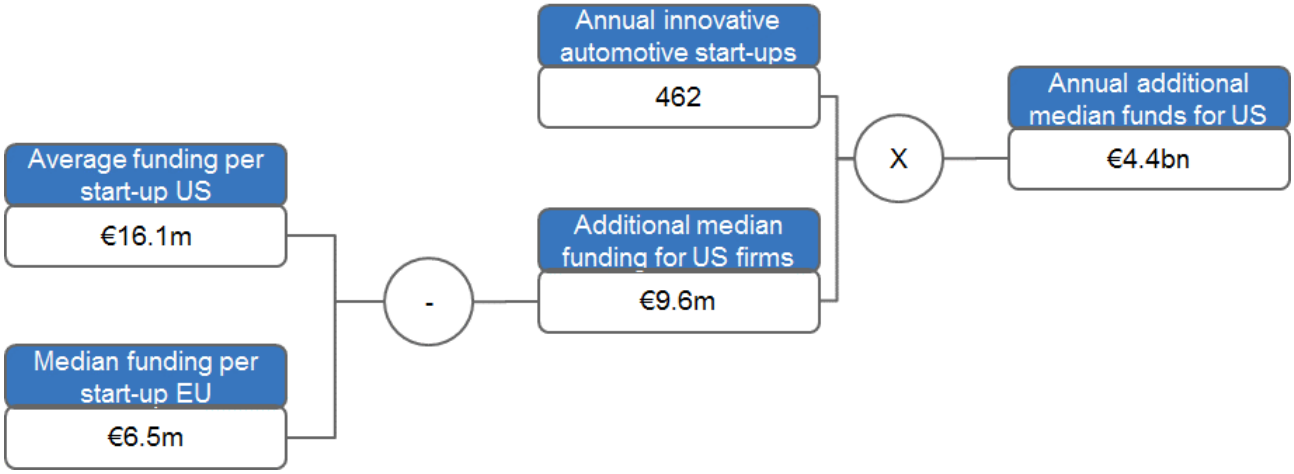
Lower bound

The lower bound for the disadvantage that EU Innovative Transport firms have in comparison to US firms is calculated as follows.

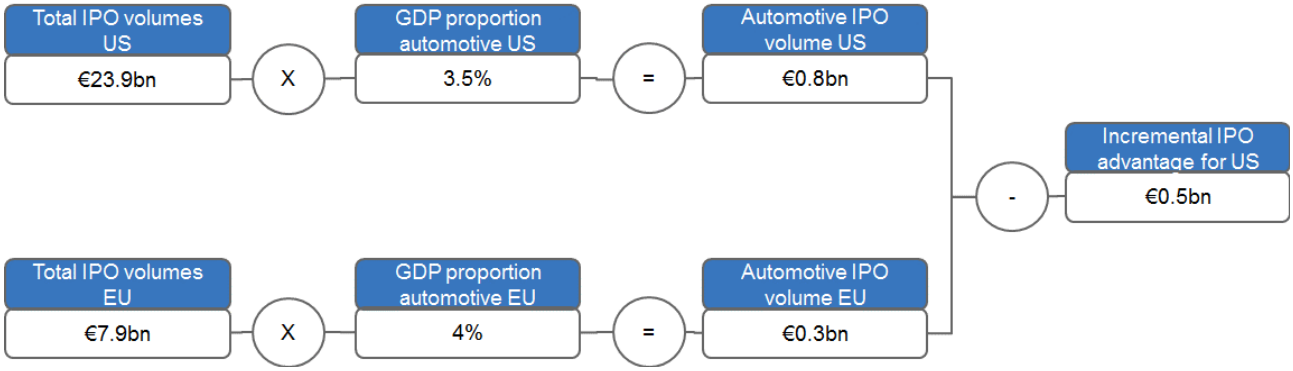


Upper bound

The upper bound for the disadvantage that EU Innovative Transport firms have in comparison to US firms is calculated as follows.



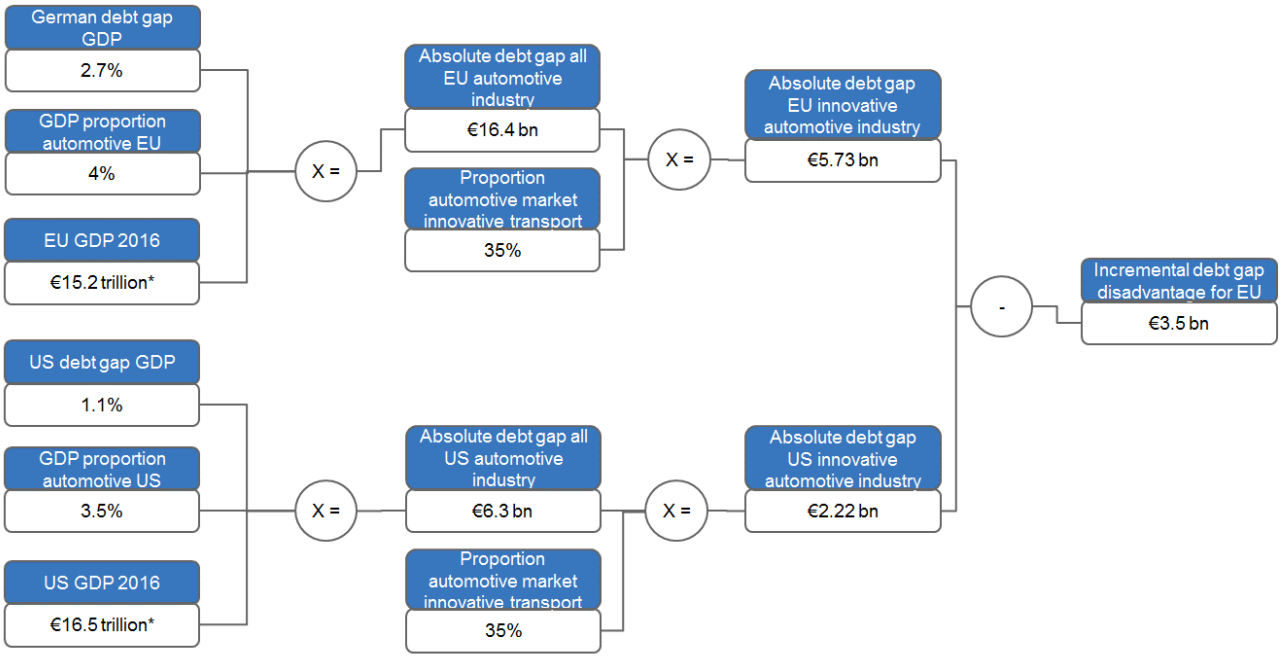
Equity gap – Lower IPO exit volumes



Debt gap – SME debt gap

Lower bound

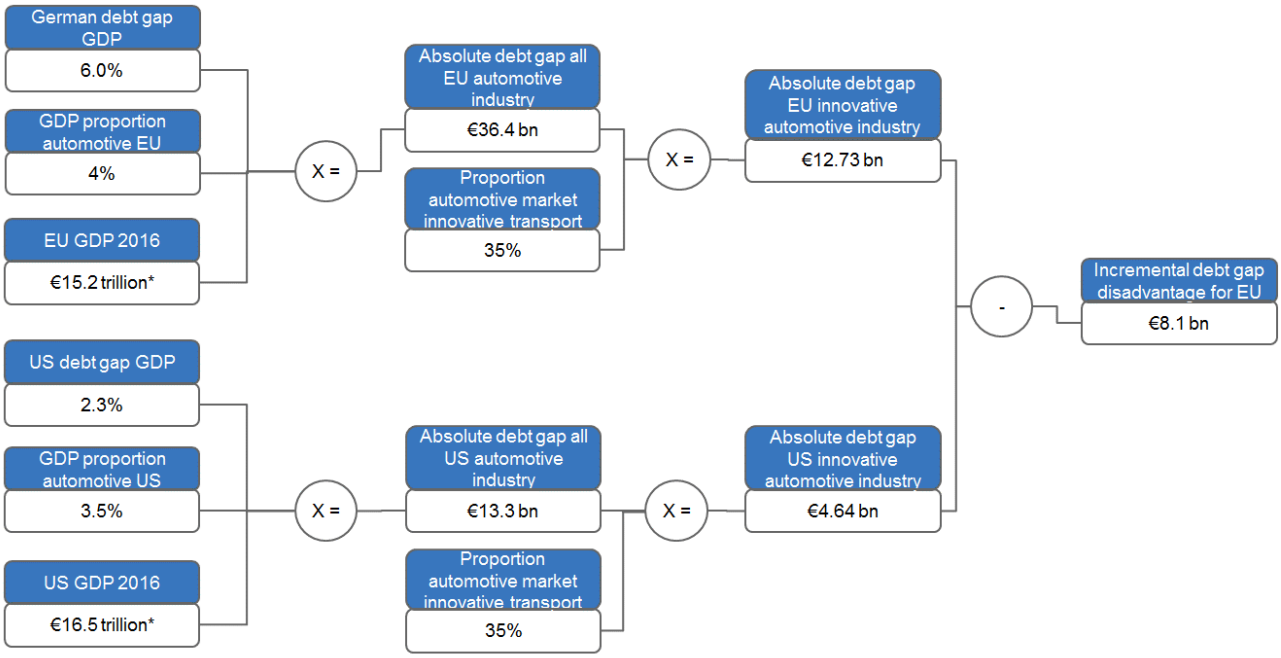
The lower bound for the disadvantage that EU Innovative Transport firms have in comparison to US firms with regards to the SME debt gap is calculated as follows.



* IMF figures for 2016, converted to Euros at 2 Jun 2017 rate of USD:EUR 1:0.8863

Upper bound

The upper bound for the disadvantage that EU Innovative Transport firms have in comparison to US firms with regards to the SME debt gap is calculated as follows.



* IMF figures for 2016, converted to Euros at 2 Jun 2017 rate of USD:EUR 1:0.8863

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