EGVI
European Green Vehicles Initiative

EGVI 10 YEARS IMPACT ASSESSMENT

Comprehensive impact assessment covering EGVI decade of existence

EGVIA

European Green Vehicles Initiative Association (EGVIA), non-profit organisation engaged with the European Commission services in the EGVI (European Green Vehicle Initiative) public private partnership

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EGVI
10 YEARS
IMPACT ASSESSMENT

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in collaboration with

advancy

10 YEARS emisia
CONSCIOUS OF TRANSPORT'S IMPACT

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EXECUTIVE SUMMARY

Mobility is one of the keys of European economic growth and development. Since 2012, passenger and freight road mobility in Europe has been on the rise and is expected to still grow significantly by 2030 (+10%). In the meantime, transport represents almost a quarter of Europe's greenhouse gas emissions and is one of the main cause of air pollution in cities.

To conciliate the necessary reduction of GHG emissions with societal mobility needs, Europe's answer should be a rapid and massive shift to low-emission mobility solutions.

In 2008, the European Green Vehicles Initiative (EGVI) cPPP has been set-up to tackle these challenges and support the European automotive value chain to overcome the consequences of the economic crisis. Over its 10 years duration, the European Union has funded 178 projects distributing €886 million to all stakeholders along the value chain: industry players, SMEs, research centres, universities … via the EGVI partnership.

Covering many different areas in the field of the improvement of energy efficiency of vehicles, EGVI has improved the performance of many vehicles types and has been a success so far by:

- **Helping achieve CO_2 emission reduction:** reduction potential amounts to 34% by 2030 compared to 2015 best in class vehicles, of which 10% thanks to fleet electrification and 24% is due to type improvements at vehicle level and improvement of traffic conditions which EGVI projects are contributing to
- **Accompanying the growth of automotive R&D spending** leading to highly skilled job creation within the EU, including within SMEs & outside of the automotive industry
- **Supporting the European industry to enter and take a leading position** in the race of Green Vehicle technologies
- **Fostering new technology developments** to help Europe keeps its leadership in automotive innovation and low emission vehicles.

However, several challenges still lay ahead for the EU low-emissions road transport:

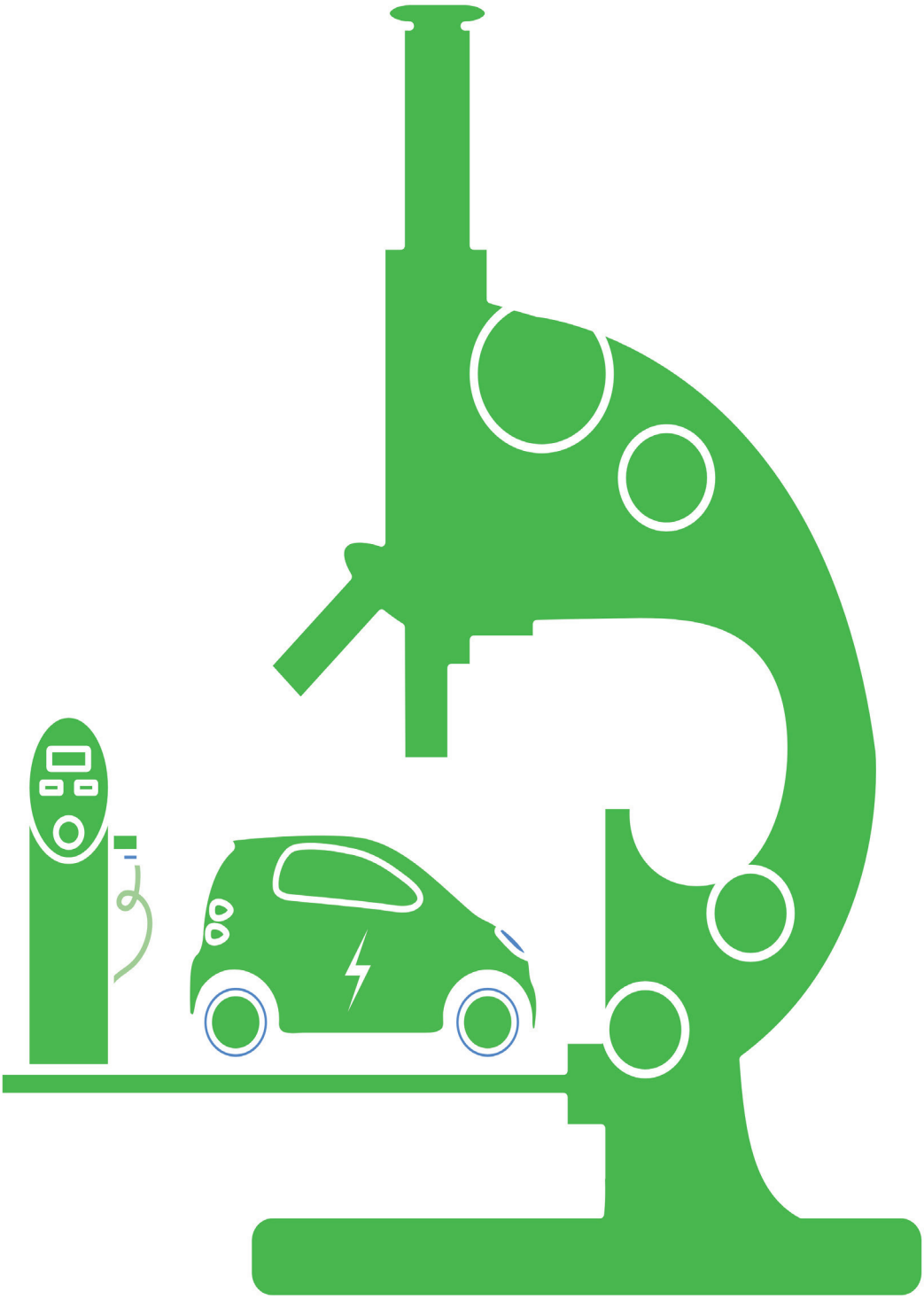
- **Technical challenges**: the future CO_2 emissions targets are very challenging and can only be achieved by investigating all technical options available, at an acceptable cost level
- **A competitive challenge**: several new contenders emerging in comparison to the 2008-2017 period, especially China where the industry weight in the GDP has tripled in less than 15 years
- **A research funding challenge**: China, USA & Japan invest between €100M and €1Bn per year in public funded research that needs to be matched by the EU to stay in the global race.

To consolidate its achievements and deliver additional impact in the future Research Framework Programme Horizon Europe, EGVI needs to:

- Accelerate and support the roll out in serial life of new technologies already developed
- Push further in-vehicle technology topics, with a specific focus on affordability and manufacturing
- Move from a tank-to-wheel view to cradle-to-grave and full life cycle thinking on all emissions type
- Find the right balance between disruptive and incremental innovation projects
- Expand its scope of research by developing a holistic view of the transportation system, by deepening the links with energy production and by leveraging digital technologies
- Extend its membership and collaboration to new stakeholders within automotive and outside such as ICT, battery manufacturers, infrastructure and energy producers and distributors.

The challenge of reducing road transport emissions to deliver on environmental and societal goals is only going in one direction: getting bigger and harder to achieve. The European RTD ecosystem has only started to deliver results in the car fleet, and more will follow soon thanks to the activities currently performed in collaborative research, but reaching the 2030 and 2050 targets is not getting any easier. The amount of work to be done and the number of people to be put around the table to achieve our targets is very high and is continuously growing. The EU needs to make sure to keep its leadership in clean vehicles technologies and to maintain the associated necessary levels of investment in R&D and CAPEX in order to lead the race in Green Vehicles technologies.

The achievements are already significant, but we need to continue building on the successful EGVI experience to achieve a Green Vehicle fleet on European roads!



1 INTRODUCTION

A. PRESENTATION OF EGVI

The European Green Vehicle Initiative Association (EGVIA) is a European non-profit organisation engaged with the European Commission services in the EGVI (European Green Vehicle Initiative) public private partnership. It federates its 84 members around the future challenges and research and innovation activities needs to achieve a smart, sustainable and integrated road transportation.

EGVI was created 10 years ago, following the 2008 economic crisis, to increase European competitiveness and to keep an EU competitive edge on powertrain efficiency, alternative powertrains and a leading edge on mobility systems in a context where technological competition from the USA but also Asia is growing with a risk of taking over the undisputed long lasting EU leadership in automotive innovation and clean powertrains.

The main activity of EGVIA is to identify research and innovation priorities and support activities performed under the relevant R&D&I projects funded under the partnership, as part of the Horizon 2020 programme. EGVIA fosters collaboration among its members thanks to a technical roadmap defining commonly shared objectives, its participation to the preparation of biennial calls for projects, the sharing of information on research project results, dedicated events and networking with public entities.

EGVIA members are typically:

- **Industrial companies**: OEMs, suppliers, smart system providers, infrastructure developers…
- **Research entities**: Contract Research Organisations, Universities…
- **SMEs** developing new technologies and services…

Since 2009, the partnership is strongly connected with three European Technology Platforms: ERTRAC[1], EPoSS[2] and ETIP-SNET[3] and covers all types of road vehicles: passenger cars, light commercial vehicles, trucks, buses and 2-wheelers.

The EGVI cPPP role is to accelerate the research, development and demonstration of new technologies to facilitate the use of clean energies in road transportation to reduce CO_2 emission from road transport.

1. European Road Transport Research Advisory Council
2. European Technology Platform on Smart Systems Integration
3. European Technology and Innovation Platform for Smart Networks for Energy Transition

B. A 10 YEARS PARTNERSHIP, TIME TO ASSESS ITS IMPACT

A first assessment on the research PPPs established under the European Economic Recovery Programme was performed in 2013 and was very supportive of the research PPP model, although it noted that only a few projects had been completed yet and that it was still somewhat early to be definitive about the magnitude of the effect in terms of achieved commercialisation.

EGVIA has already conducted an impact assessment in 2016. This analysis has already demonstrated tangible results obtained thanks to EGVI cPPP and was covering the 2009-2015 period. EGVI kept accelerating after this period.

For its tenth anniversary, EGVI has decided to reflect back on its activities and to carry out a more comprehensive impact assessment covering its decade of existence with the support of two external consultancies: Advancy and EMISIA. Beyond the impact assessment itself, one objective is to identify areas for improvements and opportunities for new R&D topics on clean and sustainable mobility.

While Horizon Europe, the next Framework Programme for Research and Innovation, is currently being discussed, this new assessment aims at reflecting what has already been achieved by EGVI while identifying areas for improvements in the next financial framework.

The objective of this new study is to assess the benefits and impacts of EGVI cPPP on the automotive value chain along several dimensions:

- CO_2 savings thanks to the market introduction of more efficient combustion engines, electrification and alternative powertrains
- Market development of EVs, hybrids and alternative fuels vehicles
- Increase of Europe competitiveness with a specific focus on the financial crisis of 2009
- Leverage effect of the PPP on private R&D investment
- Creation of new jobs across the European Union
- Development of new skills around E-Mobility and smart mobility systems
- Emergence and participation of SMEs in the new green transportation eco-system.

This study also addresses specific topics to understand what was the contribution of the EGVI cPPP during the last ten years in order to fuel the next programme:

- Support of stakeholder to overcome the "*Valley of death of innovation*" and resulting in a reduction of time-to-market of innovations introduction
- Contribution of new skills being developed to keep European leadership in green and sustainable transportation
- Value added of co-programming thanks to the involvement of private partners in the programme definition
- Project key success factors of the above successes
- Potential benefits beyond the automotive industry.

C. OUTLOOK OF THE METHODOLOGY

The methodology used to perform this assessment combines three dimensions:

- A quantitative assessment of EGVI's impact on CO_2 emissions, based on EMISIA's fleet and emission projection tool **SYBIL**:
  - Detailed bottom-up fleet projection using survival curves based historic fleet composition and age information
  - Integrated baseline for all EU Member States individually and EU28 as a whole
  - Detailed model parameters such as:
    - COPERT vehicle categories and trip patterns (urban / rural / highway / e-mobility)
    - Advanced fuel and efficiency parameters (fossil, electricity, bioethanol/biodiesel, LPG/CNG, Hydrogen)
  - Detailed information on vehicle stocks and activities, covering 5 main domains of outputs:
    - Greenhouse gas and energy (CO_2, CH_4, N_2O, fuel consumption, energy consumption)

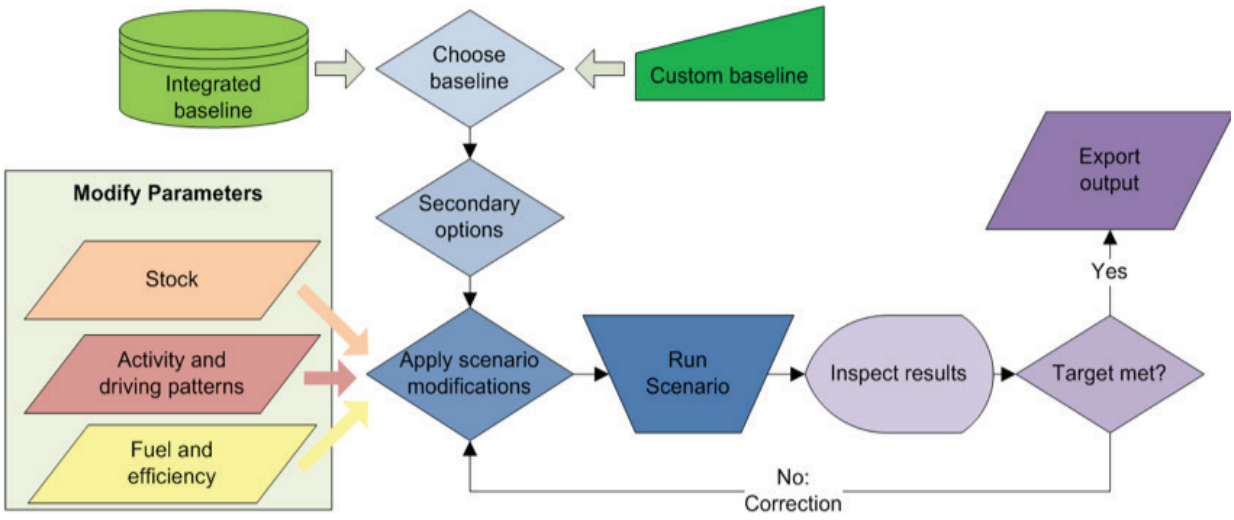


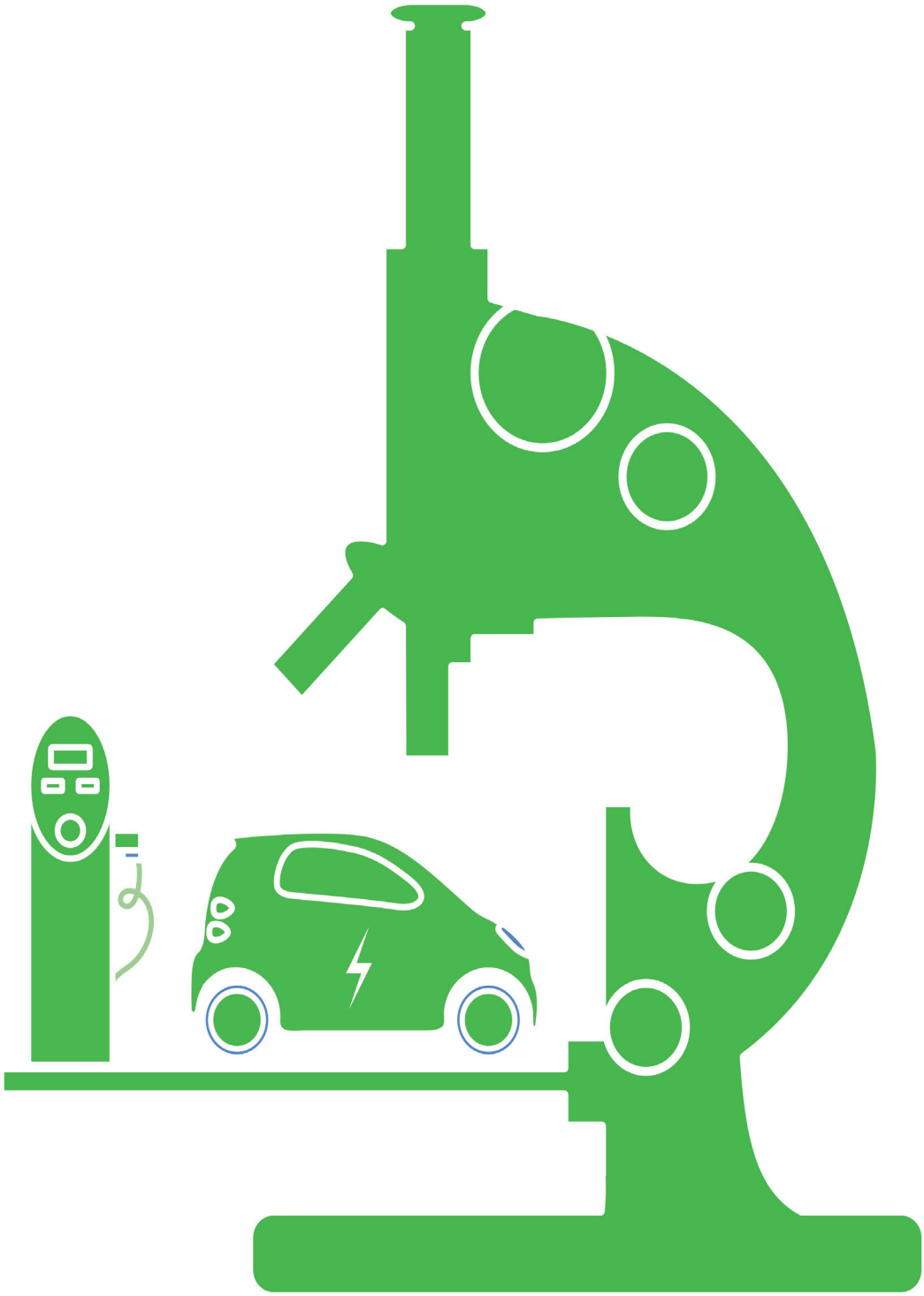
Fig. 1 - SIBYL model structure

- A quantitative and qualitative assessment of the industrial & societal impact of Green Vehicles on European competitiveness and competencies run by Advancy:
  - Quantitative assessment of industrial & societal impact on the Green Vehicle product plans and volumes designed and developed in Europe, R&D spending evolution, patents and standards
  - Benchmark between Europe, China, USA and Japan in terms of investment, R&D spending, government-funded research
  - Qualitative assessment of the skills and non-swappable jobs creation, development of SMEs and development of the research ecosystem in Europe.
- A qualitative review of EGVI strengths, success stories, improvement areas and possible need for scope enlargement, based on stakeholder's interviews [more than 30 interviews performed]

Establishing a direct link between EGVI projects and technologies in serial production is a very challenging exercise, for two main reasons:

- A newly launched vehicle embarks several technologies; hence, it is usually more the result of a combination of projects rather than the direct output of a single pre-competitive project
- EGVI projects are focused on the pre-competitive phase. Before reaching the commercial stage, automotive players have to invest on their own funds to deploy new technologies on the market and the information becomes harder to trace due to confidentiality issues.

However, the co-programming aspect of the partnership ensure that topics funded in the frame of the EGVI cPPP are of high interest to the automotive community. Results are indeed taken to higher TRLs and are included in the portfolio of technologies developed by each stakeholder.



2. EGVI current coverage: modules and domains

EGVI research topics were able to federate a large number of participants (1 000+ of which 160+ SMEs), allowing to fund more than 65 projects, leading to c.25 peer-reviewed publications between 2014 and 2017.

By addressing a large portion of the challenges faced by the full automotive value chain and research ecosystems, it allowed to structure the pre-competitive research effort around all types of Green Vehicle formats and to cover most of the key decarbonisation topics.

- **Passenger cars**: EVs, Plug-in Hybrids, Full Hybrids, Mild Hybrids…
- **Light Commercial Trucks**: EVs, Full Hybrids…
- **Heavy duty Trucks**: Natural Gas, Electrified trucks…

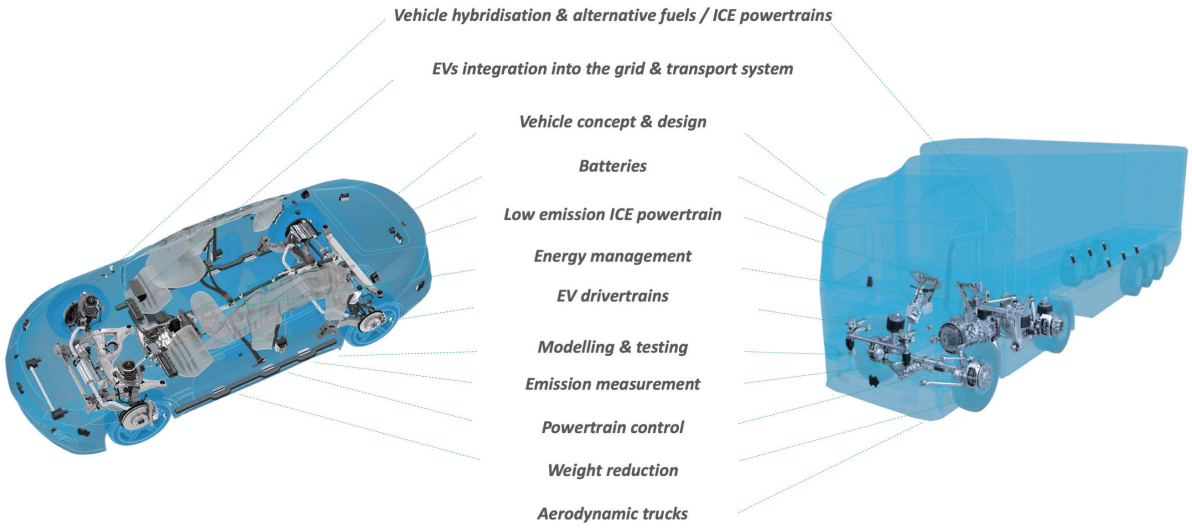
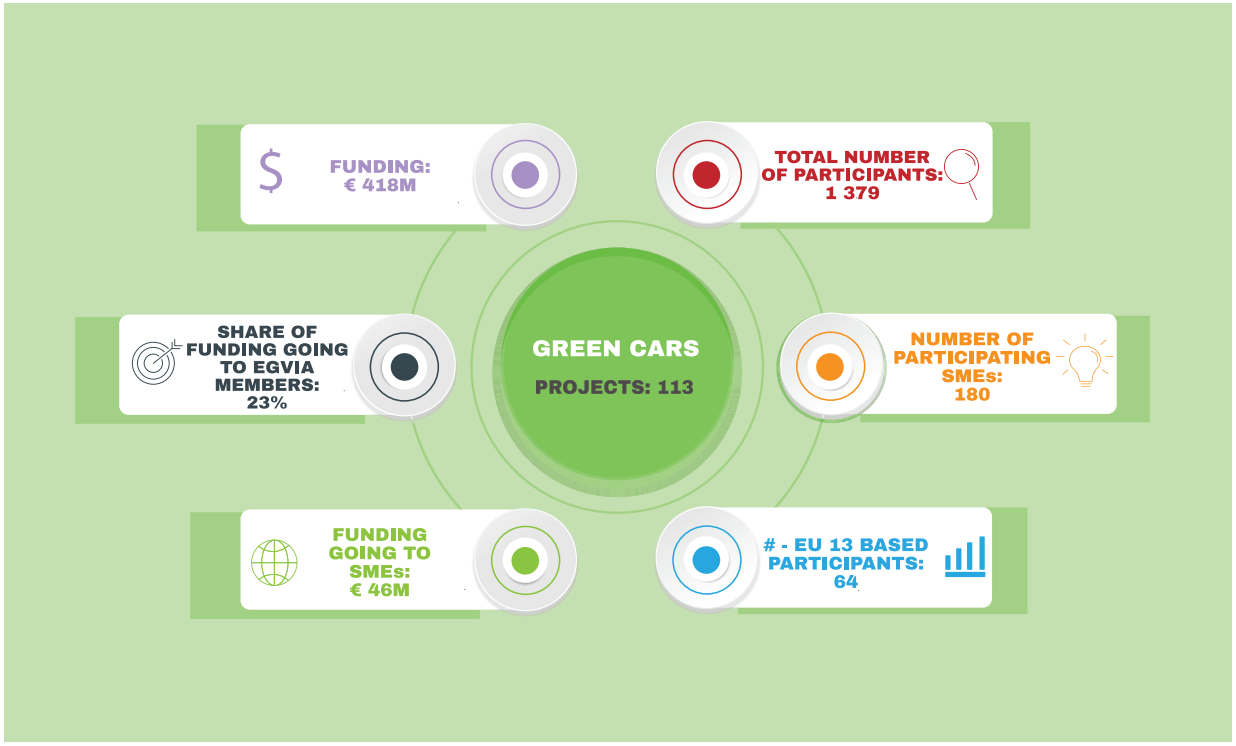


Fig. 2 - Main research areas of EGVI projects

Through both Green Car and Green Vehicle initiatives, a major funding has been dedicated to European research on road transportation decarbonisation.



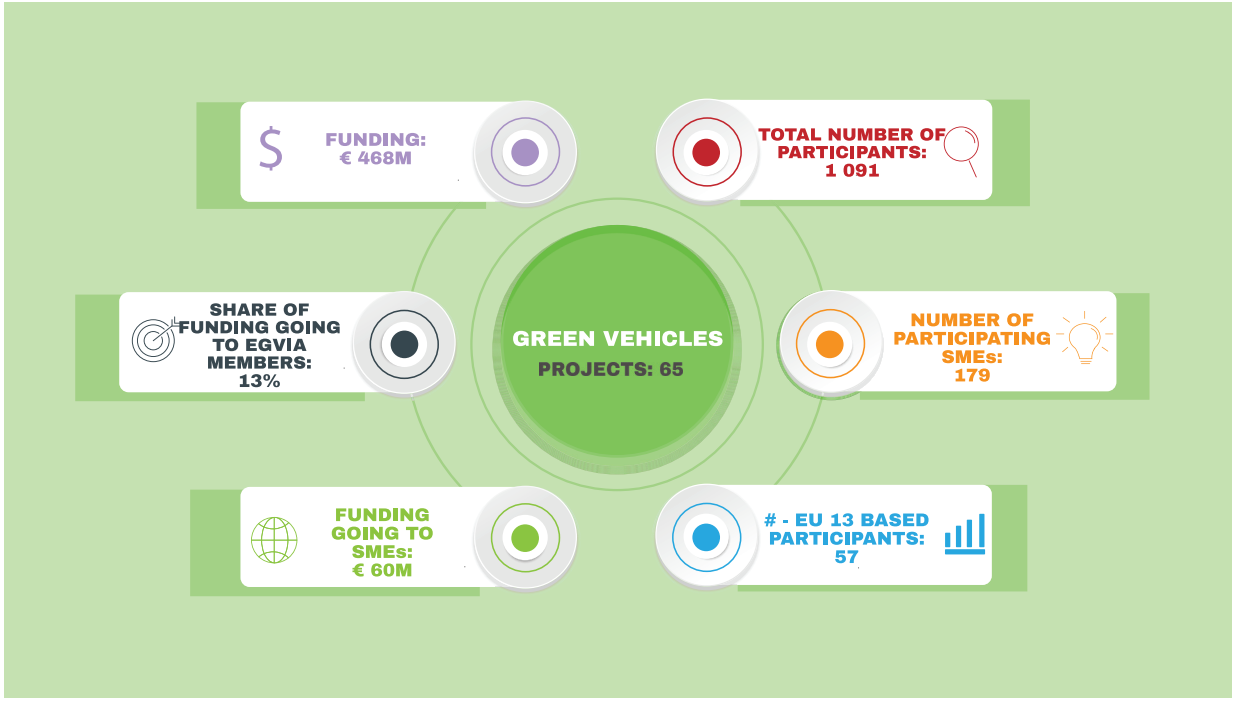
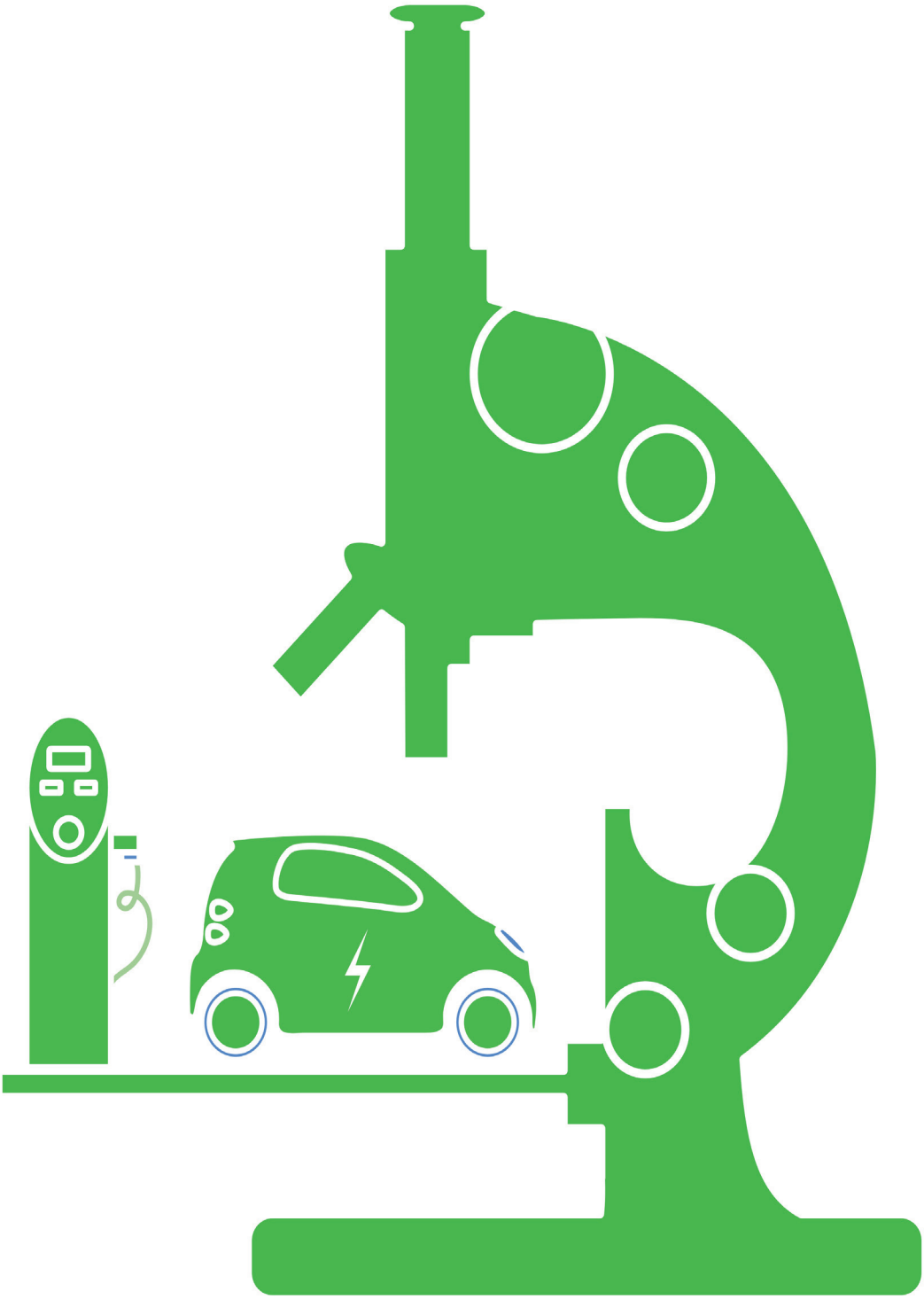


Fig. 3 - Status of projects funded by EGCI and EGVI (2009-2018)



3. EGVI's role in helping Europe reach its CO_2 emissions objectives

A. EUROPEAN STRATEGY FOR LOW-EMISSION MOBILITY

Transport represents almost a quarter of Europe's greenhouse gas emissions and is one of the main cause of air pollution in cities. The transport sector has not seen the same gradual decline in emissions as other sectors: emissions only started to decrease in 2007 and still remain higher than in 1990 (see Figure 4). Within this sector, road transport is by far the biggest emitter accounting for more than 70% of all GHG emissions from transport in 2014. It has only recorded a decrease between 2007 and 2012 mostly due to a decrease in road mobility, in the aftermath of the 2008 economic crisis (see Figure 4).

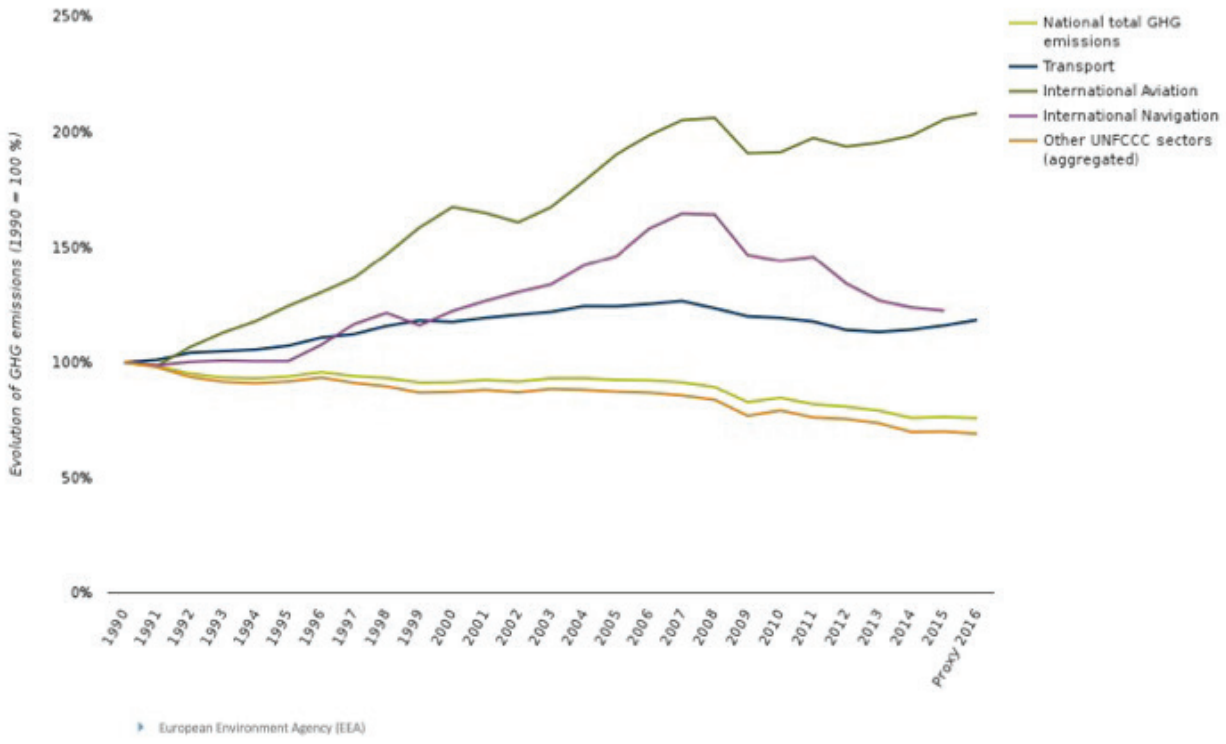


Fig. 4 - GHG emissions in the EU – Index 100 = 1990

With the global shift towards a low-carbon, and circular economy already underway, the European Commission's low-emission mobility strategy, adopted in July 2016, aims to ensure Europe stays competitive and able to respond to the increasing mobility needs of both people and goods.

Europe's answer to the emission reduction challenge in the transport sector is an irreversible shift to low-emission mobility. By mid-century, greenhouse gas emissions from transport will need to be at least 60% lower than in 1990 and be firmly on the path towards zero emission. Emissions of air pollutants from transport that harm citizens' health need to be drastically reduced without delay.

The strategy integrates a broader set of measures to support Europe's transition to a low-carbon economy and supports jobs, growth, investment and innovation.

The strategy will benefit European citizens and consumers by delivering improvements in air quality, reductions in noise levels, lower congestion levels and improved safety. Consumers will benefit from less-energy consuming cars, from better infrastructure for alternative fuels, better links between transport modes, better safety and fewer delays thanks to the roll-out of digital technologies.

B. EU MOBILITY DEVELOPMENT AND GHG EMISSIONS

Passenger & freight mobility in Europe, and in particular road mobility, has been on the rise since 2012.

One may think that increasing the share of rail in transport mode, especially for freight as suggested by the White Paper on "*Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system*" published in 2001 and updated in 2011, could be an efficient solution to reduce EU GHG emissions. However, the share of rail transport has not grown sufficiently to replace road mobility in the last decade and no game changer take off is expected in the short to medium-term.

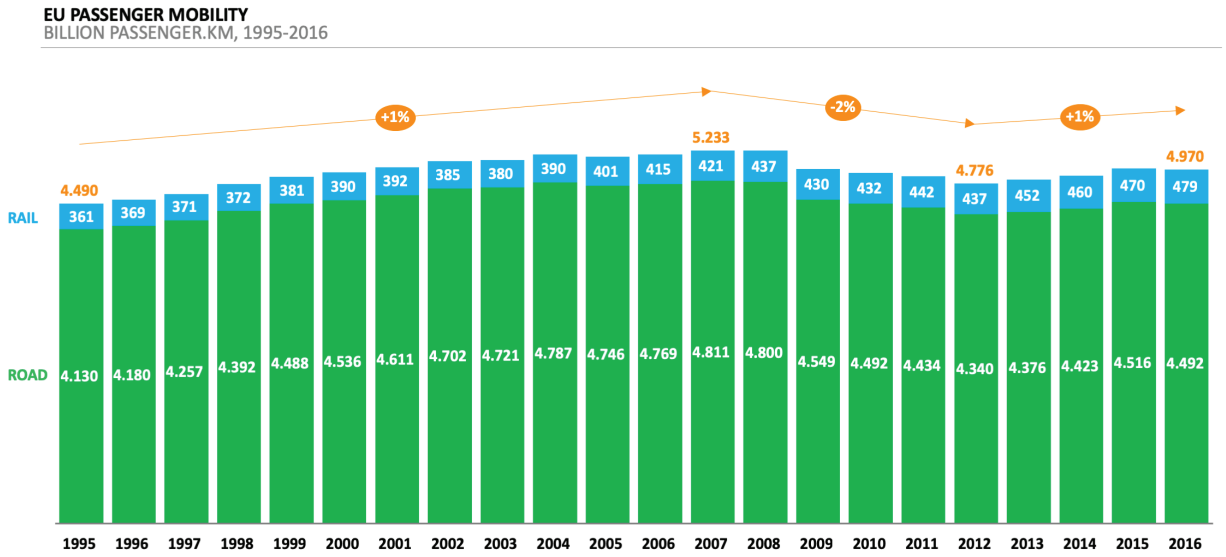
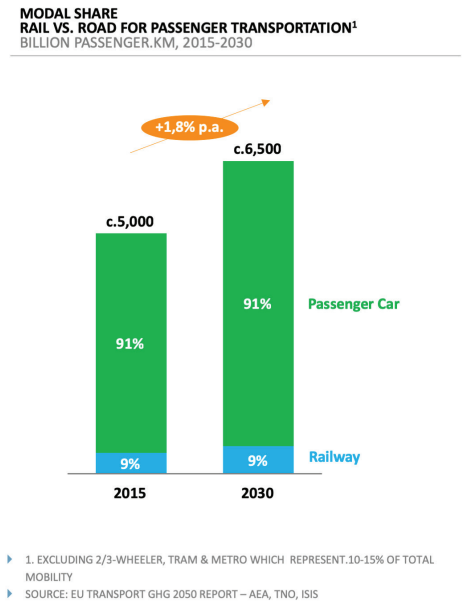


Fig. 5 - Long-term passenger mobility evolution in the EU

In addition, mobility, and in particular road mobility, are expected to rise significantly by 2030 (c.+1% p.a. long term trend) driven by the population growth, the economic development, the rise of e-commerce and an increase in people mobility.



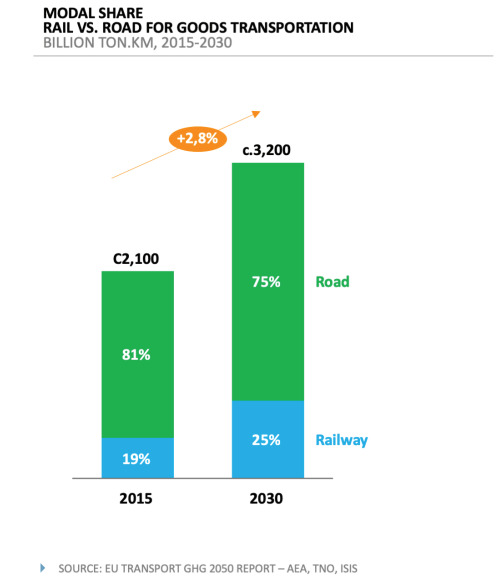


Fig. 6 -Passenger and freight mobility forecast to 2030

Most of the mobility increase will be achieved thanks to light and commercial vehicle. The share of rail is still very low in passenger and goods transportation as illustrated in Figure 6.

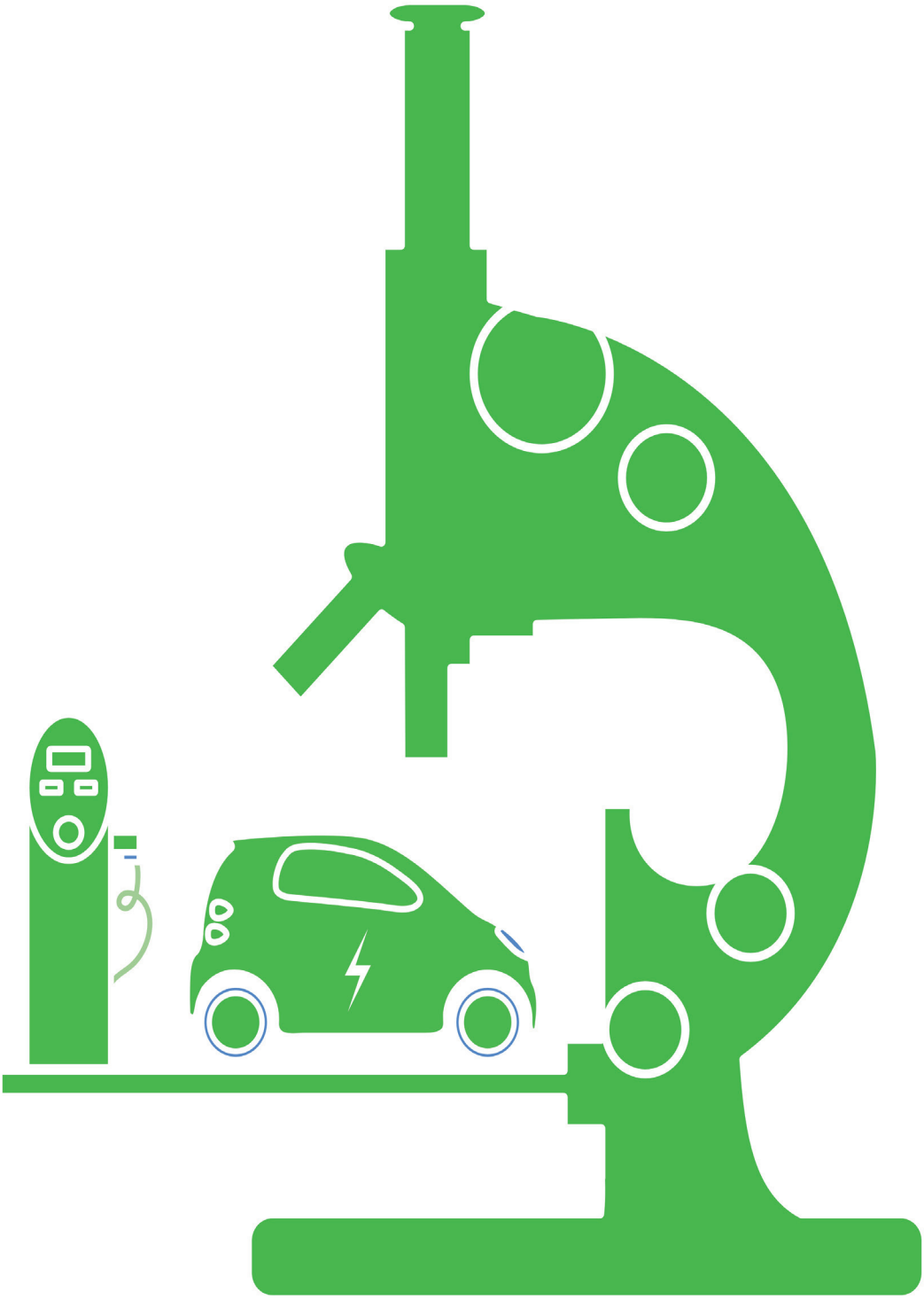
As it is politically and societally not acceptable to limit mobility of people and goods, disruptive progress needs to be made to reduce the climate and environmental impact of the constantly growing road mobility needs, both in terms of green powertrains and mobility systems. Therefore, it is even more critical to invest more in R&D to develop these requested technologies and PPPs like EGVI are key contributors to achieve this objective.

To compensate for this increase in mobility, it is mandatory to further reduce emissions of road transportation.

In this context, achieving EU's GHG objectives will require a step change in vehicle emissions, doubled with an active renewal of the fleet of licensed vehicles in Europe, by proposing Green Vehicle alternatives to European and worldwide consumers. The final aim is to reduce our dependency on fossil fuels for both environmental purposes and economic impact by reducing oil imports and energy dependency.

During its first decade, EGVI funded **178 projects** for a total funding **exceeding €800 million**; all projects contributing to the reduction of emission directly or indirectly. **All these new technologies will be embarked in vehicles reaching the European roads between 2014 and 2024** (typically 5 years after the project completion). EGVI ambition is to keep funding new projects in the future to help reach these more than ever challenging emission targets.

Achieving this goal will require to broaden the scope of emission reduction levers, to develop new technologies, and to foster collaboration with more players, traditional and new comers, including SMEs.



4. EGVI BENEFIT BY THE NUMBERS: A QUANTITATIVE IMPACT ASSESSMENT

A. 10 YEARS IMPACT ON CO_2 EMISSIONS REDUCTION

The CO_2 emission reduction was calculated using 2 distinct elements:

1. **The fleet composition mix.**
2. **Various technical measures that can reduce CO_2 at vehicle level**

To ensure consistency with previously performed activities, it was decided to rely on the ERTRAC fleet composition scenarios which included:

- A highly electrified scenario that describes a situation with maximum market uptake of plug-in hybrid electric vehicles (PHEV) and battery electric vehicles (BEV)
- A partially electrified scenario which is more conservative with regard to the market penetration of advanced electrified powertrains (PHEV and BEV)
- **A mix scenario that assumes substantially lower fleet electrification, halving the shares of BEV of the partially electrified scenario.**

In order to use a "neutral" basis for the calculation of the EGVI impact assessment, the CO_2 impact of the fleet composition was calculated by applying the ERTRAC "Mix" scenario values for new vehicle registrations and comparing the result to the SIBYL baseline (see Figures 7 and 8).

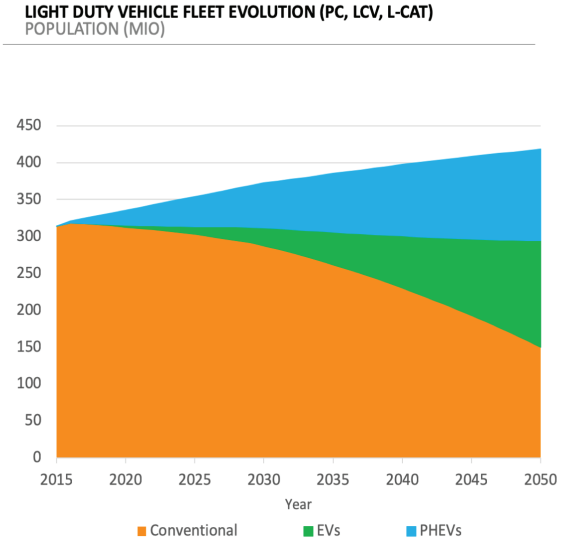


Fig. 7 - LDV fleet evolution

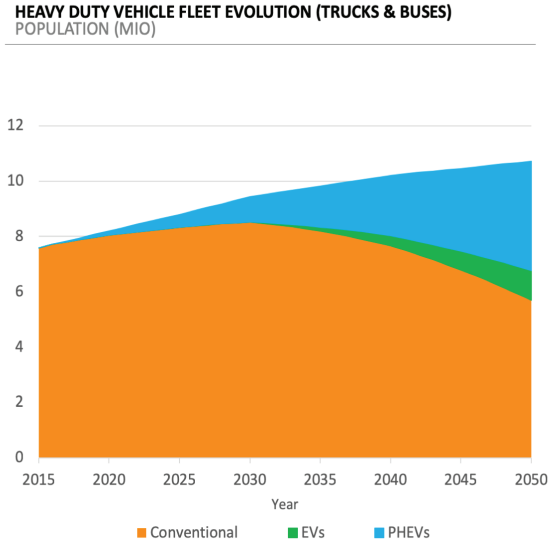


Fig. 8 - HDV fleet evolution

The various technical measures that can reduce CO_2 at vehicle level have been grouped according to the following ERTRAC measure types:

- **Type A**: Improvements at vehicle level (e.g. powertrain)
- **Type B**: Improved traffic conditions (e.g. green traffic light)
- **Type C:** Traffic reduction technologies (e.g. truck load optimisation)

The calculations for the CO_2 impact assessment were performed using the ERTRAC "Mix" scenario and type A and type B measures only; type C measures have not been considered since this type of activities are not covered by the EGVI partnership. It is noted that the CO_2 reductions refer to real-world rather than type approval values.

Because a direct link between EGVI projects and technologies embarked into the vehicles is difficult to establish (see paragraph 1 C above), a detailed scientific assessment of the possible CO_2 impact of all the different technical measures was made as a first step[4].

For each single measure, energy or CO_2 reduction potentials relative to a 2015 typical vehicle of the same type were assessed, by means of vehicle powertrain simulation models, for the vehicle categories considered. Saving potentials were defined for three different driving profiles (urban / rural / highway) separately.

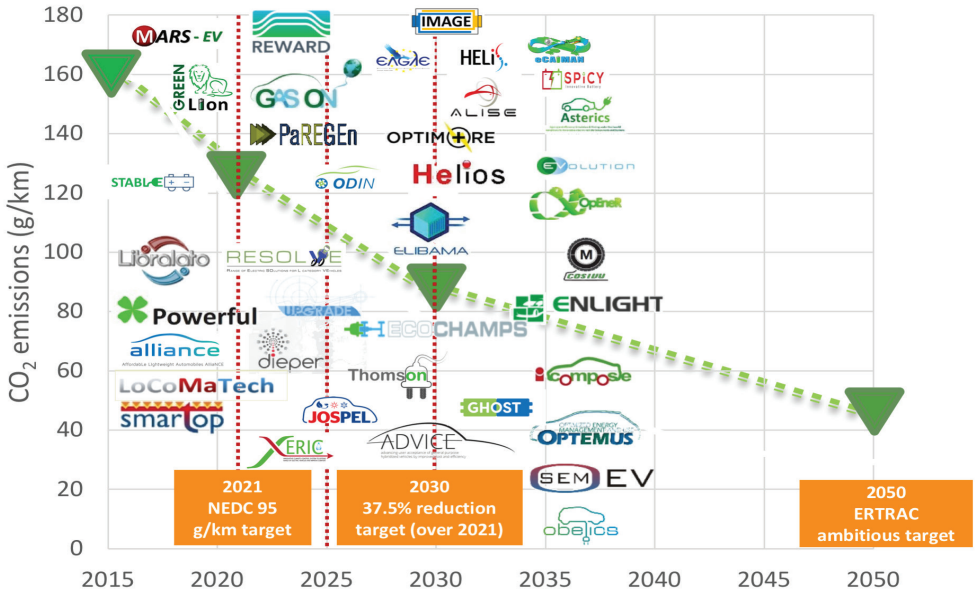
To limit uncertainty, for each measure, each vehicle type, and each driving profile, optimistic as well as pessimistic 2050 scenarii were developed. The optimistic value represents the upper limit of the effect a measure could have, while the pessimistic value gives a more cautious estimate of the measures' minimum potentials.

In a second step, the different technical measures were combined per vehicle category and class to compute an overall efficiency improvement from the implementation of all type A and type B measures applicable for each vehicle category and class. This was done by multiplying the individual fuel consumption reduction percentages assigned to each type A and type B measures for each vehicle category and class.

The resulting improvements in fuel economy were then applied in the SIBYL model using the fuel consumption evolution parameters. As an example, the fleet average CO_2 value per vehicle for new passenger cars is given in Figure 9. It needs to be highlighted that for this assessment the real-world emission values available in the SIBYL model and the average over all vehicle sizes without compensation for the vehicle mass were used, which as such, results in higher values than the CO_2 industry targets set by the European Commission.

4. See Krause et al. "EU Road Vehicle Energy Consumption and CO_2 emissions by 2050 - Expert-Based Scenarios" paper submitted for publication to the Energy Policy

CO_2 EMISSIONS REDUCTION – PASSENGER CARS



- EMISIA analysis
- Non-exhaustive list of EGVI-funded projects

Fig. 9 - Evolution of the average CO_2 emissions (in g CO_2 /km) from new passenger cars assumed for the calculations of an ambitious pathway

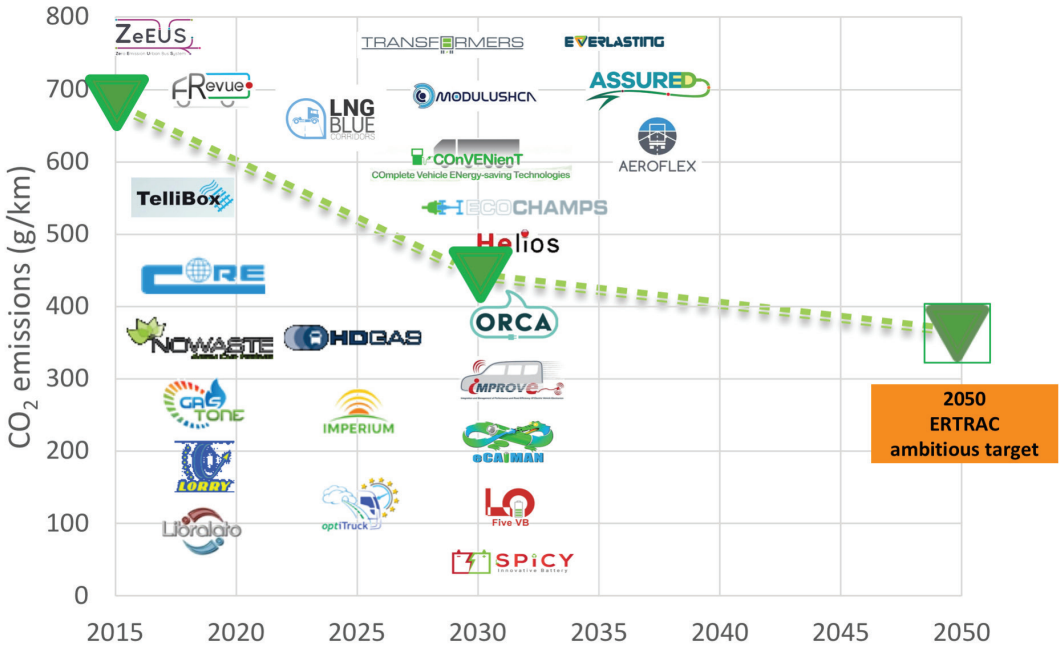
Figure 9 shows the evolution of the average CO_2 emissions (in g CO_2 /km) from new passenger cars in real world driving conditions. **The observed reductions are due to the combined effect of fleet composition change (i.e. the electrification effect) and the overall vehicle efficiency improvements brought by type A and type B measures (optimistic values)**. For the latter a gradual implementation (penetration) of relative technologies starting from 2020 until 2040 has been assumed.

The reductions shown in Figure 9 in particular for the years 2025 and 2030 compared to 2021 levels are calculated using the 2050 optimistic ERTRAC target and interpolating in 2030 with the most ambitious CO_2 reduction targets arising from the array of relevant EGVI projects. This ambitious line shows that there is the technology potential to achieve the 15% and 37.5% reduction targets set for new cars sold in the EU, provided that there is

- on one hand, a strong electrification of the fleet and,
- on the other hand, a substantial improvement of the Internal Combustion Engine, possibly coupled with a decarbonisation of the fuel.

It is noted that the values in the graph show real-world emissions, whereas the CO_2 regulatory targets are based on the legislative driving cycle (WLTP).

CO_2 EMISSIONS REDUCTION – HEAVY DUTY VEHICLES



- EMISIA analysis
- Non-exhaustive list of EGVI-funded projects

Fig. 10 - Evolution of the average CO_2 emissions (in g CO_2 /km) from new heavy-duty vehicles (including buses) assumed for the calculations of an ambitious pathway

Similarly, Figure 10 shows the evolution of the average CO_2 emissions (in g CO_2/km) from new heavy-duty trucks and buses. As in the case of passenger cars, the reductions represent here an ambitious pathway, also calculated using the 2050 optimistic ERTRAC target and interpolating in 2030 with the most ambitious CO_2 reduction targets arising from the relevant EGVI projects.

CO_2 EMISSIONS REDUCTION POTENTIAL (1/2) – ENTIRE FLEET (ALL VEHICLE CATEGORIES)
TAILPIPE (TTW) ONLY, OPTIMISTIC SCENARIO, 2016-2050

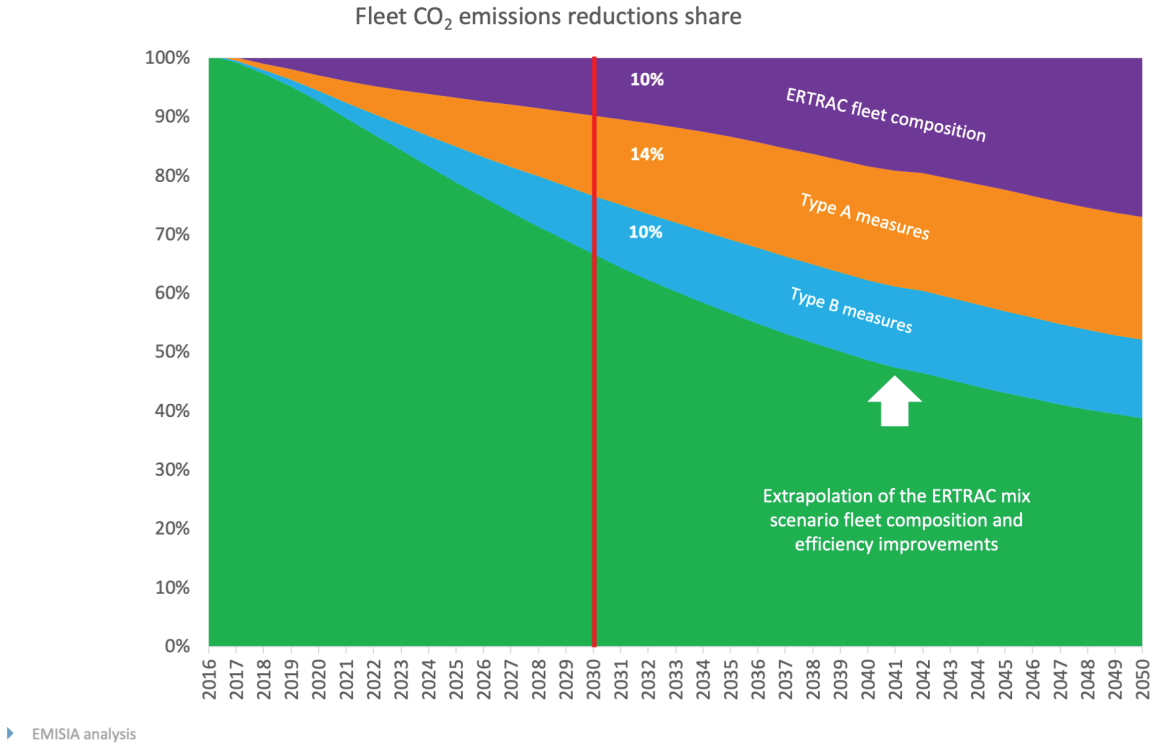


Fig. 11 - Relative CO_2 reduction potential for the optimistic scenario

Figure 11 presents the total CO_2 emissions reductions potential – for the entire vehicle fleet – from the change in fleet composition, and the implementation of type A and type B measures, compared to reference emissions. This reduction potential is presented as percentage reduction over the reference CO_2 values assuming no drastic change in the fleet composition and no further improvement in fuel efficiency after 2020.

In 2030, the maximum CO_2 emissions reductions potential amounts to **34%**, of which **10%** is due to the fleet electrification and **24%** is due to type A and type B measures to which EGVI projects are contributing to.

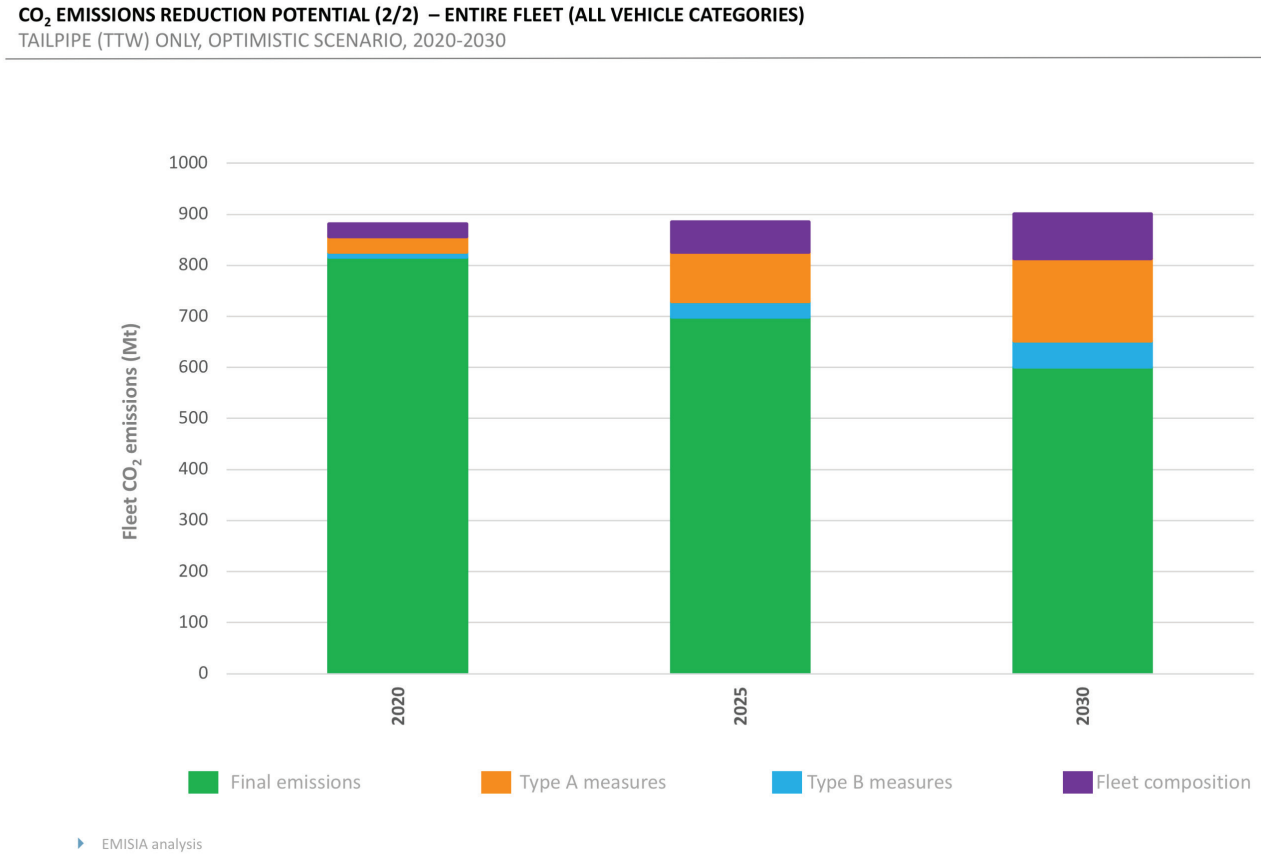


Fig. 12 - Absolute CO_2 reduction potential

The Figure 12 shows the absolute emission values (in Mt of CO_2 emitted) for three years – 2020, 2025 and 2030 – attributed to fleet composition change, type A and type B measures.

Figure 12 complements the above pictures by providing the reduction potential in absolute terms for the target years 2025 and 2030.

B. ECONOMIC IMPACTS OF EGVI: R&D INVESTMENTS AND MARKET DEVELOPMENT

R&D INVESTMENTS

R&D investment of the industry has massively increased in recent years leading to a worldwide European leadership in automotive, with regulation being a strong driver.

EU is the world leader in automotive R&D spending (45% of world investment, at an 8% p.a. growth rate since 2011, to reach €56B in 2017). In particular, EU R&D investment remained resilient during the height of the 2008-2010 crisis, with a drop of only 2% in 2009 and a decrease of €2 Billion in EU.

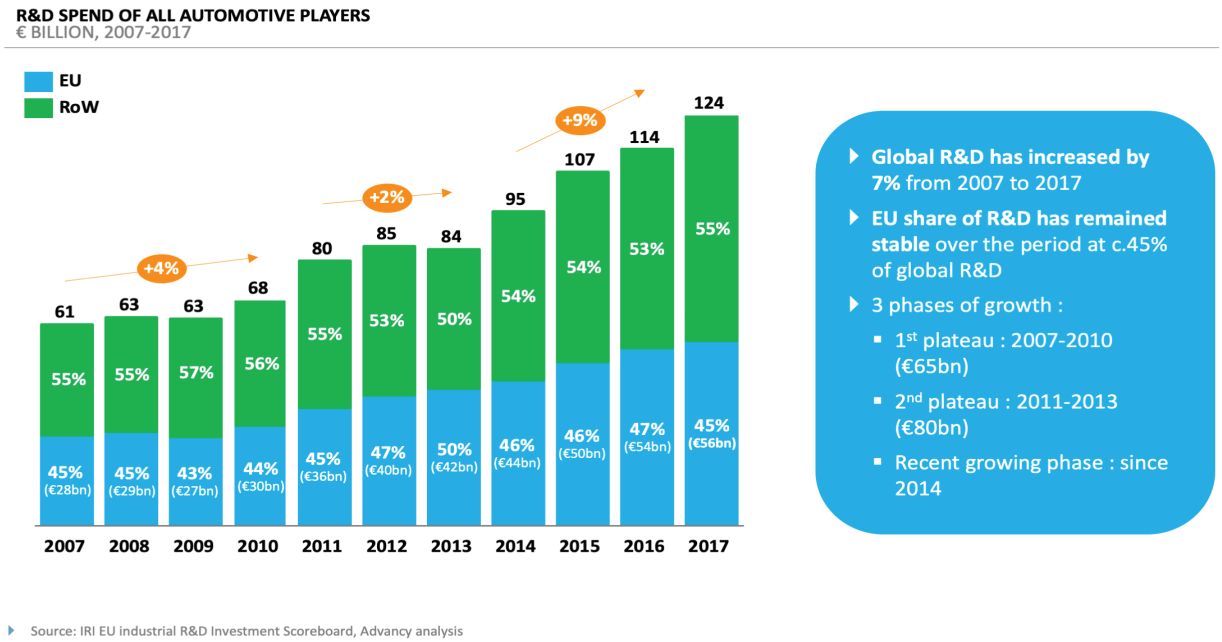


Fig. 13 - Automotive R&D spending evolution – 2007-2017

Compared to other regions, the growth of R&D spending has been strong and steady in Europe. EU is stabilising its share of R&D around 45-46% globally. This growth is clearly driven by the need to develop new products incorporating the new technological trends: vehicle electrification, connectivity, autonomous vehicles, light-weighting and new mobility services. The main driver are clearly car electrification and ICE efficiency improvements which are taking a higher share of R&D spending in EU according to stakeholders. **EGVI cPPP is spending around € 85 M per year and, including the share of private contributors, it represents around 2% of total EU R&D spending per year and has spent in 10 years about € 850M.**

This has been a major positive societal impact on the support of the R&D in automotive in Europe. Pre-competitive collaboration research activities are one of the backbone of the development of knowledge and partnerships in the automotive industry. Without financial support from the EGVI partnership, it is most likely that private companies would not have pursued this type of research, hence some of the innovations developed in the last 10 years would not be available today.

EGVI and the European Union have significantly contributed to the growth of automotive R&D spending which has been consistent and sustainable over the decade; this growing spending has turn out into highly skilled job creation within EU.

MARKET DEVELOPMENT

Decarbonised transportation has been a strong item in the R&D agenda of EU vehicle and parts manufacturers between 2008 and 2017, with measurable benefits at an industrial level and as a consequence, the EU expected to take leadership positions on these technologies between 2020 and 2025.

During the 2001 through 2008 period, EU OEMs have focused their R&D efforts on Natural Gas and Flexfuels, while significantly lagging behind Japanese and Korean OEMs in the field of electrified powertrains (Hybrid, Plug-in Hybrid and Battery Electric Vehicles) apart from Renault and its EV product range.

However, starting from 2012, thanks to the heavy investments in electrification R&D undertook in the aftermath of the 2008 crisis, OEMs have managed to bring to the market the first models, while gaining traction between 2012 through 2017 to reach 25-30% of electrified vehicle sales in Europe.

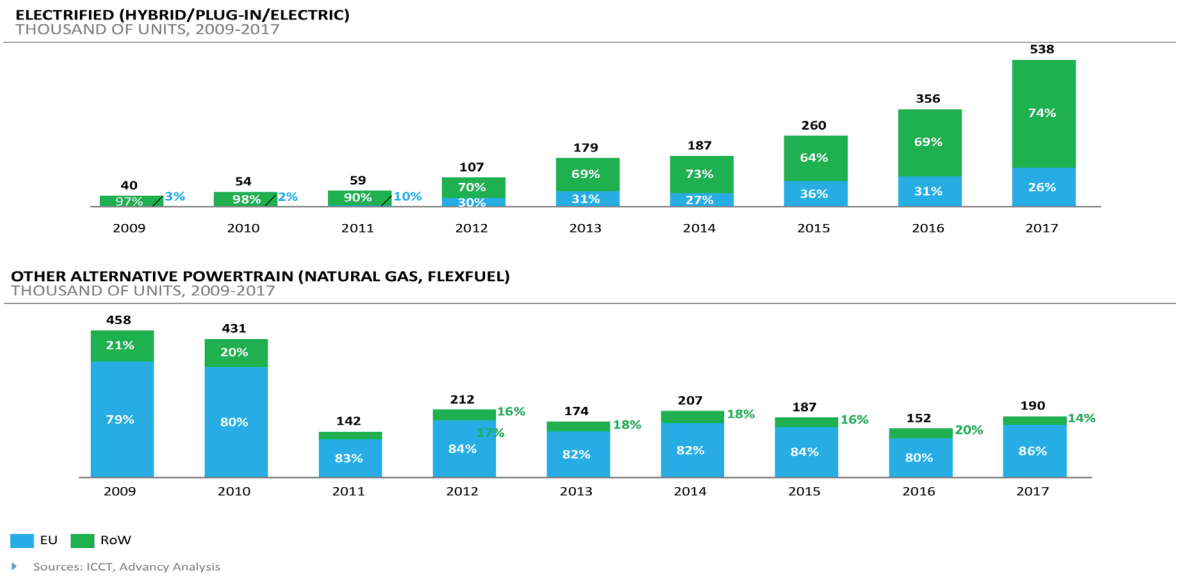


Fig. 14 - OEM market shares of passenger cars (volume) in Europe by origin of OEM

In addition, product plans show that the EU OEMs electrified vehicle (EV+Hybrid) market share in number of new models are set to reach more than 25% of total new vehicle launches, above the worldwide average, showing a clear inflection point and positioning themselves as leaders on this market, especially in the field of hybrid powertrains.

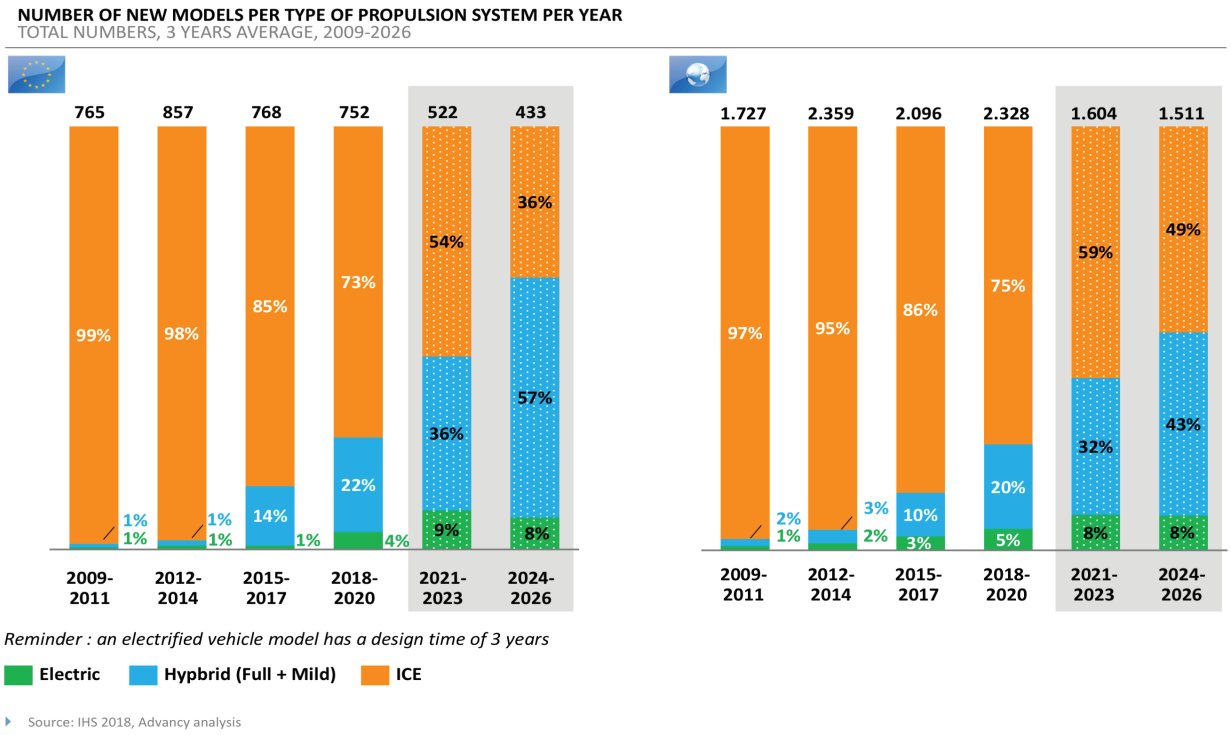


Fig. 15 - Powertrain mix evolution per OEM origin

In the field of hybrid vehicles, EU OEMs are launching many new models and are getting ahead of the race closely followed by Japan. Hybrid vehicles are expected to remain the fastest growing segment in OEM's product plans. This trend is likely to be sustained in the near future. Indeed, according to known product plans and expected volumes, **EU OEMs should reach by 2026 a market share of 65% of their new launches being electrified vehicle models**. This should allow them to reach approximately 40% market share in number of models starting in 2020.

The situation is more disputed in the field of Electric Vehicles, as the EU OEMs market share will be hindered by the push of China on Electric Vehicle demonstrated by the high number of new products launched in the last five years.

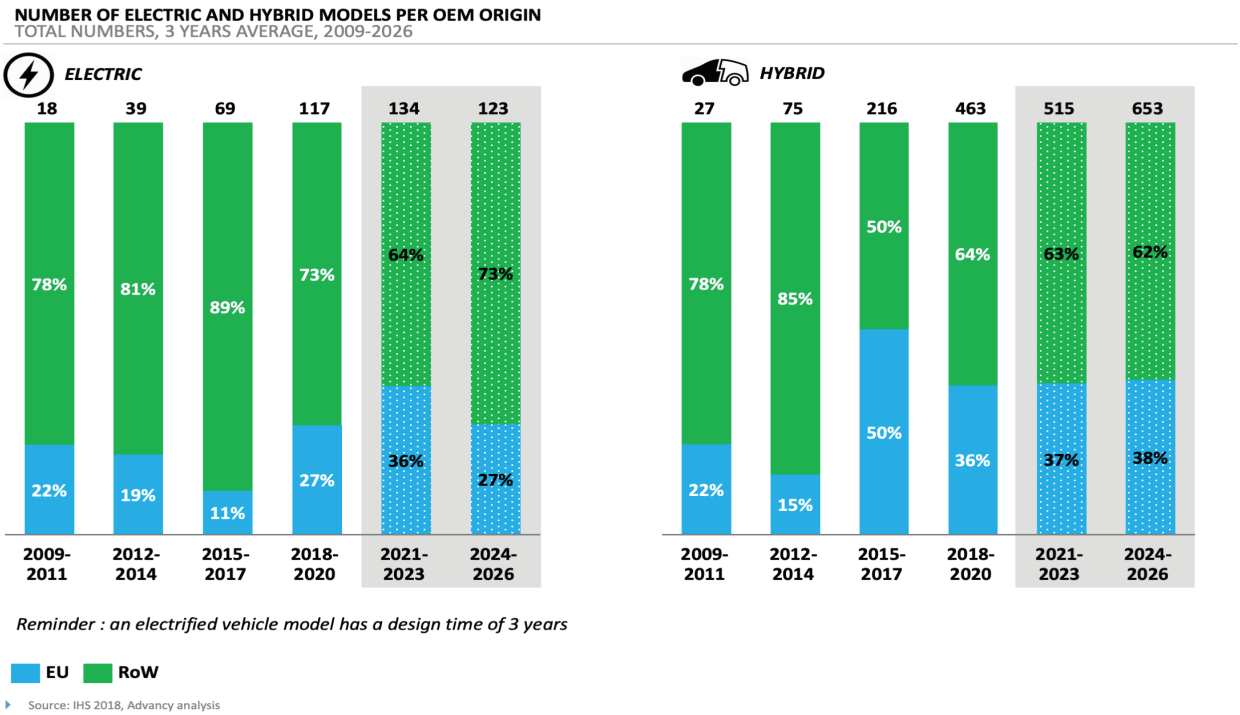


Fig.16 - EU market share evolution in Hybrid & Electric Vehicles

At the beginning of the PPP, EGVI projects were very much focused on EV and Energy Storage Systems and move to hybrids at a later stage. This has contributed one way or the other to the acceleration of EV product launches in 2017 and onwards. On hybrids, it contributed to help European OEMs to catch up with Japanese OEMs.

Hybrid vehicles were not a focus before 2011 when new model market introduction started to take off with moving from 32 new models in 2016 to a plateau of more than 170 market introductions in 2016. New EVs started to grow at the same time but at a much slower pace with a jump in 2017 with a peak at 42 in 2017 & 2018 most likely to prepare for the entry in force of EU CO_2 emission regulation in 2020.

This rise of electrified and green vehicles and the acceleration would not have been possible for the European OEMs without the availability of emission reduction technologies which have been partially developed in EGVI funded projects and incorporated into these vehicles. Even though it is not possible to make a direct connection between specific EGVI technologies and new vehicle models, the domination of EU players is the testimony that these technologies have been developed in Europe with the support of private and public funding.

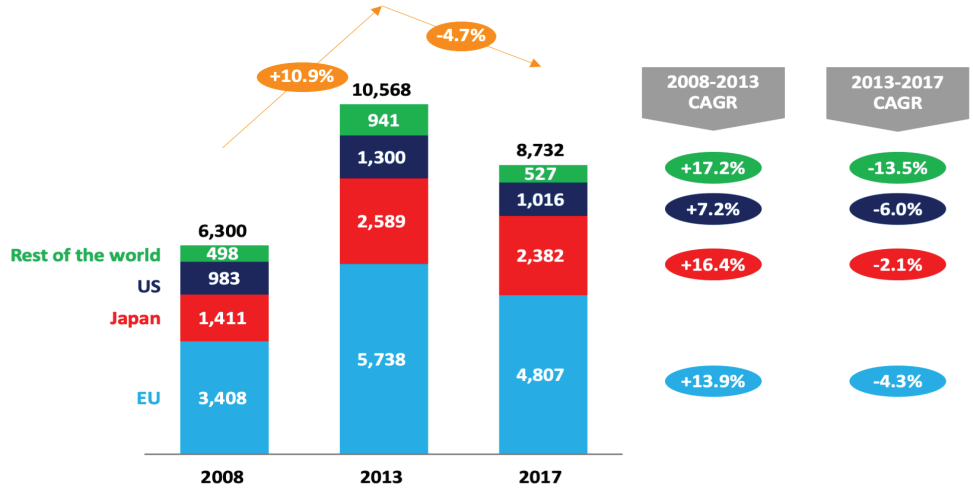
One key question for the future technological development is: will the product offer of hybrids and electric vehicles be attractive enough to consumers to allow reaching the 2030 targets (less than 60gCO_2/100km, NEDC cycle)?

If not, efforts to further reduce ICE fuel consumption will need to be reinforced and it is expected that diesel engines will keep a significant share of the market since theyse are 20% to 25% more efficient than gasoline engines on long distance (which make it a relevant option for commercial vehicles). Though, they will need to be much cleaner on NOx and particles to limit the negative impact on air quality.

PATENTS AND INTELLECTUAL PROPERTY

Another important dimension is the development of patents to protect technology IP. In Europe, the number of patents has been growing strongly over the last decade to reach a peak in 2013 and has slowdown since then. **EU is clearly ahead in terms of patents filled in automotive sector with more than 50% worldwide.**

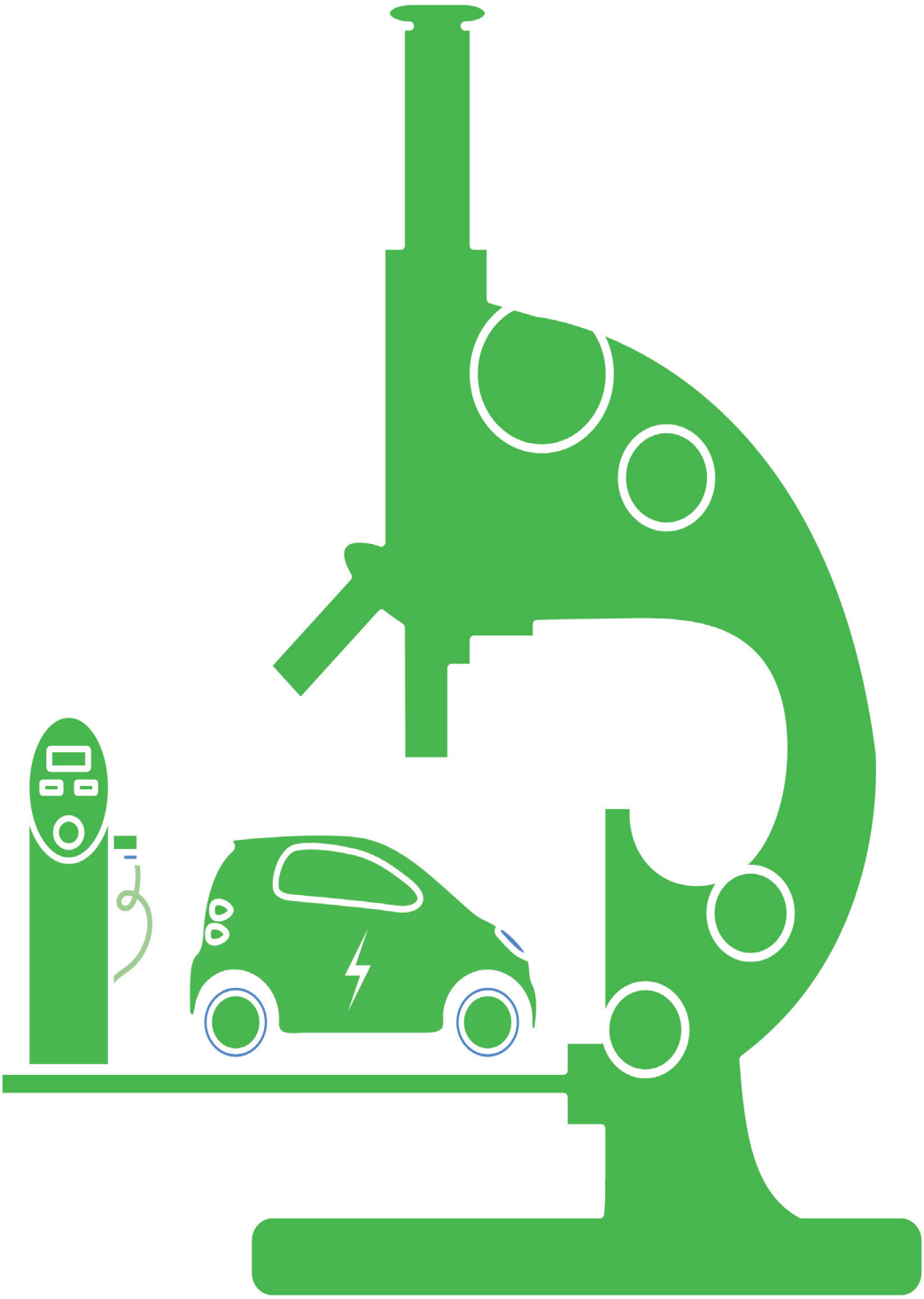
AUTOMOTIVE SECTOR PATENTS
NUMBER OF PATENTS FILED, 2008-2017



Source: European Patent Office, Advancy Analysis

Fig. 17 - Evolution of automotive industry patent filling split in EU per country of origin, 2008-2017

Staying in the patent race is key for EU since it protects technologies and generates revenues thanks to royalties helping to fund new developments.



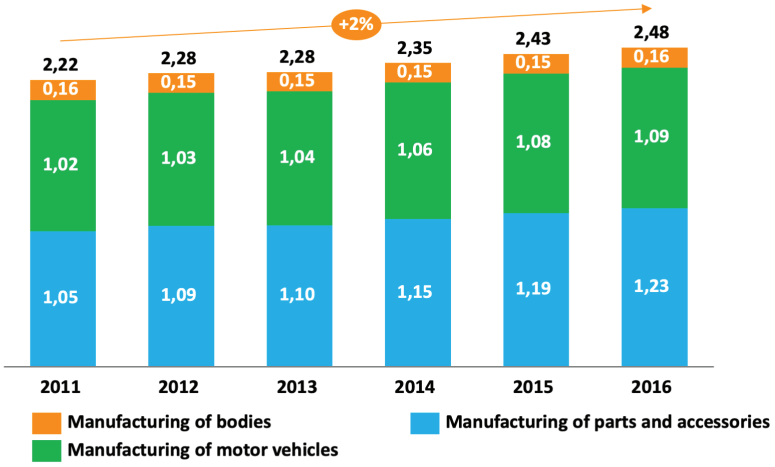
5. 10 YEARS IMPACT ASSESSMENT OF INDUSTRIAL AND SOCIETAL BENEFITS

EMPLOYMENT

Vehicle and parts manufacturing is a strong asset for the European economy and has significantly grown in importance since the mid-2000's.

The EU vehicles and parts manufacturing industry has traditionally been a pillar of European industrial competitiveness. The total direct and indirect jobs in Europe reaches approximately 13 million. The manufacturing part of the sector employed directly about 2.5 million full-time equivalents in 2016, and has increased by 2% p.a. since 2011, driven by increasing investments and innovation in the industry gaining a total of 300.000 jobs in six years.

EVOLUTION OF NUMBER OF AUTOMOTIVE INDUSTRY EUROPEAN EMPLOYEES IN MANUFACTURING
MILLIONS OF FTE, 2011-2016



- The EU automotive industry employs **2.5 million FTE in manufacturing in 2016**
- In Europe, number of automotive industry employees **is increasing** driven by growing investments and innovations in the industry

Source : Eurostat, International robotics and Automation journal, Advancy analysis

Fig. 18 - Automotive industry employees in manufacturing in Europe

When looking at job creation at European OEMs level, the growth is spectacular in the last decade since the **total worldwide R&D FTEs of EU car manufacturers have increased by about 50,000 FTEs, which represents +50% in a decade**.

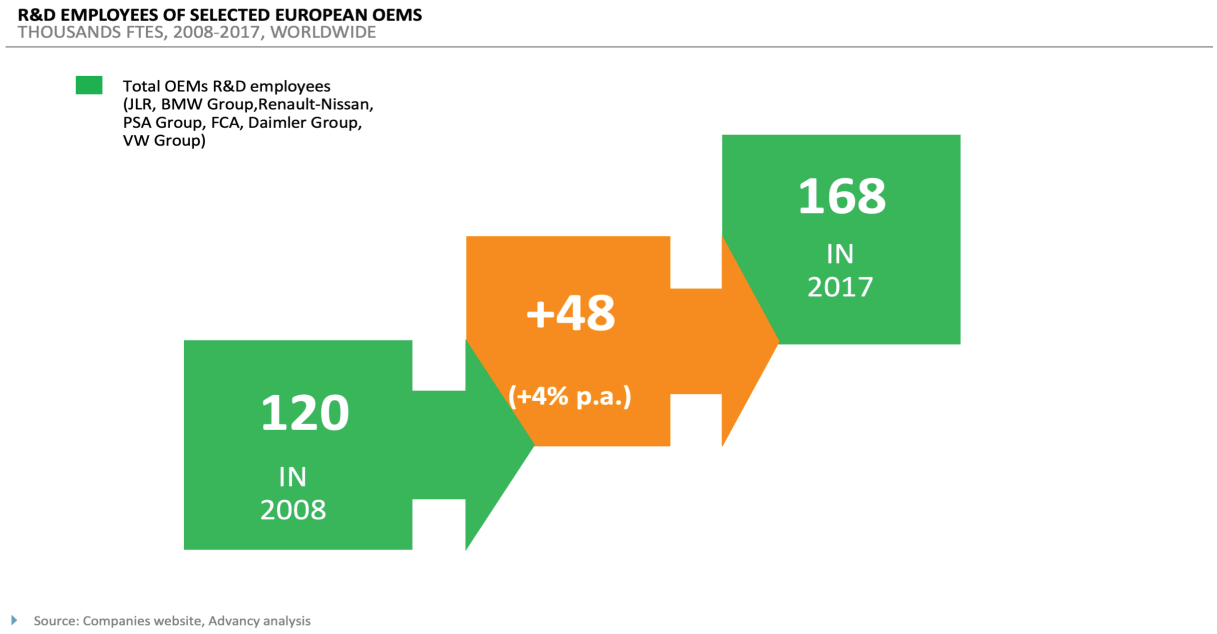


Fig. 19 - Evolution of European Automotive OEM R&D Employees

Benefits are not only for OEMs but go across the full supply chain where it helps the eco-system to be more competitive on all fronts.

As an example, one RTO was involved from the beginning of the partnership. It has been able to dedicate 5% of its R&D headcounts to work on EGVI projects which directly or indirectly led to an additional 5 to 10% headcount working downstream to industrialise the developed technology: **it is the "multiplier effect".**

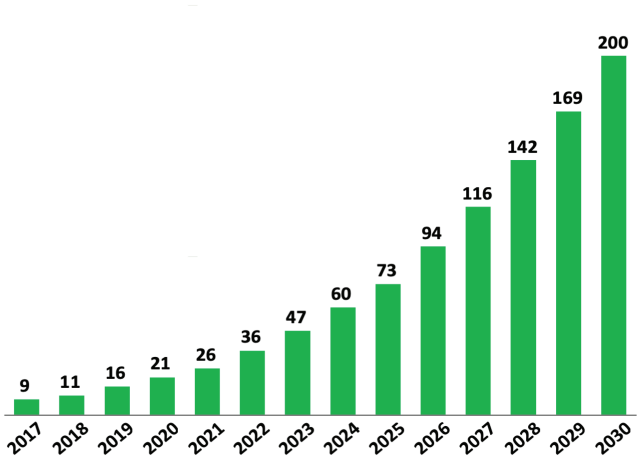
Some European players have started a few years ago to expand their R&D employment footprint outside of the EU and their FTEs abroad is growing. Keeping a significant level of public R&D funding on Green Vehicles is critical to keep high-value jobs in Europe and create the future technologies for green and sustainable mobility.

There are many jobs at risk not only in R&D but also in production. We will still need significant R&D spending on traditional ICE since it will remain a key pillar of hybrid powertrain and need to be much more efficient, but at the same time, there is a clear need to transition some of the engineers to new technologies and to develop the skills of tomorrow. It is also highly critical to master the key technologies so that they can be produced in Europe. Ten thousands of workers in Europe are producing ICE engines every day; when the EU will be transitioning to EV and other clean powertrains solutions, we need to ensure that Europe will maintain a high level of integration in order to avoid losing (many) manufacturing jobs. Battery production is a good example that can become a game changer.

In 2014, a study by the European climate Foundation estimated that by reducing oil demand through the introduction of more efficient and less carbon-consuming vehicles, EU economy could witness a significant increase in EU GDP, and create between 350,000 and 500,000 jobs economy-wide through avoided oil-use.

More recent figures suggest that in particular, the plug-in hybrid and battery electric vehicle ecosystem, that requires a wide array of expertise to develop innovative components (including batteries, software, semi-conductors) and infrastructure (including charging stations, upgrades to the grid) could be benefit the European industry and society through jobs that are almost all skilled or semi-skilled.

GROSS EMPLOYEES CREATION LINKED WITH EV PENETRATION
THOUSANDS OF JOBS , 2017-2030, EU



Employees creation for electrified vehicle industry assuming 35% share of EV in European new vehicle mix in 2030 and progressive ramp-up

TYPE OF JOB CREATED

Field	Skilled	Semi-skilled	Un-skilled	Representative job profiles
Scientific research of batteries	✓	✗	✗	Chemists, materials scientists
Design and development of automotive techno	✓	✓	✗	Engineers, engineering technicians, software developers, industrial designers
Manufacturing	✓	✓	✗	Assemblers, machinists, production manager
Vehicle maintenance	✗	✓	✓	Automotive service technicians, mechanics
Infrastructure development	✓	✓	✗	Urban and regional planners, powerline installers/repairers, electricians
Sales and support	✗	✓	✓	Retail salespersons, customer service representatives

Employees creation and skills requirements for electrified vehicle industry

Source: AIF – European Association of Electrical contractors – Powering a new value chain in the Automotive , US forecast Synapse Energy economics, International robotics and Automation journal, Advancy analysis

Fig. 20 - Electric vehicle impact on employment

If investment in the automotive sector has supported job creation, especially in R&D, the specific investment in Green Vehicle technology yields significant upsides even beyond automotive. A large portion of the jobs created through EV and PHEV penetration will benefit industries outside of automotive and transportation, especially in the maintenance of charging infrastructure and grid, electricity generation, installation and manufacturing of charging equipment.

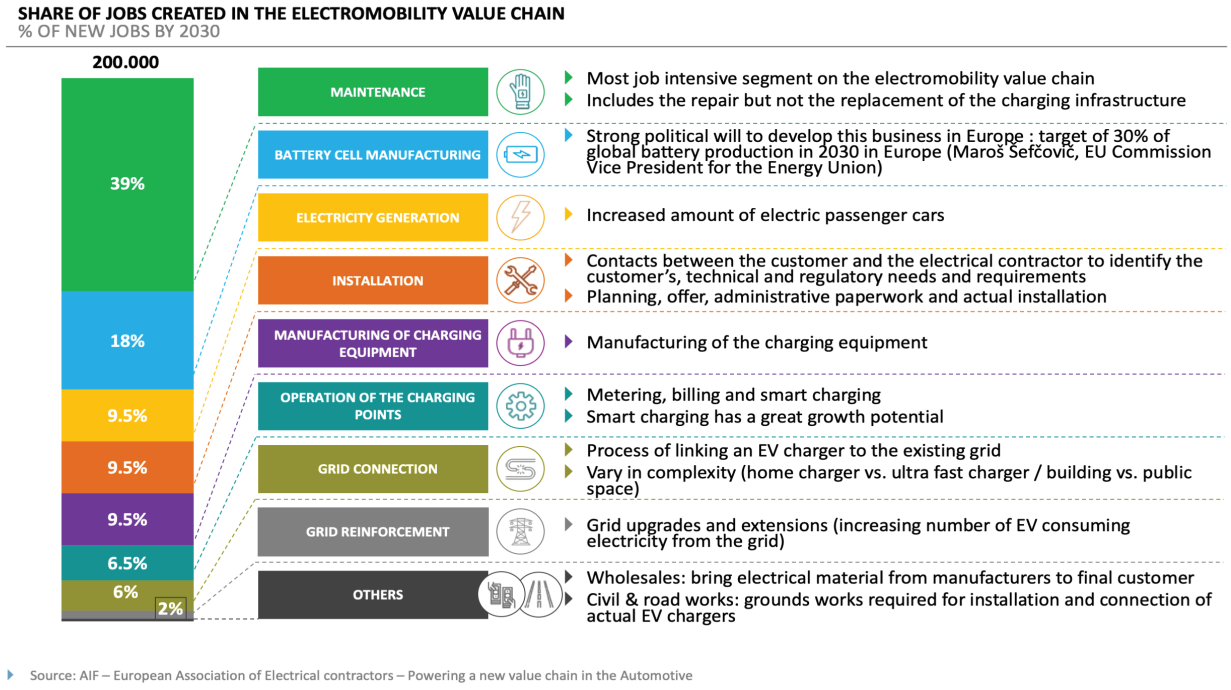


Fig. 21 - Mix of jobs created in the electro mobility value chain

These figures need to be put in perspective with the risks weighing on the full European automotive value chain that is likely to suffer from the move away from ICE technology as these know-hows have been preserved as core capabilities by most OEMs and their direct suppliers, and constituted a clear competitive advantage versus new comers (especially China).

When balancing those effects, **it appears necessary for European industry to focus on capturing a large portion of the EV manufacturing, including batteries, to be able to offset the impact and maintain its pool of employment in Europe.**

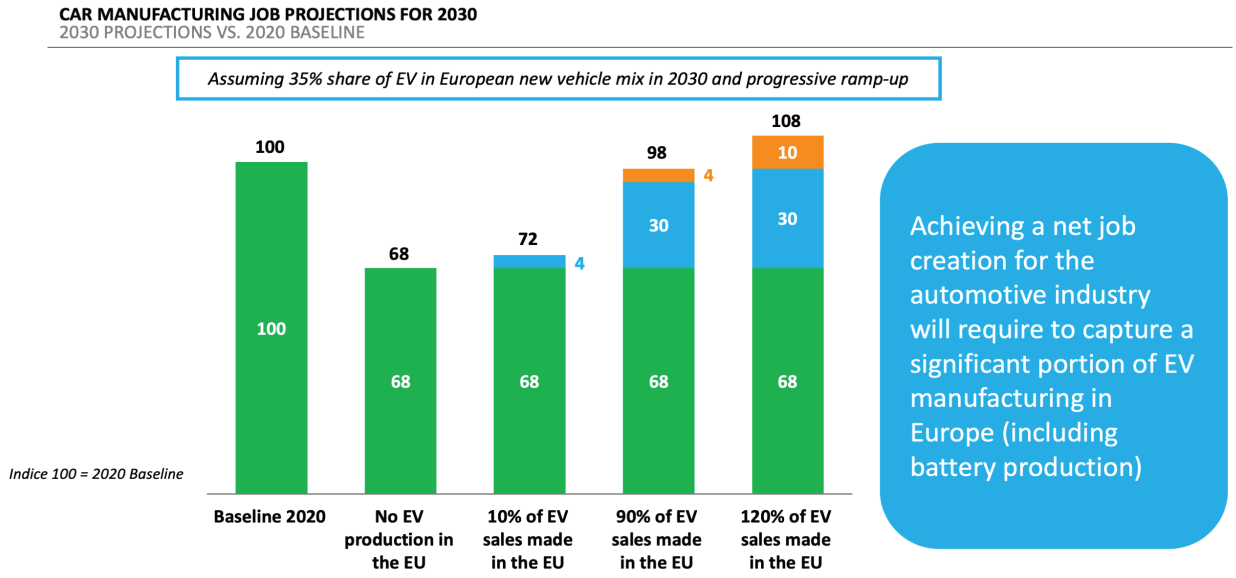


Fig. 22 - Car manufacturing jobs evolution vs. 2020 baseline

STRUCTURATION OF THE AUTOMOTIVE RESEARCH ECOSYSTEM

In addition to quantitative emission reduction, EGVI PPP projects have, according to project participants, allowed to reap qualitative benefits for the European ecosystem of green road mobility by:

- **Bringing together the European research ecosystem around Green Vehicles with an appropriate time-horizon to work on, by**:
  - **Allowing sufficient collaboration time between stakeholders to achieve sizeable and long-term projects goals**: *"Technology scouting early on is key to identify promising technologies; without it, EU would not be the clear leader in Green Vehicles. Long-term planning on green vehicle technologies is clearly an asset and should be pursued as well. Typically, EGVI projects engage partners in a 5-year timeline: about 18 months to build and get the project, the rest to deliver it; some national projects are shorter (for example in UK) but it is not as effective since working for a longer period with our partners is very beneficial. EGVI is the best tool we have to involve and make large groups of very different entities on innovation subjects"*

- **Giving SMEs access to large industrial corporations**: *"EGVI projects have allowed large companies to have access to small enterprises they would not have known of without the PPP and vice versa: SMEs and start-up can promote their technologies to potential customers. This is also an opportunity for engineers at large corporations to be challenged by youngers and more agile engineers"*

- **Bringing CROs closer to industrial stakeholders**: *"CRO can demonstrate their skills and tools in pre-competitive phase thanks to EGVI projects and win business later on to help industrialise the technologies thanks to relationships you have built during projects. EGVI projects was an excellent opportunity to improve the quality of our simulation backbone"*

- **Helping sustain academic research relevant to the Industry**: *"EGVI helped universities to keep investing in upstream research (low TRLs) by getting access to European funding for R&D. Consequently, it also allowed to finance projects with TRL between TRL3 and 6 which are critical (Innovation death valley) for EU future competitiveness"*

- **Enabling future commercial relationships between European companies during competitive stages**: *"We are exposed early to the Green Vehicle Roadmaps and we start building relationships with future client by developing new technologies in EGVI projects; this has led years after to bilateral projects to industrialise the technology; this exposure is key for us".*

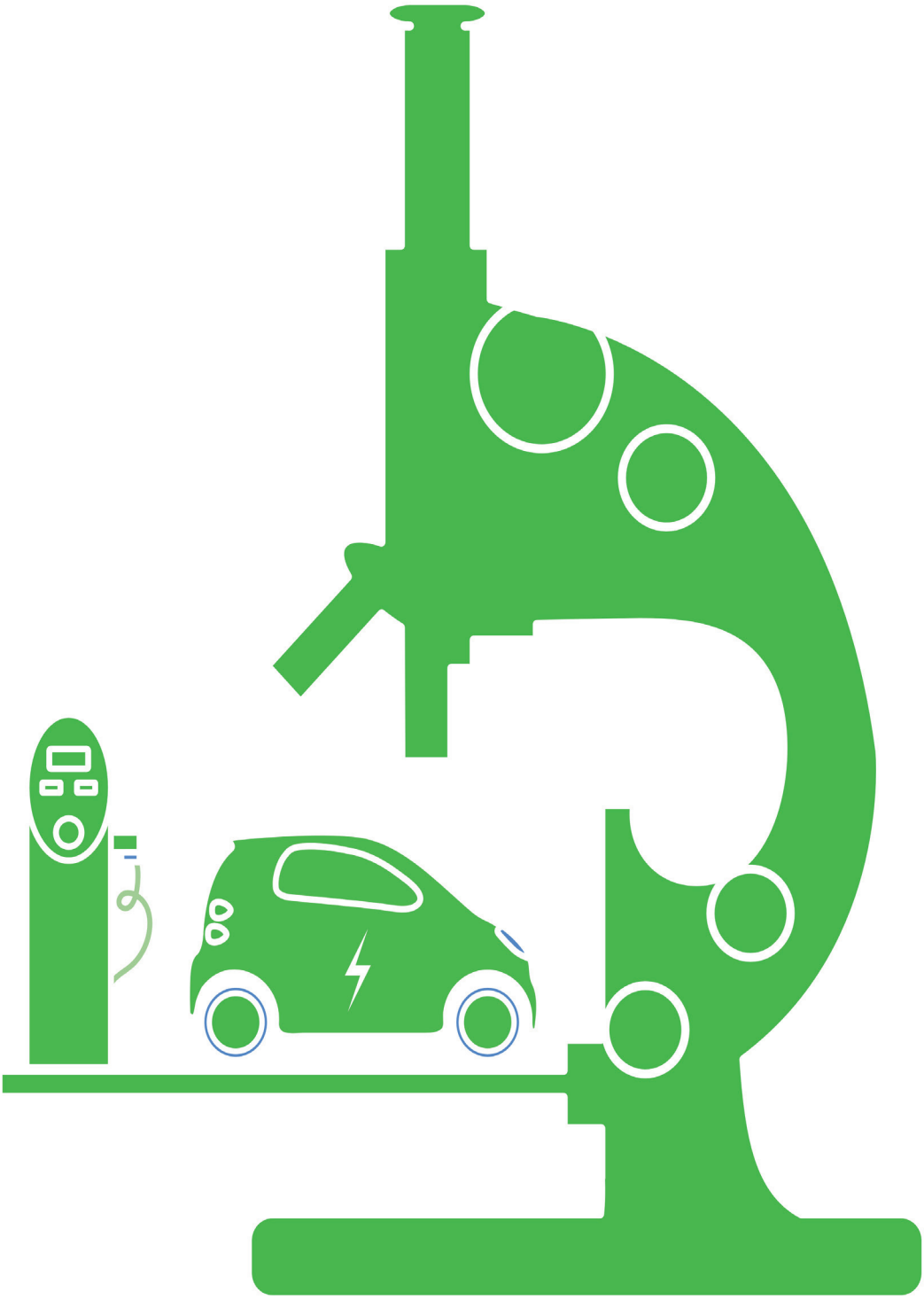
- **Contributing to new skills being developed to sustain European leadership in green and sustainable transportation**:

  - **Battery chemistry innovation in the path to higher energy density**: *"We have been able to develop knowledge on battery chemistry and new materials thanks to EGVI projects, especially useful for increased energy density"*

  - **Battery safety management to reduce hazards linked with EVs and foster faster adoption**: *"Battery safety was a field in which we started from scratch and gained significant knowledge thanks to the EGVI project"*

  - **In-vehicle software for improved vehicle system energy management**: *"Our project's system was developed for the project to act as a powertrain manager and will probably be re-used in other applications such as ADAS / AD".*

- **Bringing benefits outside of the automotive industry and disseminating them in the R&D ecosystem and society as a whole**:
  - **Disseminating innovation beyond automotive through additional synergy effect for other industries:** *"We are developing not only for automotive, we now work on low emissions large engine ship powertrain, off-road"*
  - **Long-lasting impact on design capabilities through the development of tools, especially for simulation**: *"Thanks to EGVI projects, we have developed powerful and trustful simulation tools, for battery systems (cooling simulation) or hybrid powertrain systems (energy flows, emissions, EMC)"*
  - **Facilitating collaboration across the ecosystem by establishing standards & paving the way towards interoperability**: *"One key benefit in working with the whole value chain, is being able to initiate discussions about interoperability and standards and gain understanding from the constraints of each stakeholder. For example, as a follow-up to EGVI projects, we are working on a project dealing with Interoperability & standardisation of charging infrastructure for buses between OEMs"*
  - **Improving road experience for EU citizens & road-users**: *"Users of vehicles should have an improved on-board experience thanks to the command software that was developed during the project, while at the same time reducing their emissions".*



6. A RATIONALE FOR ACCELERATING R&D FUNDING IN GREEN VEHICLES

However, this situation cannot be seen as sufficient to maintain European competitive advantage in the longer term, and to sustain the societal and economic benefits attached to the achievements completed in the field of Green Vehicles.

Europe needs to further sustain and even accelerate its investments in Green Vehicles for several reasons.

First, there is an increasing competition in the automotive industry, with several new contenders emerging in comparison with the 2008-2017 period, especially in China where the weight of the industry in the GDP has tripled in less than 15 years.

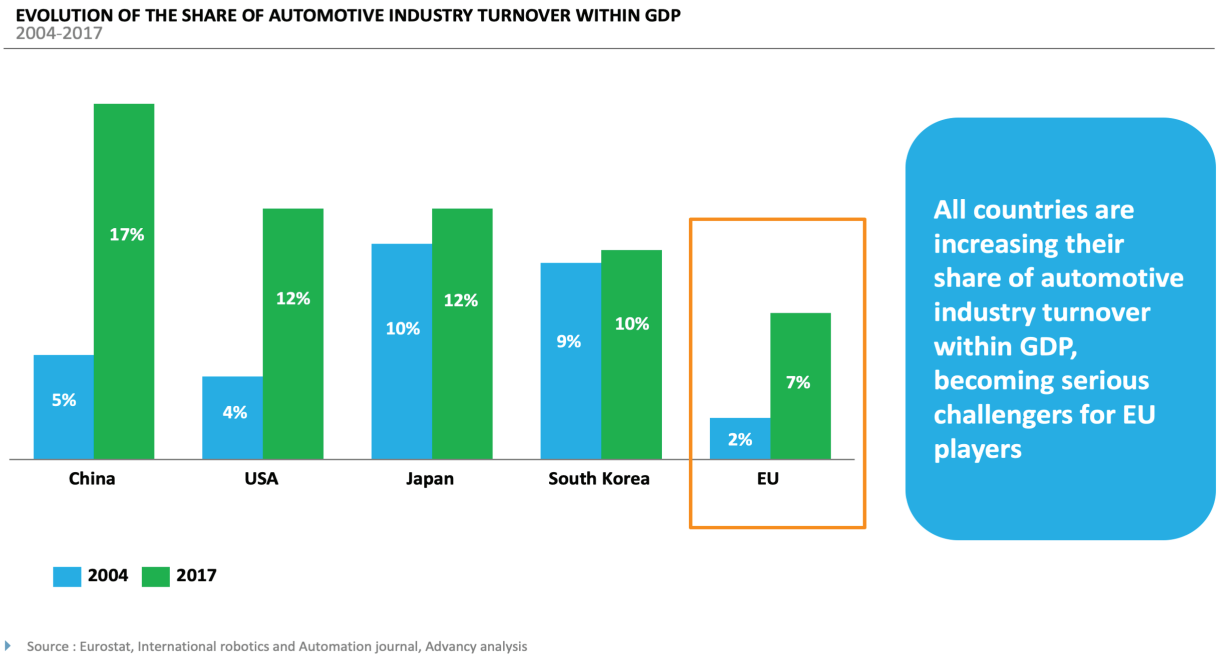


Fig. 23 - Share of automotive industry in the GDP for key automotive country

Even if Europe is still leading the race in R&D spending with a compound annual growth rate (CAGR) of 7%, Japan is just behind in terms of spending and growth with 6% in average per year and China is clearly accelerating with a growth path of 21%, though starting from a much lower base.

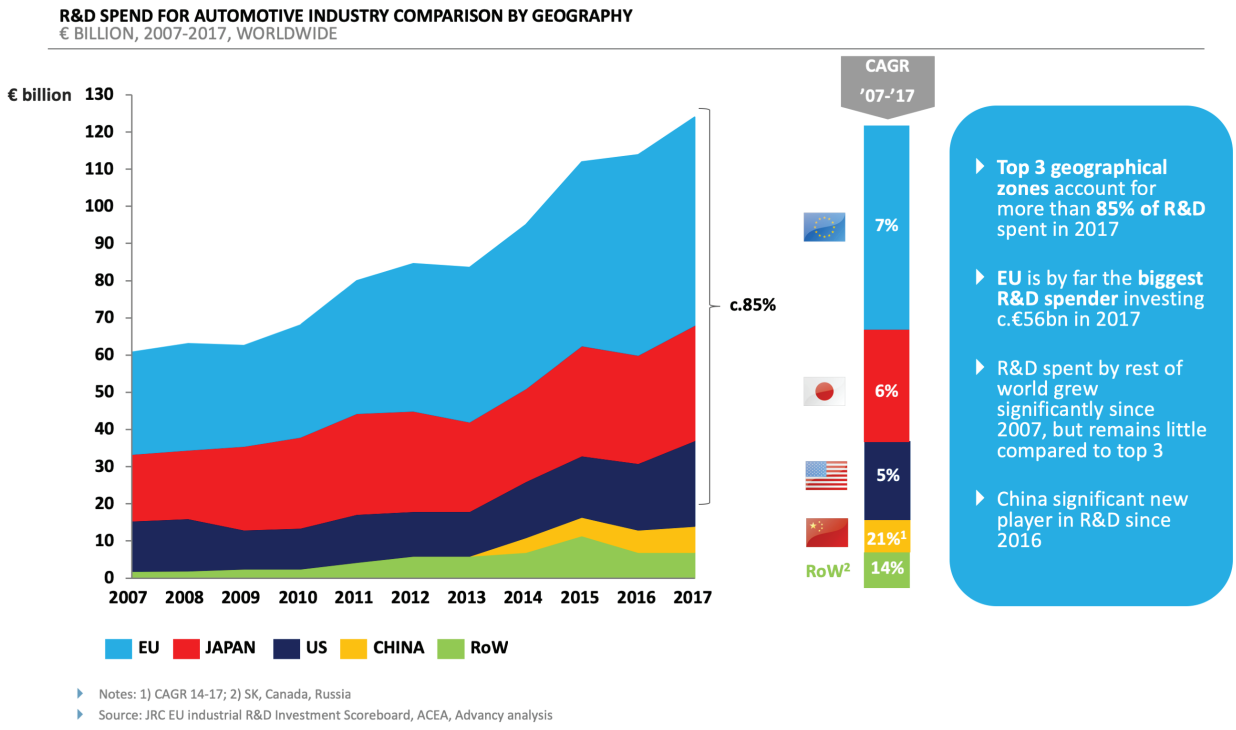


Fig. 24 - Evolution of automotive R&D spending and split by region

Furthermore, the Chinese government has invested c.€52 Billion to reach its ambitious NEV (New Energy Vehicle) initiative, that is targeting to achieve a c. 20% market share of Battery and Plug-in Hybrid Electric vehicle of new vehicle sales.

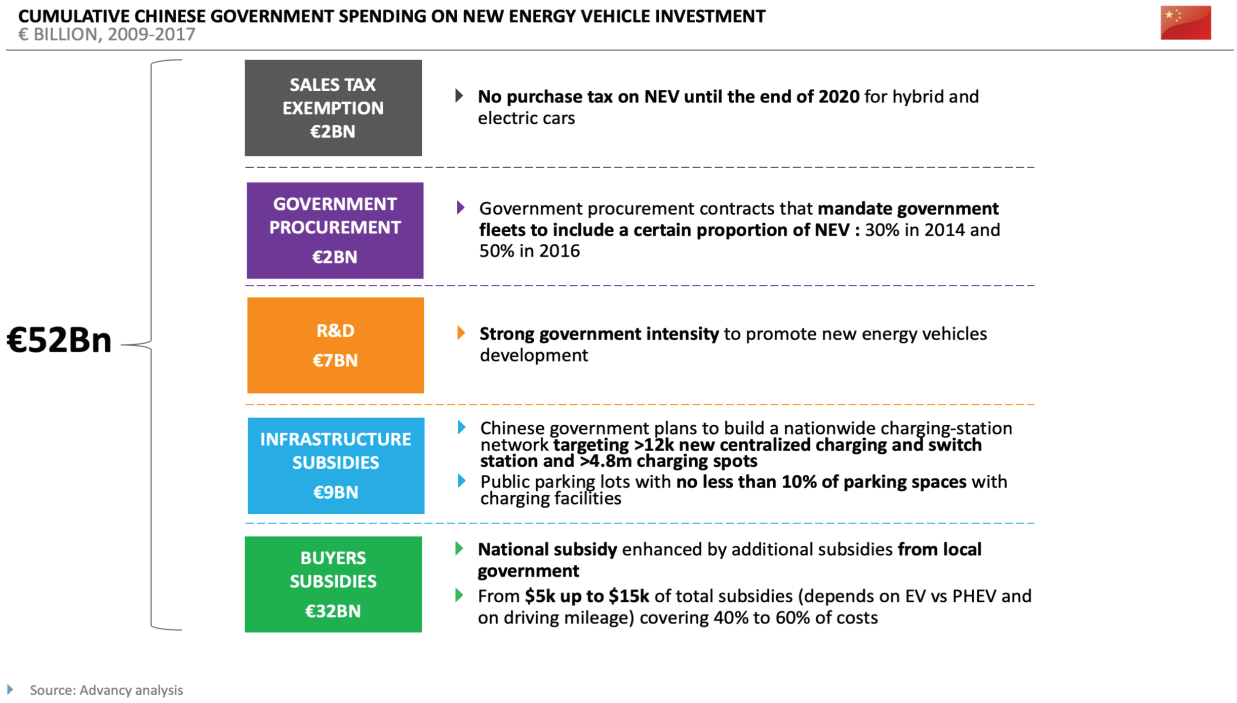


Fig. 25 - China NEV strategy & market share target

This € 52Bn package included around € 7Bn in R&D funding between 2009 and 2017 to develop the technological capabilities required, amounting to an average € 1Bn per year to sustain the research effort required to build its competitive advantage.

The US are also investing heavily to bridge the gap with European and Japanese/Korean OEMs in the field, with an overall investment reaching c.€ 250M per year, with a wider approach, covering several aspects of lower emissions vehicle: hybrid electric systems, materials technology required to achieve light-weighting solutions and fuel technology.

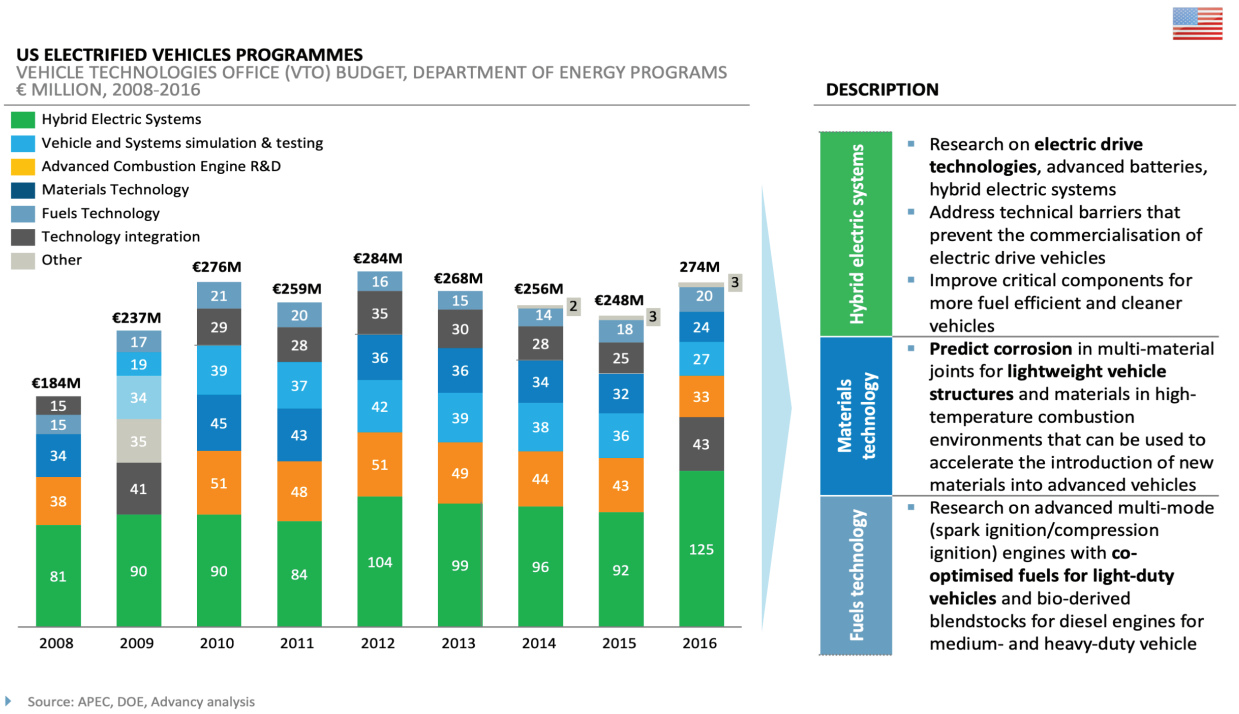


Fig. 26 - US low emissions vehicle strategy

Though, the R&D Funding is very different in the US: several competitors can be involved in a single project but it is limited to a specific step of the value chain; hence, that generates a very different eco-system.

In Japan, despite smaller scale of the automotive industry and a high emphasis on Fuel Cell / Hydrogen, investments in the field of electrified vehicle (batteries, V2G and smart charging, and new solid-state technology) seem to be reaching the same order of magnitude as in Europe.

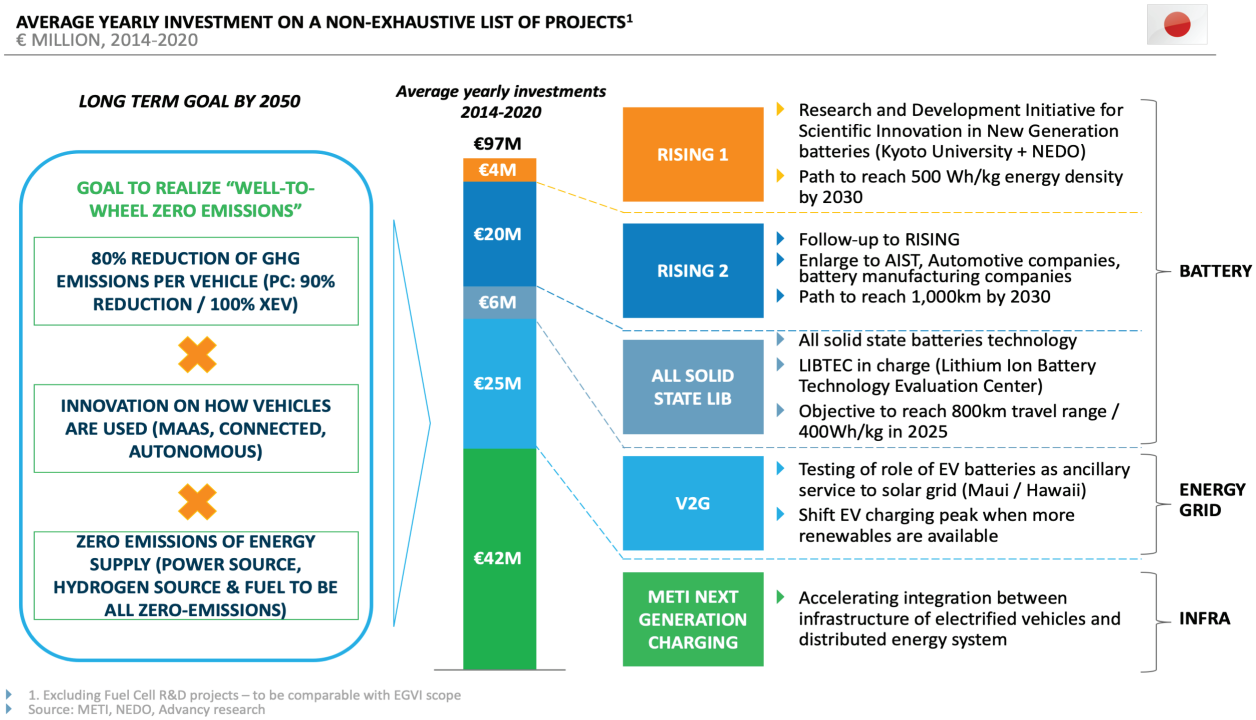
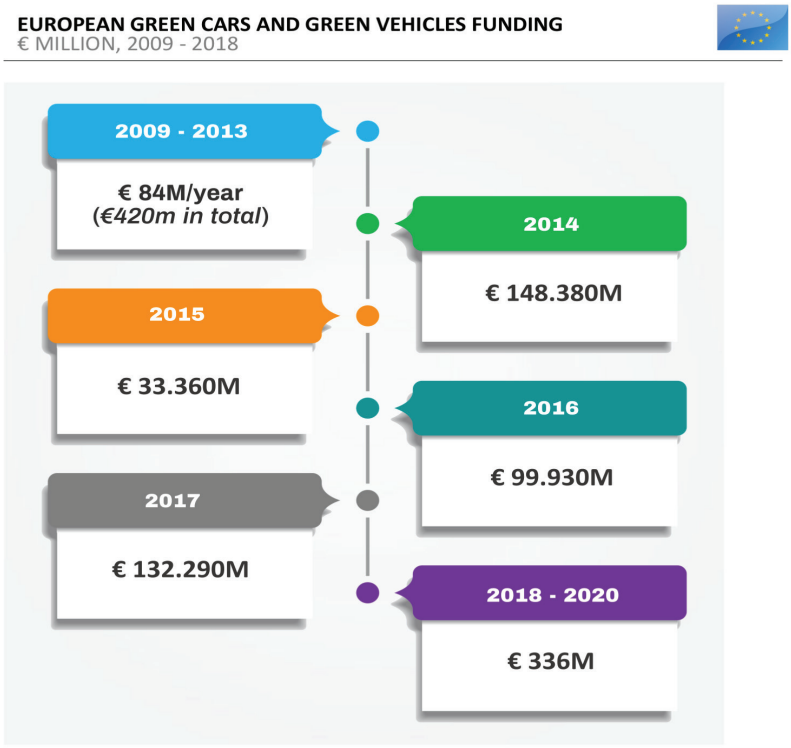


Fig. 27 - Japan long-term goal and key R&D projects (excluding Fuel Cell R&D)

The EU funding effort in the field seems smaller in comparison, with a risk of being caught up by international competition. Indeed, EGVI funding is well below these measures, reaching around €85 Million per year despite of a c.23% increase from 2009-2013 to 2014-2017 with more than €100 Million annual funding and an increased focus on electric drive and batteries. With a funding gap between 3X and 11X, it is key to at least maintain the R&D efforts to avoid being overtaken by these powerful competitors.

Average € 84M invested per year during the 2009-2013 period and € 103M in 2014-2017 (+23% increase)



The effectiveness of R&D spending is key to ensure a high level of Return on Investment and the European Union has proven to be a successful player when looking at the international competition with this approach.

Even if spending massive amount in R&D does not guarantee a leadership position, when the EU is spending significantly less than its competitors, it is more likely to be bypassed in the development of new technologies.

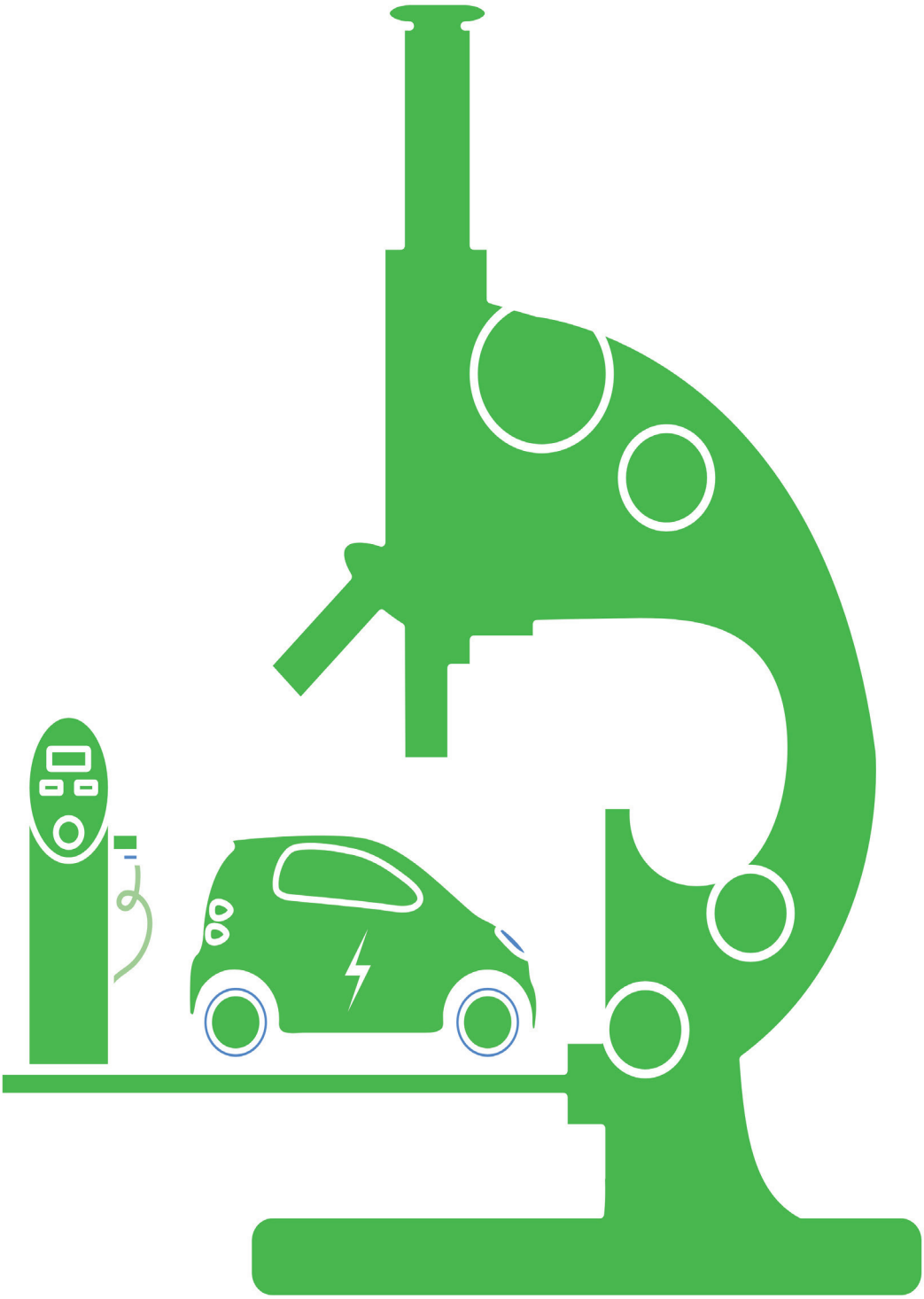
Fig. 28 - EGVI funding over the decade & budget until 2020

Keeping an ambitious level of funding associated with appropriate and efficient funding tools will be critical to maintain the European Union in a leadership position in Green Vehicles.

Last, but not least, globalisation and international trade was slow down recently after the election of President D. Trump in the US. This policy shift has reinitiated commercial trade with increasing tariffs and strategic components and products are now being constrained not to be sold in some countries. Europe is facing some threats: tariffs on steel and aluminium have been raised significantly and European OEMs have been threatened of massive tariff increases on imported cars. The next step could be to limit the access to critical components such as chips and semi-conductors to protect the American IP and to use it as a bargaining power tool. Green Vehicle development is highly dependent on the emergence of new electronic and software: being able to access the next generation, or even more being independent, is highly critical.

Car electrification is calling for new power electronics and Europe has a strong asset with several key players there (Infineon, ST Microelectronics, Valeo-Siemens, Bosch, Continental…) but we need to ensure that they will have the skills and financial resources to keep developing these technologies without being limited to access some elements (rare earths materials…).

All Li-Ion batteries are coming from Asia nowadays, especially from China and Korea. The full automotive industry in Europe is exposed to sharp and unplanned price increases or capacity limitations. It is highly critical for Europe to rely on European production: on this front the announcement in October 2017 of the creation of "Battery Alliance" is an excellent news. But Europe needs to go beyond the mass market Li-Ion technology and prepare the next generation of battery cells which will create breakthrough in performance and eliminate roadblocks in the development of EV sales. This will call for massive R&D funding to compete with the billions invested every year on this domain by other players across the world, mainly Asian companies (Panasonic, LG, Samsung, BYD, CATL….).



7. LESSONS LEARNT, IMPROVEMENT AREAS AND PROPOSED EVOLUTIONS FOR EGVI PPP

A. STRENGTHS OF THE CURRENT PARTNERSHIP

According to stakeholders interviewed, EGVI PPP has achieved tremendous success on key areas bringing forward the research topics and putting together an effective research community in Europe around the themes of Green Vehicles for road transportation. The dynamics measured by the increase of projects, funding and participants speaks for itself.

All interviewees stress **4 main factors** to support their assessment of EGVI as a success:

- **The clarity of focus** on technology supporting lower emissions of road transportation is a clear success factor for EGVI and its funded projects
- **The appropriate coverage in types of vehicles (Passengers Cars, Commercial Vehicles, 2/3 Wheelers).** In particular, with the industry being very much focused on Passenger Car emissions due to volumes, other OEMs and suppliers were happy that EGVI covered Commercial Vehicles as a central part of its project portfolio
- **An effective measurement methodology**: for large projects, the technology was introduced in a real vehicle, in real-driving conditions with measurement of impacts. When components or budget are unavailable, robust alternatives were found by bringing together different test environments and getting a validated simulation of components
- **An effective market impact stemming from EGVI programme or technology developed in the context of EGVI programme**:
    - *"We have used elements from this battery technology to do battery development for many companies"*
    - *"Integrated Starter-Alternator driveline that was part of EGVI project has been used in our commercial products, with over 4,000 buses around the world already equipped. What's more, we were able to take quickly the EU Rise / Energy management for complete vehicles into our commercial products"*
    - *"As an ESP, we look at what we have invested in terms of technology vs. what business we got from our customers based on these technologies. Overall our ROI is 20:1 in lifetime sales".*

These successes were made possible by the core strengths of EGVI PPP, as identified by its participants:

- **Setting clear and challenging technology goals for emissions and fuel efficiency**:
  - *"Our objective was to achieve -22% emissions vs. comparable Diesel technology and fulfilling EURO 7 (-50% emissions vs. EURO 6b)"*
  - *"We had an objective of -20% consumption vs. 2014 baseline".*
- **Establishing an effective ecosystem management to overcome "the Valley of death of innovation" and reduce time-to-market by**:
  - **Mobilising the right partners across the value chain in a "roundtable approach"**: Universities, CROs, OEMs, Suppliers, SMEs, start-ups…
    - *"One of the main success factors was to have a roundtable approach, gathering people form the whole value chain discussing the issues we were facing: from OEM down to battery manufacturers: all were on-board and allowed exchange of information at the right level (material, cell integration, scaling-up for cell production, pack integration)"*
    - *"Bringing the whole value chain together and the right level of competencies in the same project allow to have not only the right level of competences, but also a first level of supply chain for the future once the technology is ready, thus reducing time-to-market by at least 5 to 10 years"*
    - *"Bringing the stakeholder community together without collusion, to be more efficient on R&D is one of the core strengths of EGVI PPP"*
    - *"We had the right profile of people involved: technical representative, technical staff AND management".*
  - **Involving SMEs, academia & research organisations to enrich the consortium through additional flexibility and specific skills:**
    - *"SMEs bring to the table their higher degree of flexibility, in particular for research tasks where they offer highly specialised skills (e.g. for verification & validation). The benefit they get is to be exposed to large companies up to the OEM, and better understand their expectations and the way they design and think of their products"*
    - *"We had the chance to count the Technical University of Graz as a participant in the consortium. That helped us gain access to official testing equipment and allowed us to participate on standardisation topics and gain in know-how"*

- **Being focused on conducting high risk / low maturity breakthrough projects**: *"You could never do a project on Natural-Gas commercial vehicle (€ 28M funding) with a single company: it would be too expensive and you would never have all the skills required in-house"*
- **Maintaining a balanced private-public dedicated organisation avoiding administrative slow-down and delays while fostering a trustworthy culture:**
  - **Size of the consortia is contained to avoid dispersion and inefficiencies**: *"EGVI has managed to rein in the size of the consortia, and it is a good thing to keep them effective"*
  - **It is very easy to engage projects within EGVI and the process is transparent**: *"project targets are clear and you know clearly the reasons why you have lost when your project was not selected"*
  - **Innovation Time to Market is not hindered by bureaucratic processes**: *"engaging critical R&D projects cannot sustain the low speed of bureaucratic organisation"*
  - **EGVI organisation is perceived as lean and agile**: *"We see EGVI administration as very lean and very efficient. Bureaucracy level is low compared to other EU programmes and JU & association fees are small as well; value added time is maximised on projects not on regular & useless reporting"*
  - **EGVI managed to established a trustworthy and safe environment for exchange**: *"We feel we have a very open communication level with EGVI: we can trust them and we feel free to discuss sometimes sensitive topics".*

B. WHAT SHOULD COME NEXT? IMPROVEMENTS AREAS AND PROPOSED EVOLUTIONS FOR EGVI PPP

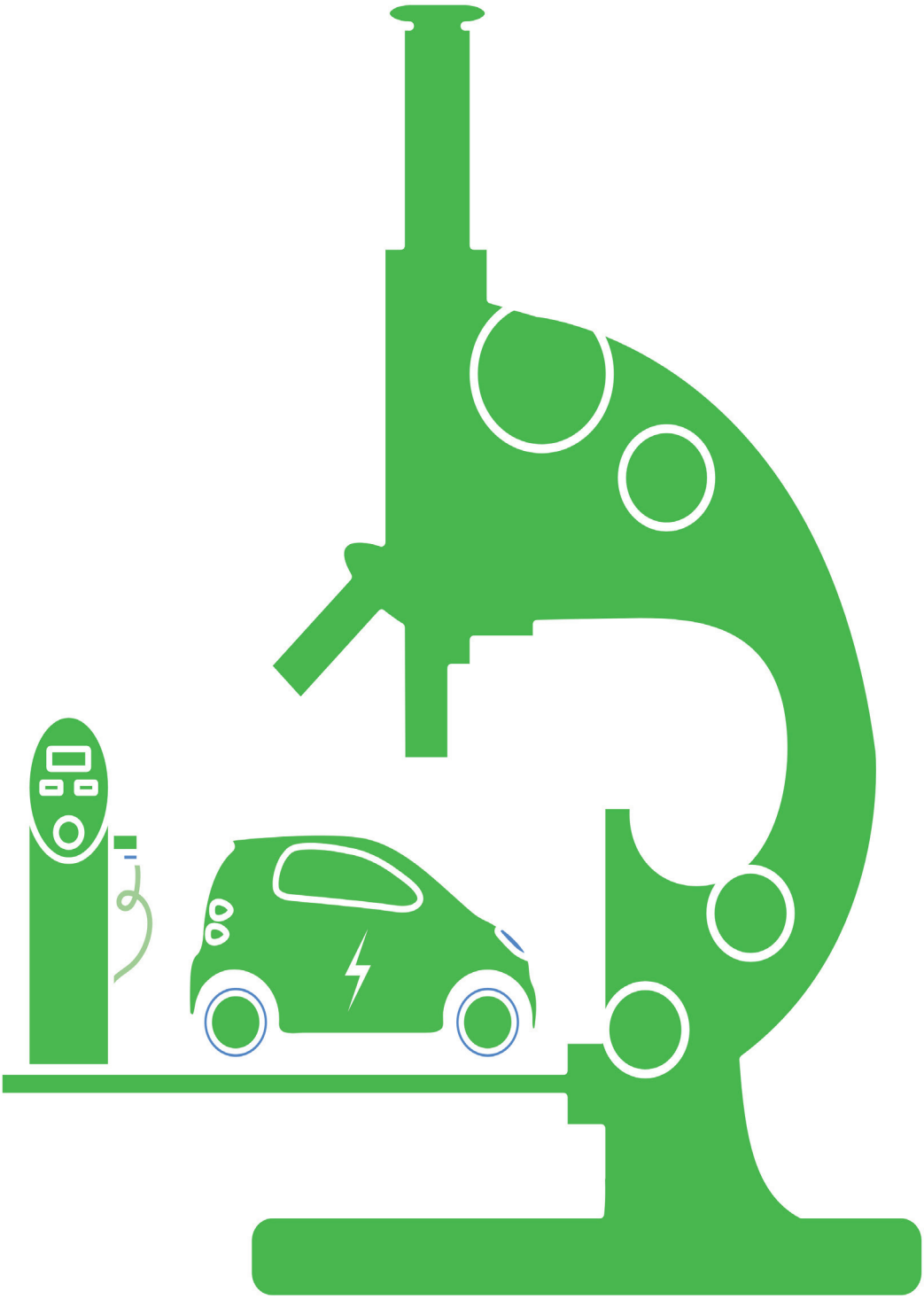
However, interviewees have also highlighted some improvement areas on which EGVI PPP could work to further improve its impact and effectiveness which is already broadly acknowledged:

- **The focus of EGVI on technologies could be adjusted for the next phases:**
  - The vehicle itself has been the core focus, by optimising the overall efficiency, when more room could be made to also work on key component efficiency
  - On batteries, efforts have been more focused on battery systems and less on the cells whereas the latter are critical for performance; it is necessary to understand why we are lagging behind in battery cell technologies while Europe count some of the most innovative chemical groups
  - So far, EGVI has under addressed some topics that are critical to achieve the low carbon footprint vision for the EU within a system approach, such as the links between vehicles and infrastructure or renewable/synthetic fuels.

- **The solid funding mechanism in place helps accelerate mature topics, but could restrict potential breakthroughs:**
  - EGVI funded a majority of incremental projects at the beginning but included more disruptive ones moving forward; finding the right balance is not easy but both are needed to deliver tangible results
  - Current mechanism does not allow enough flexibility to explore riskier projects leading to fund mainly incremental innovation projects; reaching more stringent targets will require research activities supporting also disruptive innovation though failure has to be accepted as well: *"We have very strict funding rules, that discourage scope changes along the way. This hinders "moon-shot" projects or "fail fast projects". There are certainly other EU Programmes dedicated to breakthrough projects. However, we should strongly underline that this step-by-step approach is also having an important impact on innovation deliverables and market results in the European Union"*
  - There is also a need to better coordinate the various EU R&D funding schemes and programmes on R&D priorities.
- **One limitation of EGVI is that innovation development cannot be pursued when we enter competitive phases** which means that innovation time to market is linked to the willingness of private companies to pursue the development activity and to put the innovation on the market ideally as fast as possible. While anti-trust laws should be respected at all stage of the innovation process, creative solutions should be investigated to keep the link with previous EU-funded projects and follow-up investments and activities.
- **Involvement of SMEs remains low and needs to be addressed specifically:**
  - Need for a simplified / accelerated induction process for SMEs to lower cost & effort, possibly supported by mentoring:
    - *"It is very difficult for SMEs which are not used to these processes to participate in such consortia. It is often too much cost & effort for such small companies. This could be improved by having a "guide" company to help them. The situation is different for start-ups: they might have a technologically brilliant idea from the beginning, before having their own internal structure"*
    - *"It could be beneficial to set-up continuous mentoring of SMEs along the stages of the project".*
- **Balancing consortia size, required by the nature of the topics at hand, with contained set-up times & project complexity remains a challenge:**
  - *"The larger the number of partners, the harder it gets to have an impact. There is difficulty in balancing bringing a large panel of stakeholders (150+ companies in total) around the table with answering the EC's objective to be very focused on 6-10 topics".*

- **Participant diversity should be increased** and there is a need to launch a specific screening to identify new potential partners:
  - Members & participants are mainly coming from Western Europe and we need to develop the participation of EU-13 countries which is not so easy given that they are more developed on production than in R&D
  - But at the same time, there is a **need to keep extending membership to traditional players like OEMs.**
- **Finally, communication with European Commission has not been optimal, in particular regarding final impact. This point has recently been improved:**
  - *"The final impact of EGVI project was not always properly quantified and communicated to EC stakeholders in the past. This has changed, as was shown in the H2020TR session in November 2018".*

In synthesis, EGVI PPP remains largely a successful initiative in the eyes of stakeholders interviewed from all backgrounds: project coordinators, Member States, industrial companies, SMEs and academia. A PPP like EGVI emphasises the need for a combination of disruptive innovative thinking brought by SMEs, large field of application, robustness of programme management.



8. HOW TO MOVE FURTHER IN THE NEXT 10 YEARS?

The EU's Green Vehicle strategy has shown several successful achievements. Spearheading this strategy, the EGVI PPP has helped to bridge the industry and capability gap of Europe in this field, and will help achieve the short- and long-term CO_2 emissions reduction targets.

However, several challenges still lay ahead for the EU automotive industry that could see its leadership severely challenged.

So far, an important part of the CO_2 emissions reduction has been achieved through incremental improvements, there remains a strong need for additional research to achieve the upcoming targets. CO_2 savings have been achieved following a linear path from 2002 to 2014; the "low hanging fruits" of emission reduction has been picked. We now need to accelerate and work on new levers and technologies.

Every single component of the Green Vehicle system will be critical to reach the new emissions reduction targets, both CO_2 emissions and fine particles. It will be necessary to combine incremental and disruptive innovations to go beyond what has already been achieved.

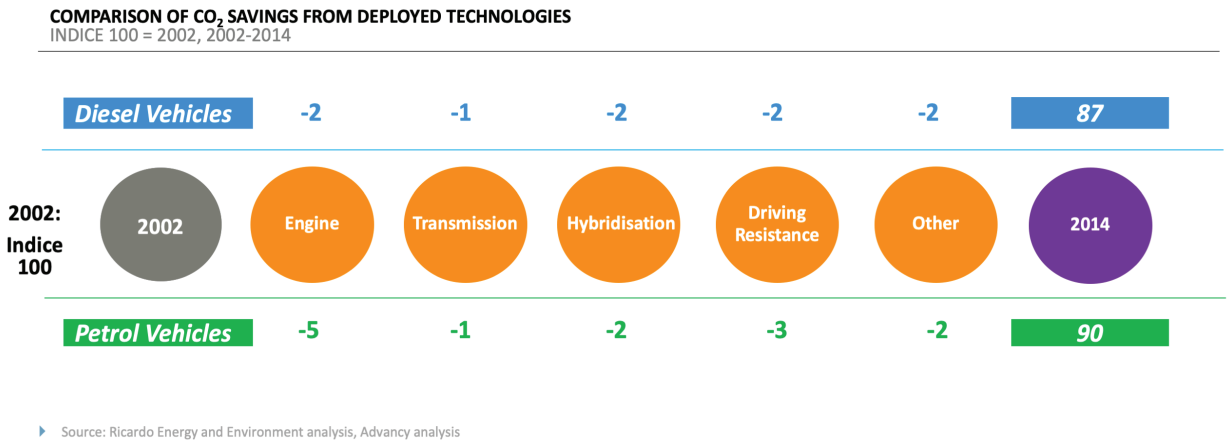


Fig. 29 - CO_2 Emission average savings brought by main technological levers

The upcoming CO_2 emissions targets are very challenging and can only be achieved by investigating all technical options available at an acceptable cost level.

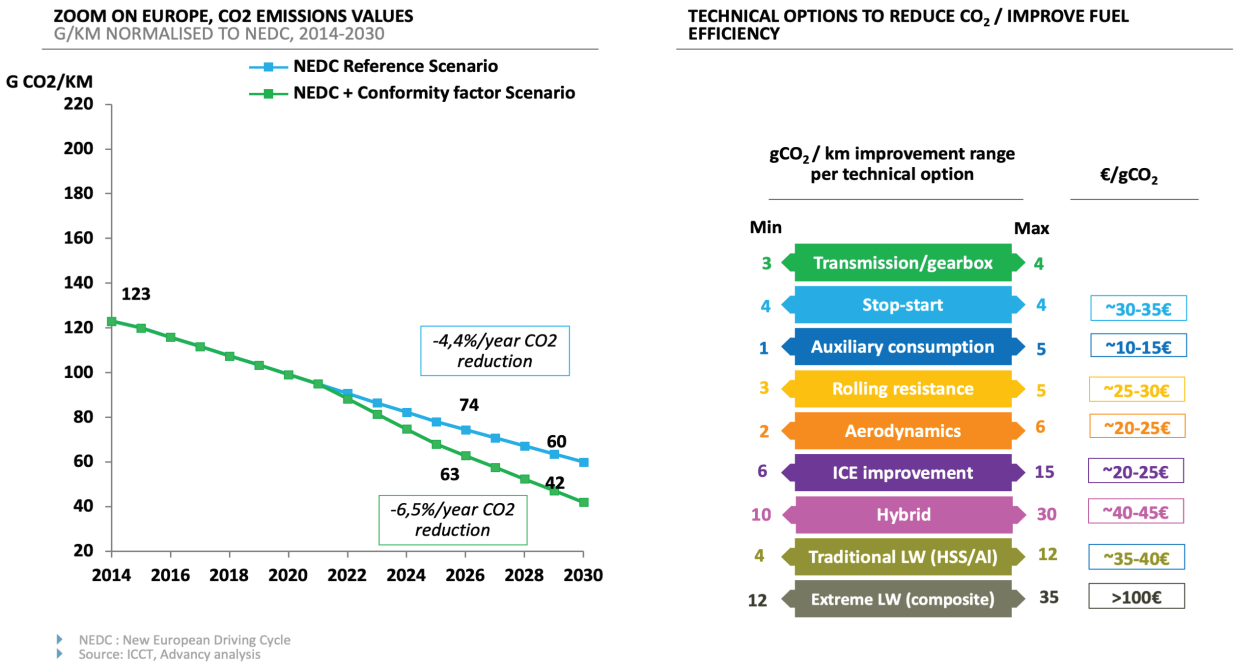


Fig. 30 - Inflection point in emissions targets and available levers to close the emissions gap levers to close the emissions gap

In this study, the ERTRAC Mix scenario was used as a basis for calculation, which is associated with a relatively moderate vision regarding the penetration of electrified vehicles in the fleet by 2050, shown in Figure 31.

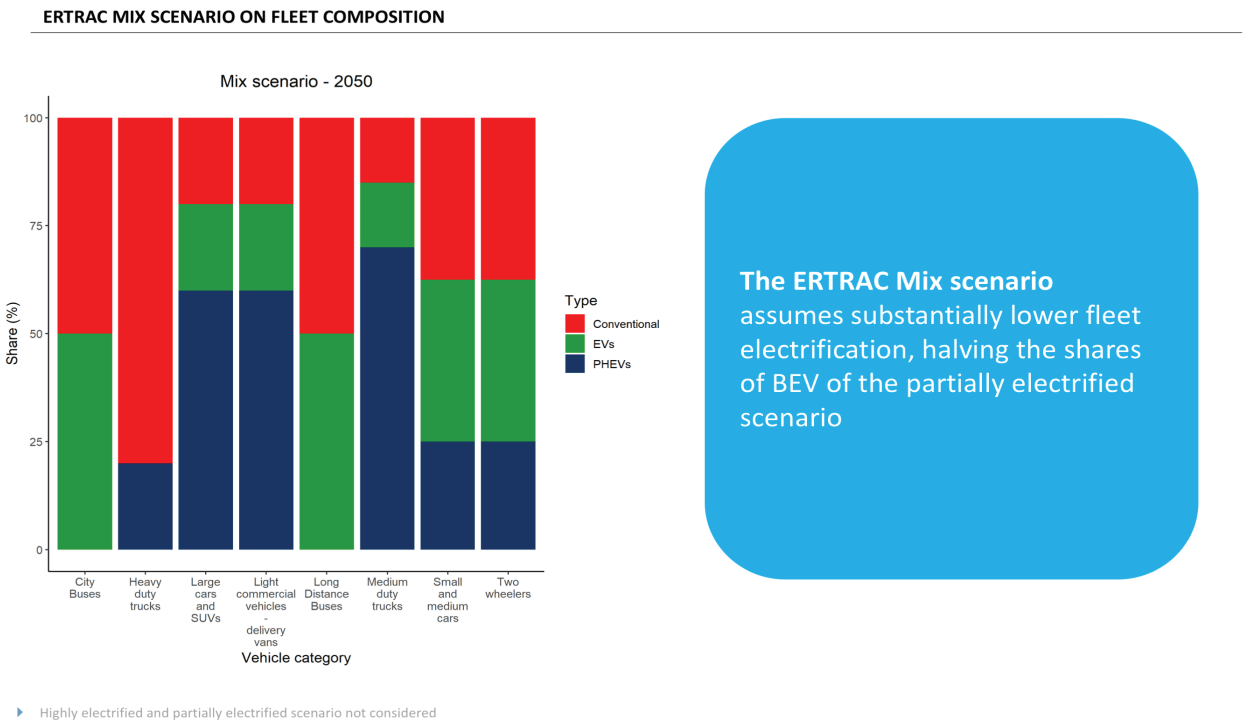


Fig. 31 - Vision of fleet composition by 2050 according to ERTRAC Mix scenario

The back extension of the ERTRAC 2050 vision towards 2030 and 2021, accounting for both the technology portfolio developed in the EGVI related research projects and the ambition to comply with the EU 2030 CO_2 emission targets, led to a 2030 breakdown per technology for passenger cars as follows:

- Conventional vehicles (including hybrids): 63,5%
- PHEV: 25%
- BEVs: 11,5%

It was shown that, to achieve the required average fleet CO_2 reduction, improvements in the internal combustion engine and related technologies are absolutely necessary while at the same time more than 30% of electrified vehicles (BEV + PHEV) will be required. EU leadership on this segment is not guaranteed, as it is expected to be strongly disputed by Chinese OEMs on mass market and US OEMs on Premium.

Level of investments from China, Japan and the US in the field of Green Vehicles are significant and already above the EU funding of EGVI. The result is already measurable in terms of lost ground of patents filed as seen in previous sections.

New entrants in the value chain from the semi-conductor and the tech industries have significant firepower in terms of R&D and are heavily focused on the mobility / automotive industry with more exposure to the US and Chinese market than to the EU market.

The combined R&D resources of non-automotive players (GAFA, BAT and top 10 semi-conductors) is comparable with those of automotive player. This is testified by the acceleration of mergers and acquisitions deals in the four new value spaces (electrification, connectivity, autonomous and mobility services) since 2012: tech companies (semi-conductors, GAFAs and BAT) now represent 34% of mergers and acquisition activity in the automotive sector. For deals where the value has been disclosed, more than $ 77 Billion have been invested in electrification, connectivity, autonomous and mobility services; and tech companies have spent more than $37 billion in total so far.

The EU is not far away from the US is in terms of total amount invested in new value spaces but Asia is quickly catching up.

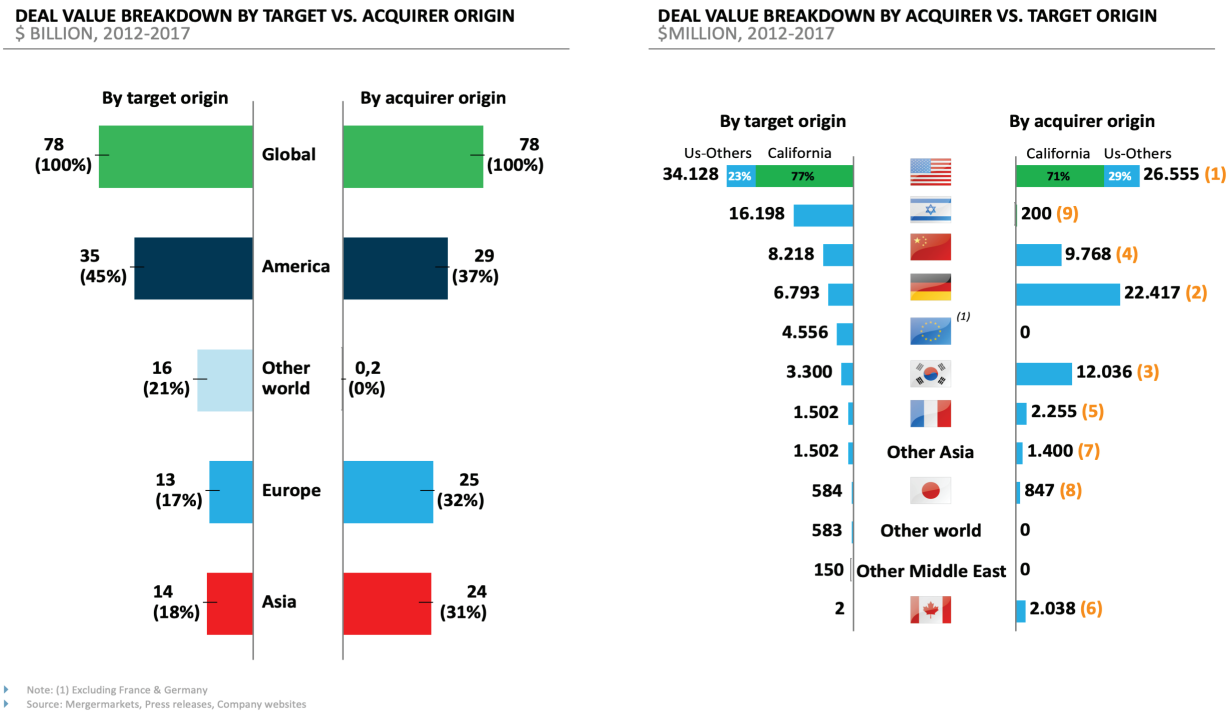


Fig. 32 - M&A by region of acquirer & target region

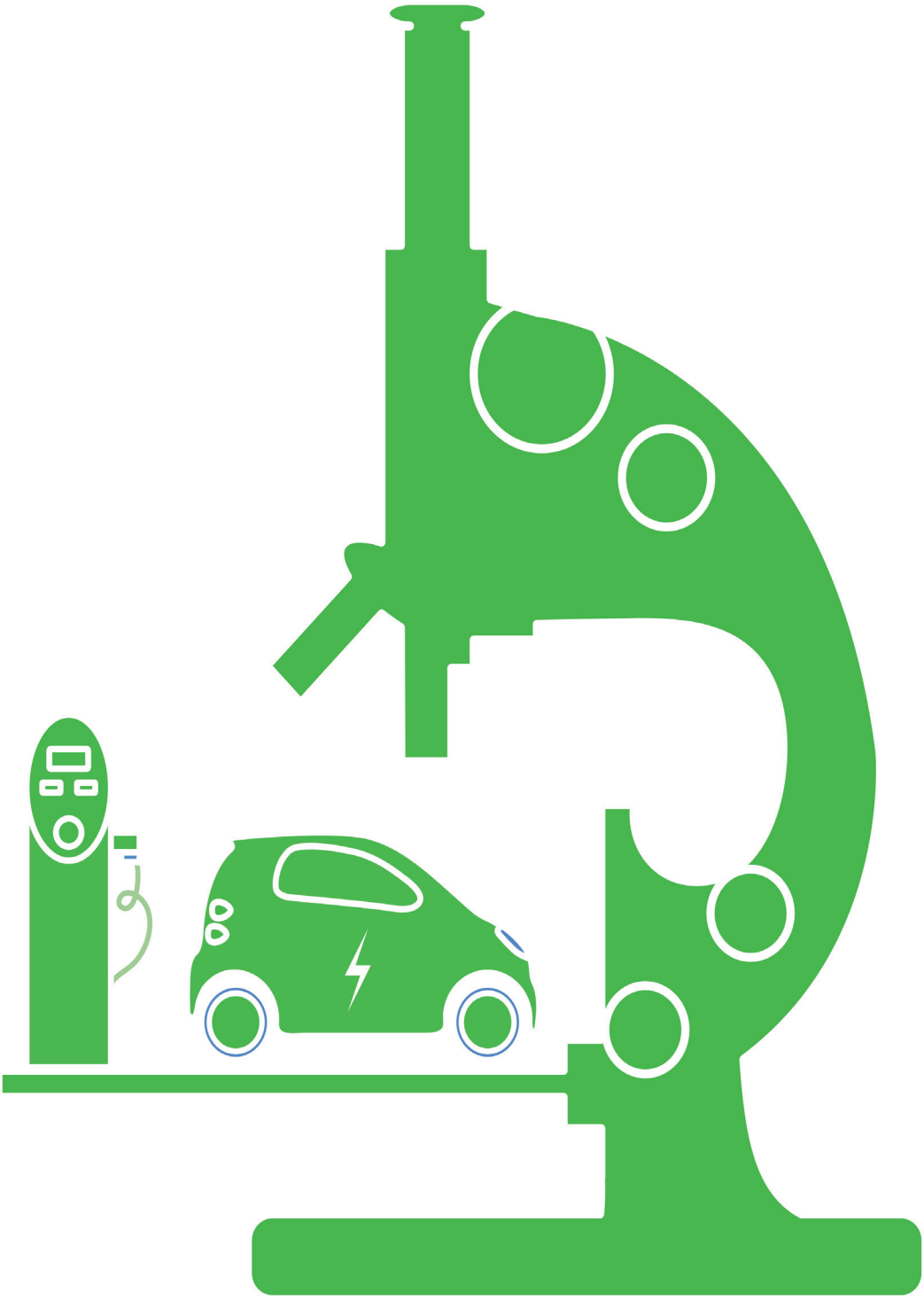
In defining and executing its long-term strategy for GHG, Europe needs to maintain its leadership on technologies that will shape the future of the continent. That will imply to involve new stakeholders active in road transport and mobility solutions into the road transport ecosystem.

The remarkable step change that the EU industry has achieved in the field of Green Vehicle during the 2008-2017 period has positioned the community as a leader in the 5 years to come. **However, by the conjunction of the technical challenges lying ahead and the intensifying competitive pressure from the US but more significantly from China, Japan, South Korea, there is a strong need for continuing to support R&D effort that will sketch the future of decarbonised mobility in the EU.**

Public funding is key to the automotive industry: its share might be low compared to other part of the world, but when having a look at private R&D expenditure, the share of spending purely dedicated to research does not exceed 20%, the remaining part being dedicated to the competitive product development. Hence, the relative share of public funding related to pure research activities is much higher in practice.

One key role of EGVI is to support policy-makers in identifying the research priorities and providing the appropriate tools to measure the impact of EU-funded research activities, thus allowing to set the rules in the most appropriate way (funding priorities, emission reduction measures…).

Emissions targets will be more and more stringent up to 2030. Therefore, it is rather time to accelerate and spend more in R&D via PPPs like EGVI and make sure we stay ahead of competition by involving new players dealing with transport and mobility, including digital technologies and car connectivity that can contribute to emission reduction and support both incremental and disruptive innovations.



9.WAY FORWARD

To consolidate its achievements and deliver additional impact, the stakeholders interviewed during the study are proposing several areas to be addressed by EGVI in the future Framework Programme Horizon Europe:

- **Accelerate and support the roll out of new technologies already developed thanks to EGVI (finished or close to completion projects) via the enhancement of European activities and other sources of funding**, as a pragmatic way to demonstrate the positive results of the PPP and to link our activities to the impact on emission reduction
- **EGVI should keep finding the right balance between incremental and disruptive innovation:**
  - Disruptions are key to make performance breakthrough on selected topics
  - Yet, incremental progress is key to reach the market as soon as possible and get tangible results
  - We need more at-scale demonstrators to gain visibility from customers & citizens.
- **Push further in-vehicle technology topics:** in order to achieve the CO_2 targets, it will be key to further study several areas within the tank-to-wheel emission reduction research topics:
  - **Alternative fuels**: as hybrid vehicles will remain dominant in the car fleet by 2030, it is an absolute pre-requisite to maximise the reduction of their CO_2 emissions by ensuring the fuels used have the lowest carbon footprint possible (and further investigating the environmental benefit of the use of bio-fuels and e-fuels)
  - **Efforts on hybrid vehicles** should also be accelerated as they will represent an important market share in the future
  - **Need to work now on both the integration of new components at system level as well as optimising the performance of existing components**
  - **Affordability:** the focus of EGVI programmes in FP7 and H2020 has been on making the technology work. Now, we need to make it more robust and affordable to ensure its fast market uptake, both in Europe and in the world
  - **Manufacturing**: a lot has been done on the parts and concepts. Further work should be done at system level (reliability / durability) and manufacturing now that the technology has achieved higher readiness.

- **Go beyond tank-to-wheel CO_2 emissions control**: most of EGVI projects have effectively focused on reducing CO_2 emissions from tank-to-wheel. EGVI has now to extend the scope:
  - Move from driving emissions to cradle-to-grave emissions and consider the energy costs to produce the various fossil fuels
  - Consistently work not only on CO_2 but also on both regulated (e.g. NOx and PM/PN) and non-regulated emissions (such as CH_4, N_20, NH_3, PAHs etc) as internal combustion engines will remain in production (especially for heavy duty vehicles) and will require to solve these challenges
  - Consider the full life cycle of vehicles especially the production of key modules such as batteries
  - Take a system view on energy management.

- **Technologies developed under EGVI need to allow reduction of all type of emissions not only CO_2 since public policies need to address both climate change and air pollution issues**
- **Expand its scope of research from the vehicle system to a system approach by leveraging all the available technologies**, including digital technologies to further reduce emissions, also beyond powertrains related activities:
  - Include research on connectivity & autonomous driving technologies that could help reduce fuel consumption, through improved interactions between the vehicle and its environment (e.g. traffic lights, city traffic) and other vehicles (e.g. platooning) and accelerate the development of EVs
  - Broaden its ecosystem to include new stakeholders from the energy and ICT sectors. This should allow a global perspective across different sectors and avoid silo thinking.
- **Further develop EGVI's holistic view on the transport system (logistics optimisation, ITS …) leveraging digital technologies and on the energy production upstream (biogas, biofuels…)** by deepening the links & coordination with other PPP working on these topics
- **More specifically, on batteries, the acceleration of investment in R&D is key to achieve a disruption in terms of performance and safety by looking at:**
  - The cells development – in coordination with the EU Battery Alliance:
    - New battery generation of cells to reduce costs and improve performance
    - Working on raw materials to prepare for the next generation of batteries, new cell concepts as well as new electrochemistry
    - Low power electronics
    - Integration into the battery pack.

- EGVI was focused on improvement of energy efficiency so far; there is now a **need to broaden the scope to the Green Vehicle as a system and extend the PPP to other key stakeholders in order to include all the relevant new skills:**
  - Semi-Conductors
  - Infrastructure players
  - Battery and Energy producers
  - Digital companies.
- **Work on increasing awareness about EGVI achievements and opportunities:**
  - All stakeholders involved in EGVI sees the benefits of the initiative, and a majority of beneficiaries are non-EGVIA members (77% in Green Cars and 87% in Green Vehicles); however, it is important to continue the efforts already undertaken to disseminate the impact of the EGVI partnership
  - **Reinforce the involvement of more European Commission DGs (GROW, Connect, Climate Action …)** and strengthened links with national authorities, in order to avoid the duplication of activities and ensure the appropriate level of support to stakeholders as a follow-up of EGVI projects will be very important in the next phase of the partnership
  - **There is a room for improvement in bringing in an even closer dialogue the industry and the Member States representatives.** Processes to enhance the dialogue between industry and the national authorities are open but many different options can be investigated to strengthen coordination between different levels of funding
  - To go further and create a "snowball effect", marketing more actively EGVI, its achievements and its stakeholders could contribute to accelerate market deployment of innovations.

The challenge of reducing road transport emissions to deliver on environmental and societal goals is only going in one direction: getting bigger and harder to achieve. The European RTD ecosystem has only started to deliver results in the car fleet, and more will follow soon thanks to the activities currently performed in collaborative research, but reaching the 2030 and 2050 targets is not getting any easier. The amount of work to be done and the number of people to be put around the table to achieve our targets is very high and is continuously growing. The EU needs to make sure to keep its leadership in clean vehicles technologies and to maintain the associated necessary levels of investment in R&D and CAPEX in order to lead the race in Green Vehicles technologies.

The achievements are already significant, but we need to continue building on the successful EGVI experience to achieve a Green Vehicle fleet on European roads!

EGVI
European Green
Vehicles Initiative

EUROPEAN GREEN VEHICLES INITIATIVE ASSOCIATION

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