



EGVI

IMPACT ASSESSMENT 2014-2020

Final Report
Edition 2023



EGVI
European Green
Vehicles Initiative

The EGVI Impact Assessment 2014-2020 was carried out for the EGVIafor2Zero association by Strategy Engineers GmbH & Co. KG.



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FOREWORD

Strategy Engineers (SE) – an independent, international management consulting firm that specialises in the mobility industry, has carried out an impact assessment for EGVI (now EGVIafor2Zero) – the association representing the private side of the EGVI contractual public private partnership.

The purpose of the assessment is to better understand the outputs and added value of the European Green Vehicles Initiative (EGVI) programme and associated projects that received funding from Horizon 2020 between 2014-2020, and benefits of EGVI membership for participating parties, to support more targeted and efficient impacts in upcoming activities and day-to-day operation.

Research and inputs to the approach are based on information from project participants, EGVI members and the public domain.

A high level summary of the key findings is presented in **Section 1**, with more depth provided in the **Section 2 “Executive Report”**. Full details on methodology used and supporting information from the impact assessment can be found in the **Section 3 “Detailed Report”**.

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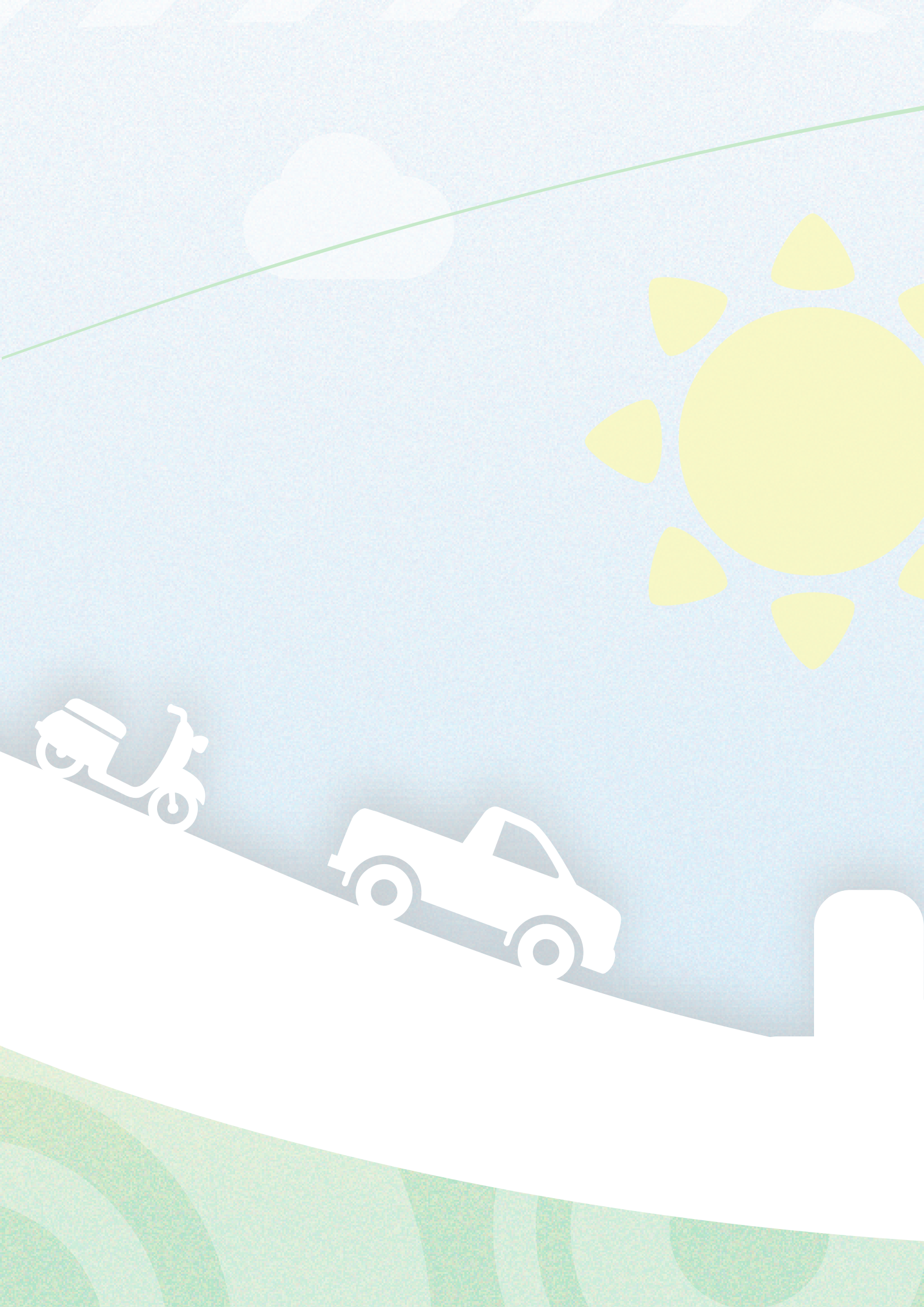
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ACRONYMS

BEV	Battery Electric Vehicle
BOM	Bill of Materials
CINEA	European Climate, Environment and Infrastructure Executive Agency
cPPP	Contractual Public-Private Partnership
DG MOVE	Directorate-General for Mobility and Transport
DG RTD	Directorate-General for Research and Innovation
EC	European Commission
EGVI	European Green Vehicles Initiative
EGVIA	European Green Vehicles Initiative Association
EGVIAfor2Zero	European Green Vehicles Initiative Association for the 2Zero Partnership
ELV	Electric L-category Vehicle
EPoSS	European Platform on Smart Systems Integration
ERTRAC	European Road Transport Research Advisory Council
ETP	European Technology Platform
EU	European Union
EV	Electric Vehicle
GFEI	Global Fuel Economy Initiative
HMI	Human Machine Interface
ICE	Internal Combustion Engine
ICT	Information and Communications Technology
IEA	International Energy Agency
IMF	International Monetary Fund

INEA	Innovation and Networks Executive Agency
KPI	Key Performance Indicator
LCA	Lifecycle Assessment
LFP	Lithium Iron Phosphate
NMC	Lithium Nickel Manganese Cobalt Oxide
NOM	Non-EU Originating Material
OEM	Original Equipment Manufacturer
R&D	Research and Development
R&I	Research and Innovation
RTO	Research and Technology Organisations
RTR	Road Transport Research
SE	Strategy Engineers
SME	Small and Medium-sized Enterprise
TRL	Technology Readiness Level
2Zero	Towards Zero Emission Road Transport
USDRIIVE	Driving Research and Innovation for Vehicle efficiency and Energy Sustainability



1. EXECUTIVE SUMMARY

European Green Vehicles Initiative (EGVI) achieved its objectives and laid the foundations for today's portfolio of European Union (EU) funded transport technology research and innovation (R&I) initiatives. The initiative generated both tangible and intangible benefits for the EU transport industry that will endure beyond the duration of the associated projects.

▶ **EGVI contributed to ongoing road transport decarbonisation through the integration of advanced technologies**

- The EGVI programme had a positive impact on the development and deployment of new technologies, demonstrating virtual or physical carbon reduction potential and representing a strong contribution to development of the state-of-the-art. Particular technical improvement areas were battery pack energy density, battery cell energy density, holistic passenger car energy efficiency and heavy-duty truck energy efficiency
 - Leading EGVI programmes demonstrated credible vehicle efficiency improvements that were several years ahead of market development trends and forecasts, based on modelling in this assessment
- EGVI projects outputs will continue to contribute towards tank-to-wheel CO₂ emissions decrease across key transport applications in the medium term
 - EGVI's outputs supported road transport decarbonisation, contributing to the achievement of 4.6 million electrified vehicles on the public road in the EU by 2020
 - EGVI contributed to a reduction in road transport carbon emissions of up to 9 million tonnes of CO₂ by 2030 through vehicle efficiency improvement, which is equivalent to taking 6 million passenger cars off the road for one year

▶ **EGVI's legacy provides an enduring boost to EU economic growth and employment through improved industry competitiveness**

- EGVI projects directly developed vital skills, knowledge and capabilities across critical topic areas, building overall EU competence and supporting academic/training curricula development

- EGVI projects improved time-to-market capability by approximately 12 months for relevant technologies, increasing EU competitiveness in a rapidly changing global industry. This competitive advantage will lead to economic and employment benefits from technology-led products
- The key skills, technologies and capabilities developed during EGVI and ongoing related R&I programmes could contribute to commercial benefits of up to €30 billion in the period from 2024 to 2030, representing a return on investment of up to 40x. This is at the leading end of international benchmarks of expected returns on investment
- This additional industry growth could require up to 16,000 high value future jobs (on average) in green vehicle technology sectors, with potential for further cascading employment benefits throughout the value chain and overall economy
- Green vehicle technology leadership, which likely supports bringing more of the technical value chain back into the EU, may provide opportunities for small and medium-sized enterprises (SMEs) and regional industry growth and job security benefits

► **EGVI supported growth of the EU-wide scientific research community and its strategic alignment**

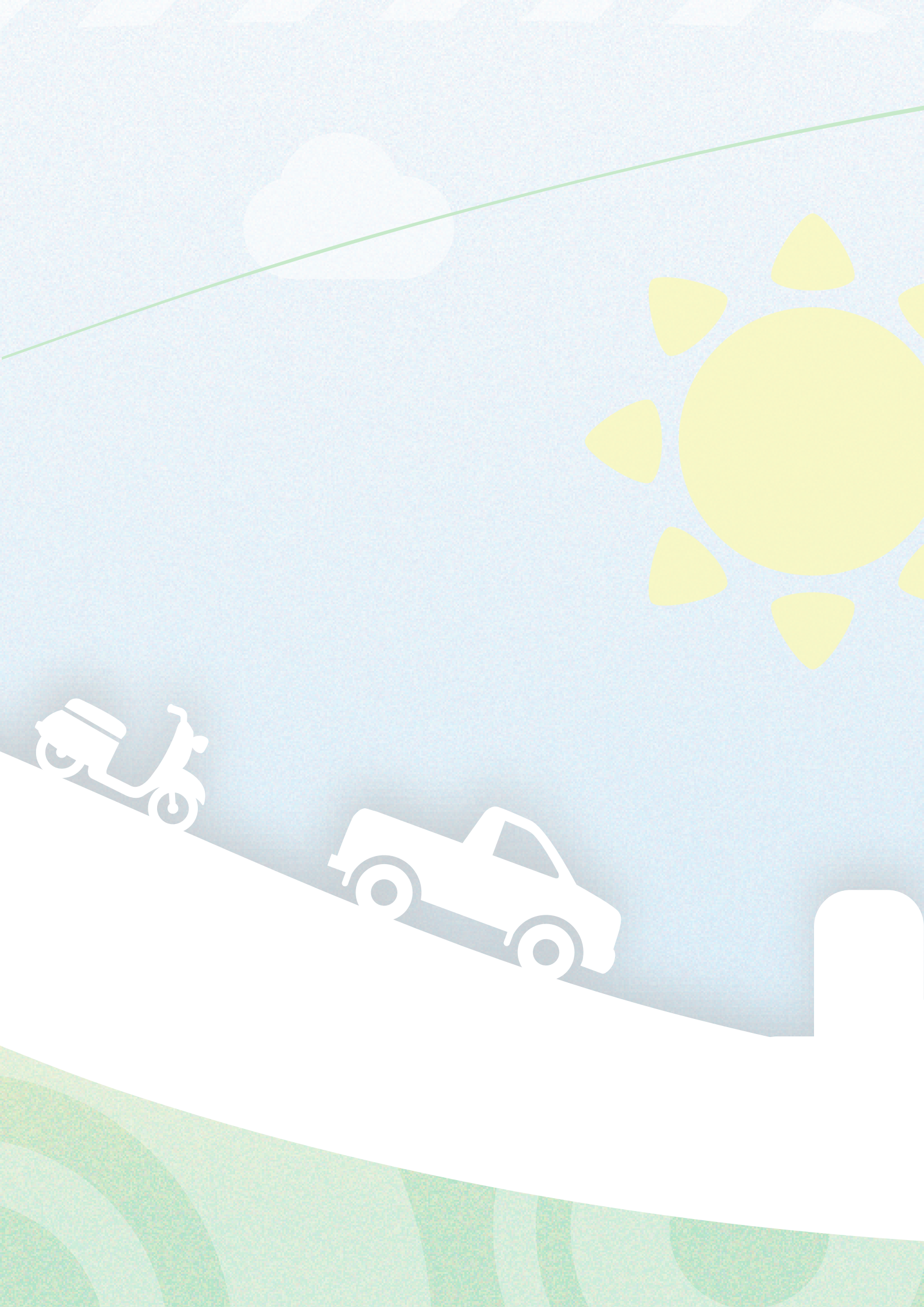
- EGVI provided a broad range of networking events, which included many different stakeholders from both within and outside of the automotive industry. This supported opportunities to promote participants' organisations, including broad outreach to new participants from non-automotive industries, with projects enabling longer-term working partnerships between participants e.g. shared research or pilot studies. EGVI enabled expansion of participants' trusted professional network within the EU supply chain
- EGVI contributed to the development of EU regulations and standards through knowledge sharing, as well as white papers and EU framework recommendations, acting as a catalyst to define the recognised industry approaches and targets seen today
- EGVI projects have enabled organisations to progress EU-wide collaborative research and development (R&D) activities further than would have been possible otherwise given financial constraints, whilst also avoiding wasteful R&D repetition. Project outputs and learnings enabled participants to be more targeted with future R&D, reducing their level of R&D risk

► **Lessons learned from EGVI should feed into current and future EU-funded programmes**

- EGVI projects were correctly targeted to provide holistic benefits, but they often suffered from a relatively long period to project start, mainly due to

Horizon 2020 procedures, which the EGVI partnership had to respect; these may have limited the technical impacts of the projects

- Targets could have been more ambitious in some areas, especially given the timeline required to start the projects; for example, AC-DC inverter power density targets were competitive at the start of the programme but no longer so by the time the respective projects completed
- An increased focus on affordability would contribute to wider technology adoption; for example, battery cell cost reduction was not a primary objective of EGVI. However, several EGVI projects contributed to a reduction in development costs, which would provide cost savings to OEMs and ultimately to the end customer



2. EXECUTIVE REPORT

EGVI BACKGROUND

The European Green Vehicles Initiative (EGVI) was a contractual public-private partnership (cPPP) launched in 2013 as part of the “Smart, Green and Integrated Transport” challenge of Horizon 2020.

The objective of EGVI was to promote European R&I in order to increase the energy efficiency of road vehicles and encourage the transition to alternative powertrains, thus improving the competitiveness of the EU in road mobility.

EGVI originated from its predecessor, the European Green Cars Initiative (EGCI), which was initiated by the European Commission under the European Economic Recovery Plan in 2008 to support the automotive sector overcoming the economic crisis through continuous innovation in sustainable technologies. Following the success of this initiative, the European Commission and the automotive sector agreed to continue their collaboration, which was formalised through the cPPP contractual arrangement. This instrument offered a more active role to industry and research stakeholders in defining roadmaps and Work Programmes and it contributed to align priorities of different stakeholders in research and innovation.

The not-for-profit European Green Vehicles Initiative Association (EGVIA) represented the private side engaged in the partnership. It was composed of 84 members in 2020, coming from academia, Research and Technology Organisations (RTOs) and industry. There are now 115 members and the association has been renamed EGVIAfor2Zero, in support of the new partnership under Horizon Europe, 2Zero (Towards Zero Emission Road Transport).

EGVIA's role was to work in collaboration with the European Commission's services to define EGVI's Horizon 2020 calls for proposals, disseminate information about the partnership and calls, and promote the results of research projects. While the identification of research and innovation needs was driven primarily by industry, the execution of the calls and programme management was undertaken by the Commission services and its Climate, Environment and Infrastructure Executive Agency (CINEA), formerly Innovation and Networks Executive Agency (INEA).

Work Programmes were initially guided by the “Multiannual Roadmap for the

Contractual Public Private Partnership European Green Vehicles Initiative” ^[1] created in 2013. This took inputs from the European Technology Platform (ETP) roadmaps, e.g. European Road Transport Research Advisory Council (ERTRAC), European Platform on Smart Systems Integration (EPoSS) and Smart Grids (now Smart Networks for Energy Transition), and other stakeholders from across the cPPP. This Multiannual Roadmap promoted a system approach integrating research in the automotive domain, together with energy, Information and Communications Technology (ICT), and smart grids. The integrated approach was meant to cover the entire process chain from resource application to demonstration and creation of services, with the aim to extend R&D to innovation.

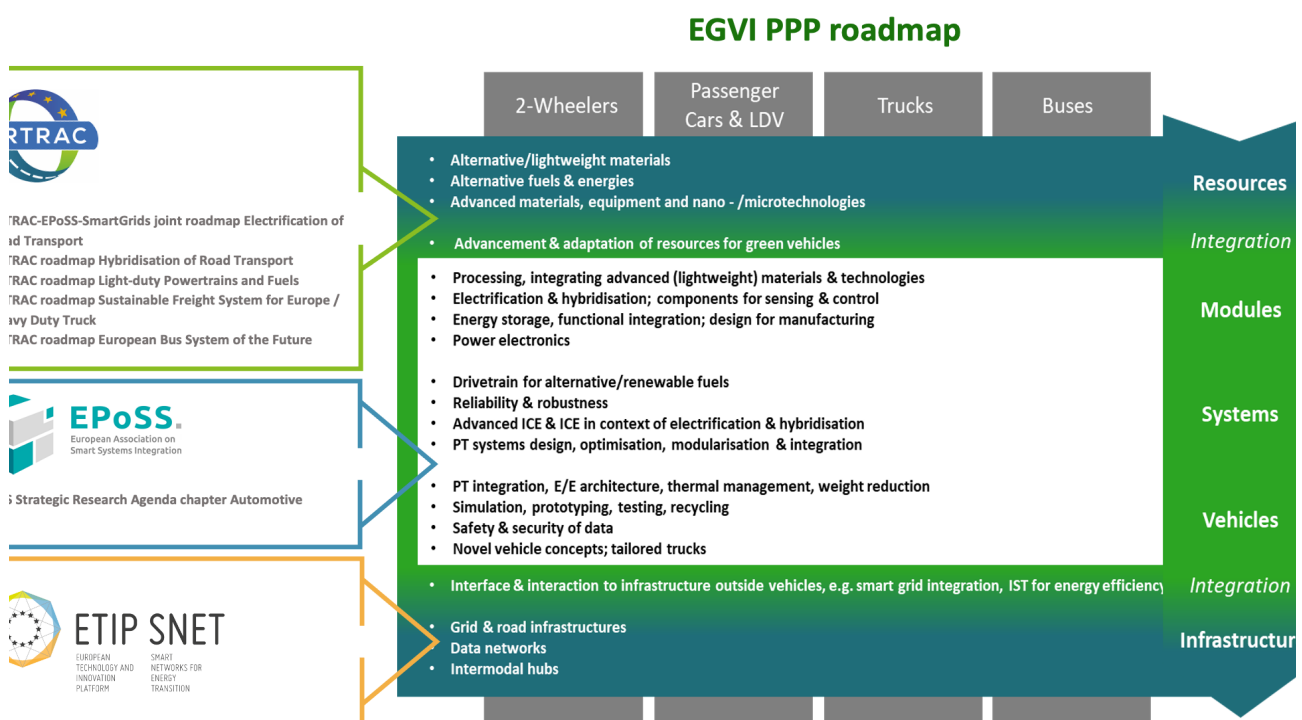


Figure 1 - EGVI cPPP roadmap ^[1]

From 2014 to 2020, the partnership launched multiple funding calls that ultimately led to 85 transnational pre-competitive, collaborative projects, that received a total of €628 million of EU financial contribution. An overview of these is shown in **Table 1**, spanning 4 family groupings and 14 technology areas from batteries to weight reduction and materials. A full list of the 85 EGVI projects assessed in this report are shown in the *Appendix*.

Table 1 - Details of the EGVI projects, family groupings and technology topics ^[2]

Family Grouping	Focus Area	Project Count
Electrification and batteries	1. Batteries	11
	2. Modelling, testing and virtual development	7
	3. Energy Management	4
	4. Electric vehicle (EV) drivetrains	3
	5. EVs Concept & Design	12
	6. EV integration into the grid & transport system	9
	7. Integrated architectures, components and systems	9
Alternative fuels, hybridisation and low emission powertrains	8. Hybridisation and alternative fuels powertrains	9
	9. Low emission internal combustion engine (ICE) powertrains	4
	10. Powertrain control	2
Transversal topics	11. Emission measurement	3
	12. Aerodynamic trucks	1
	13. Weight reduction and advanced materials	7
International collaboration	14. International collaboration	1
Other	15. Other	3

Funding has been allocated and most of these projects have now been completed, though 14 were still ongoing at time of reporting with the last planned to finish in early 2025.

Participation to Horizon 2020 Green Vehicles projects was not limited to the members of EGVIA. In total, there were 1440 participations in EGVI projects (with 804 different organisations participating in one or more projects).



ROAD TRANSPORT DECARBONISATION

A key objective of EGVI was to accelerate the decarbonisation of road transportation, in part through the initiative's focus on developing European R&I capabilities. Critically, this process was managed through well-defined and managed Work Programmes.

EGVI used robust processes and procedures to ensure that Work Programmes and R&D investments were directed on delivering relevant topic selection, with typically ambitious project objectives and deliverables. Many projects led to measurable advances in technology performance in areas that were critical to solving the automotive industry's challenges and technical barriers to adoption.

In a perfect example of the correct targeting of EGVI Work Programmes, the **OPTEMUS** project resulted in a set of mature technologies, with a clear route to timely commercialisation by participants, that will likely realise tangible benefits in society. The project focussed on improving A segment passenger electric vehicle (EV) range to alleviate range anxiety, a key barrier to mass market adoption, achieving and demonstrating at least a 30% real world driving range increase.

One ambition of EGVI was the advancement of powertrain electrification and hybridisation in the EU vehicle parc, with the aspiration of 5 million electrified vehicles on the road in 2020. More specific focus areas to support this included, for example, energy storage advancement – a goal being battery energy density increase of more than a factor of two, and cost savings of more than 20-30% against a 2009 baseline.

EGVI projects surpassed these targets, demonstrating battery energy density improvements of more than three times, and cost savings of more than 50%, against baselines. This is a clear indication of the way in which EGVI has been successfully seeding R&I activities. Meanwhile, EGVI contributed to the achievement of ~4.6 million electrified vehicles on the road by 2020 in Europe.

Data suggests that EGVI successfully demonstrated integration of more than 35 innovative technologies in green vehicles and mobility system solutions, with more than 20 relating to innovative powertrain systems and technologies. These projects often utilised virtual or physical carbon reduction demonstration approaches, representing a strong contribution to development of the state-of-the-art. Particular improvement areas were battery pack density, battery cell density, holistic passenger car efficiency and heavy-duty truck efficiency.

With project outputs positively impacting holistic passenger car and heavy-duty truck efficiency, EGVI contributed to a measurable improvement in CO₂ emissions from road transport. By supporting R&I initiatives and the development of pre-competitive technologies in the EU, robust vehicle-level improvements could also reach the market faster than would otherwise have been possible.

Vehicle efficiency improvements, a critical aspect of decarbonising road transportation, were demonstrated for passenger cars by the **PARAGEN** and **UPGRADE** projects, and for heavy-duty vehicles by **ECOCHAMPS** and **ORCA**. The demonstrated results corresponded to improvements that were several years ahead of market development trends and forecasts. EGVI's benefits thus contribute up to 9 million tonnes of CO₂ emission reductions by 2030, which is equivalent to taking 6 million passenger cars off the road for one year. In addition, the **1000kmPLUS** project created a scalable and brand-independent technology platform for key EV elements, showcasing the approach in a test vehicle that demonstrated breakthroughs in energy efficiency, driving range, charging and costs in real use cases.

EGVI contributed to ongoing road transport decarbonisation through the integration of advanced technologies

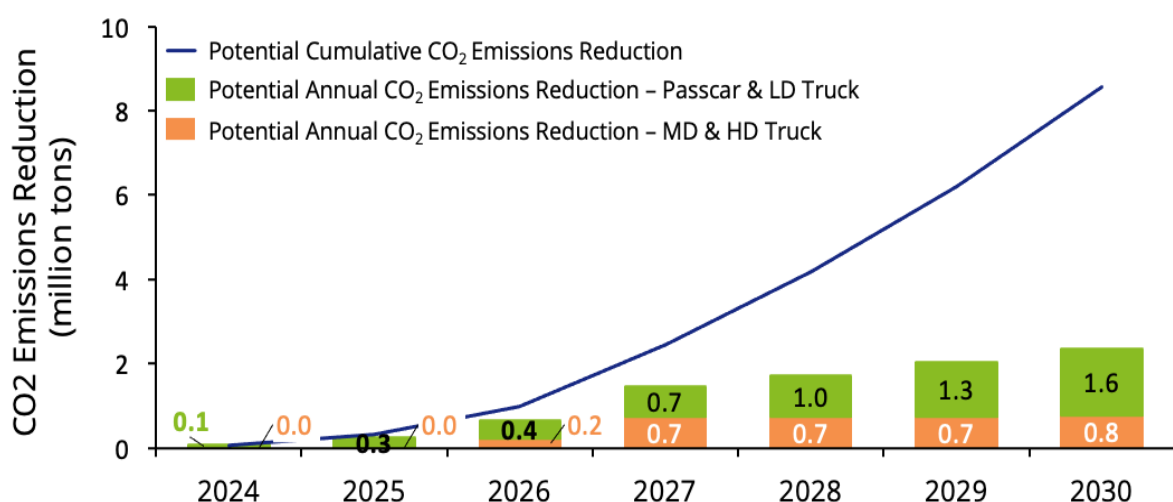
- EGVI programmes had a positive impact on the development and deployment of new technologies, representing a strong contribution to development of the state-of-the-art
- EGVI project outputs continue to contribute to tank-to-wheel CO₂ emissions decrease across key transport applications in the medium term contributing to 4.6 million electrified vehicles on the public road in the EU by 2020

EGVI demonstrated integration of more than 35 innovative technologies in green vehicles and mobility system solutions, with more than 20 relating to innovative powertrain systems and technologies – Questionnaire and interview feedback

"Private research and investment, in collaboration with industry partners, have allowed the [project's battery cell] technology to progress closer to commercialisation" – Researcher, Research Organisation

"EGVI was always forward-looking for technology [with] no major areas missed" – Senior Expert, European Commission

EGVI passenger car and truck efficiency improvements could contribute to cumulative CO₂ emissions reductions of up to c.9 million tons through to 2030



IN OUR VIEW...

EGVI contributed to state-of-the-art green vehicle technology development, with relevant projects and topics, that continue to support decarbonisation of road transportation



INDUSTRY COMPETITIVENESS

EGVI objectives also supported industry competitiveness through development of new highly skilled job profiles and curricula, the advancement of training for a higher quality workforce, mobilisation of private investment in relation to the contractual public-private partnership (cPPP) activities, and improved participation and benefits for SMEs.

By directly developing vital skills, knowledge, and capability across the focus technology topic areas, EGVI supported improvements in overall EU competitiveness and competence, with indirect input to academic/training curricula that bolsters talent development and inflows to industry. Across the projects in key technology areas, there are six skill areas that are assessed as being highly valued:

1. Thermal systems design and simulation
2. Low-voltage electrical integration
3. Engineering simulation software development
4. Co-simulation, Software- and Model-in the Loop development
5. Lifecycle and use case analysis
6. Battery system design and integration

EGVI projects delivered tangible benefits for the EU automotive industry. Building key skills, knowledge and capability supported the development of competence that was relevant and targeted to contribute to the accelerating pace of the green vehicle transition. This ensured that organisations had a workforce able to meet the requirements of private industry and the market more broadly.

As a perfect example, the **DOMUS** project was particularly effective for skills development. In the field of medium-temperature thermal systems design and simulation, capabilities were advanced to support new cabin components, systems, and control strategies for energy efficient, safe and comfortable future electric vehicles, maturing technologies for commercialisation through the critical high-risk stages. Its outputs led to commercial projects as well as related private investment in facilities, which in turn likely led to the creation of new highly skilled roles within the EU.

EGVI projects are also very likely to have improved the time-to-market capability for advanced technologies and products by more than 12 months, boosting technical competitiveness within the EU. This could both directly and indirectly

contribute to commercial benefits of up to €30 billion additional gross value-added revenue through to 2030, representing a return on investment of up to 40x from the total cPPP funding. This indicates a high level of investment efficiency and is at the leading end of international benchmarks of expected returns on investment.

By creating and sharing new technologies and skills, EGVI projects delivered social impact via an indirect longer-term positive influence on employment; modelling indicates a potential requirement of up to an additional 16,000 new skilled jobs in green vehicle technology sectors in the EU by 2030. For perspective, the upper bounds of return for certain public investment programmes carried out by the UK Government, amongst others, have reached upwards of 30x e.g. the UK Space Agency Copernicus Sentinel programme ^[3]. As a specific example, the UK Government's proposed subsidy in May 2023 for a major battery manufacturing facility is anticipated to be about €575 million which is forecast to support 9,000 new jobs. This figure is in line with similar work from the IMF ^[4]. It is clear that EGVI's economic return on investment compares favourably to industry guidelines and benchmarks.

Related new jobs based in green vehicle technology sectors are likely to be high value, creating the potential for further cascading employment benefits throughout the economy. Meanwhile, the network development associated with EGVI projects helps participants to form a more robust and diverse automotive/transport industry in the EU, creating intangible benefits that outlast the duration of the initiative. Thereby, EGVI supports ongoing employment growth potential within the industry. Improved knowledge and skills enable electrified vehicle battery technical leadership, which improves international competitiveness and increases the likelihood of more of the battery value chain moving back into the EU e.g. from Asia. Relocating supply to the EU may result in addition benefits, such as increased SME involvement, regional industry growth and creation of high-value jobs.

EGVI's legacy provides an enduring boost to EU economic growth and employment through improved industry competitiveness

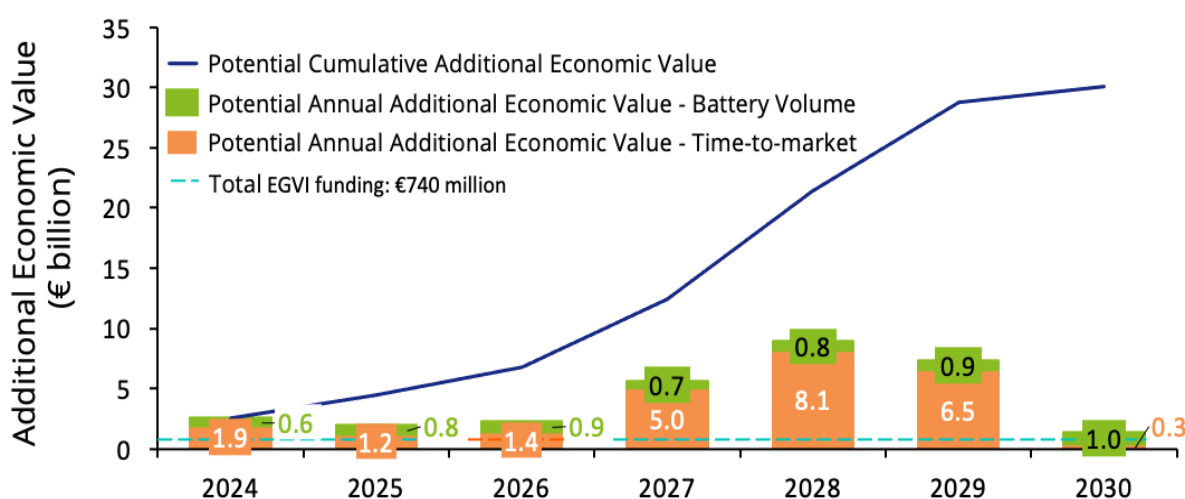
- Key skills, technologies and capabilities from EGVI could contribute to commercial benefits of >€30bn in the period to 2030, up to a 40x return on investment
- This growth could contribute to up to 16,000 high value future jobs in green vehicle technology sectors
- EV battery technical leadership, and increased battery value chain in the EU, may provide SME and regional industry growth

EGVI is very likely to have reduced time to market for advanced products by more than 12 months – Questionnaire and interview feedback

“[EGVI] Work Programme topics, definition and outputs support EU industry competitiveness” – Sector Head, European Commission

“[EGVI delivers] capabilities through knowledge diffusion from projects and those in companies learning new skills, approaches, methodologies or development processes” – Project Manager, Global Tier 1 Supplier

The EGVI programme may help support to commercial benefits of up to c.€30bn through to 2030, a total return on investment of up to c.40x



IN OUR VIEW...

EGVI could enable commercial benefits of up to c.€30bn and 16,000 high value future jobs in the green vehicle technology sectors, bolstering SME and regional industry growth



RESEARCH NETWORK DEVELOPMENT

One of EGVI's aims was to foster the sharing of information throughout the network of involved companies and research organisations, adding value complementary to national and local actions. In doing so, this would support vehicle and mobility service development for international markets, which use standardised solutions and can compete on cost and quality on a worldwide basis.

EGVI provided a broad range of networking events, which included many different stakeholders from both within and outside of the automotive industry. This supported opportunities to promote participants' organisations, including broad outreach to new participants from non-automotive industries, with projects enabling longer-term working partnerships and synergies between participants that often led to additional private investments e.g. shared research or pilot studies. The questionnaire was developed and used to help assess the key outputs and benefits of EGVI, and nearly 98% of respondents said that the EGVI programme encouraged a broad enough range of networking events to promote the organisation. This enabled expansion of participants' trusted professional network within the EU supply chain.

Projects have enabled organisations to progress EU-wide collaborative R&D activities further than would have been possible otherwise given financial constraints, whilst also avoiding wasteful R&D repetition. Outputs and learnings enabled participants to be more targeted with future R&D. By taking part in collaborative projects with multiple other organisations, participants were able to reduce their level of R&D risk by sharing knowledge, time and resource commitments. This was in part due to the value and mission of EGVI meeting the needs and requirements of industry, and being well recognised and attractive to stakeholders.

EGVI projects enabled participants from the automotive value chain and other relevant sectors to broaden their professional networks. This contributed to high levels of efficiency in R&D, diverse expertise and inputs, and greater knowledge sharing. As such, this supported competence growth across the EU and for a range of stakeholders including SMEs, academic institutions and larger private entities. The value of EU-wide collaboration was highlighted as a strong positive by those interviewed during this assessment.

As a case in point, the **ASSURED** project featured 46 stakeholders from 12 EU countries, including SMEs, research organisations, academic institutions and private entities. This diversity broadened existing knowledge and also brought

new perspectives to the achievement of challenging project objectives, including the improved integration of electric commercial vehicle charging infrastructure into urban environments.

Standardisation is critical to the automotive industry as it ensures that investments in R&I activities will remain effective and relevant to the market, establishing fair competition amongst the players and stakeholders, and accelerating development of solutions. This also helps society by ensuring consistent quality and compatibility in products, supporting safe application, and accelerating green vehicle technology adoption.

EGVI contributed to the development of EU regulations and standards through knowledge sharing, as well as white papers and framework recommendations, acting as a catalyst to establish consensus and define the recognised industry approaches and targets seen today. A great example of EGVI's effectiveness in this regard is the **AEROFLEX** project, which amongst other outputs, produced regulatory framework updates and recommendations for powertrain, vehicle aerodynamics, as well as infrastructure access policy, and also demonstrated transport efficiency gains in heavy-duty vehicle segments.

Additionally, project participants did mostly agree that there is a clear and simple process in place to support collaboration with the European Commission services during Work Programmes drafting activities, which may have helped to define EGVI topics and ambitions that best serve societal interests.

Network analysis conducted as part of the **FUTURE-HORIZON** project highlighted that the members of the EGVI Association were likely to have a greater number of connections, improved information flows, and more targeted links to key actors in industry compared to non-members. This demonstrates how EGVI helped support expansion of professional networks and created a more robust EU supply chain.

EGVI supported growth of the EU-wide scientific research community and its strategic alignment

- EGVI provided a range of networking events for many stakeholders, enabling expansion of participants' trusted EU based professional network
- EGVI contributed to development of EU regulations and standards, acting as a catalyst to define the industry approaches and targets seen today
- EGVI projects have allowed progression of EU-wide collaborative R&D activities further than would have been possible otherwise

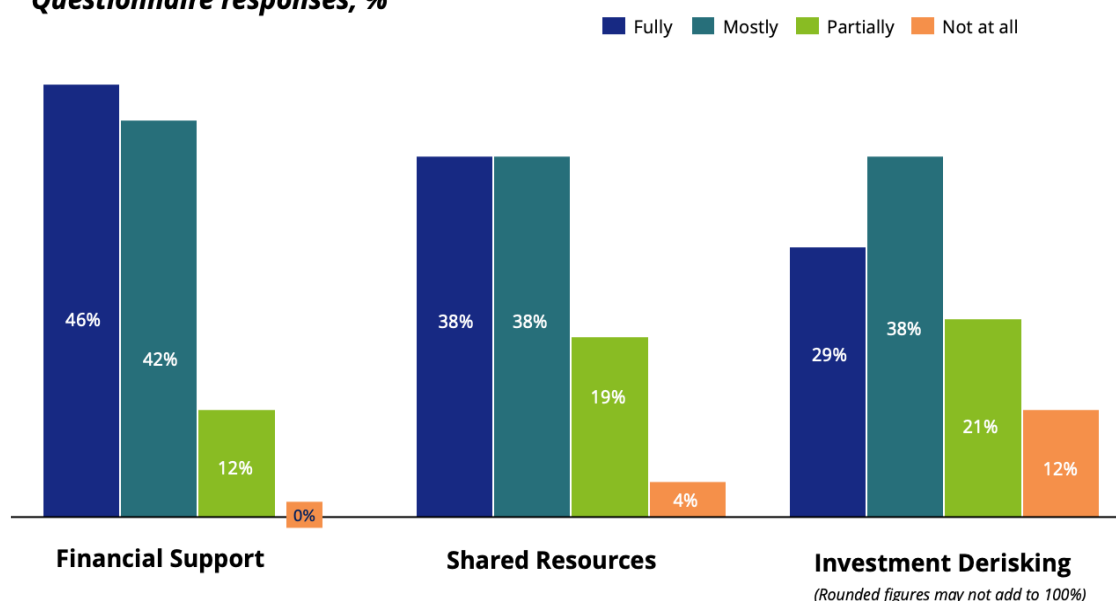
98% of respondents said that EGVI programme encouraged a broad enough range of networking activities and events to promote the organisation – Questionnaire and interview feedback

“[EGVI delivers] added value that supports delivery efficiency and avoids [R&D] repetition” – Policy Officer, European Commission

“Many new R&I and commercial partnerships have formed from the EGVI membership and EGVI project delivery” – Professor, University

The EGVI programme allowed SMEs to achieve increased levels of R&I by providing financial support, shared resources, and investment derisking

Questionnaire responses, %



IN OUR VIEW...

EGVI increased the interconnectedness of the EU supply chain, catalysing the current industry approaches and targets, and progressed EU-wide R&D further than otherwise possible

CONCLUSIONS

KEY FINDINGS

The overall assessment of EGVI's impact is strongly positive. The initiative contributed to many tangible and intangible benefits. These will probably deliver significant societal value and a high return on investment that will endure beyond the duration of its projects:

- ▶ EGVI contributed to ongoing road transport decarbonisation through the integration of advanced technologies, in particular improving the state-of-the-art in battery energy density and advancing vehicle energy efficiency measures and approaches.
- ▶ EGVI projects developed skills, knowledge and capabilities that will continue to provide an enduring boost to EU economic growth and employment through improved industry competitiveness.
- ▶ EGVI supported growth of the EU-wide scientific research community and its strategic alignment with industry, including improving inclusion, EU-wide collaboration and the generation of standards that benefit all current and future stakeholders within the industry.

EGVI has built on previous initiatives to further strengthen the foundations and approaches used for current and future green vehicle research and innovation programmes in the EU.

LESSONS LEARNED

EGVI had a strongly positive impact but several areas were noted as having improvement potential for ongoing and future EU-funded R&I initiatives.

EGVI projects were correctly targeted to provide holistic benefits, despite the challenges often associated with identifying R&I topics and defining appropriate

quantitative goals. However, it was noted that they often suffered from a relatively long period to project start, which may have limited the technical impacts of the projects. Feedback suggests that in some instances, a period of two years or more could pass between the topic publication and the project's kick off. It should be noted that Horizon 2020 procedures and calendar were fully respected while being themselves outside of EGVI control.

Given this, targets could appear to lack ambition in some areas, due to the long timeline required to start the projects. Some projects, for example relating to AC-DC inverters, had power density targets that were competitive at the launch of the call for proposals, but no longer so by the time the respective projects delivered outputs.

Several EGVI projects contributed to the affordability of solutions, which would provide cost savings to OEMs and, ultimately, to the end customer. However, an increased focus on affordability would contribute to wider technology adoption.

3. DETAILED REPORT

3.1. APPROACH

An approach was developed that used aligned key performance indicators (KPIs) and a number of data sources to provide a robust impact assessment. Six criteria were considered within the overarching framework.

3.1.1. Impact Assessment Framework

The impact assessment used the six criteria of relevance, effectiveness, efficiency, long-term EU benefits, attractiveness and EGVI added value. This framework took into account the objectives and goals of EGVI and the broader stated aims of Horizon 2020 to build out an approach for the analysis, which has been detailed in *Figure 2*.

The impact assessment used six criteria as a guiding framework and considered the objectives and goals of EGVI and the broader stated aims of Horizon 2020

Impact Assessment Framework		Quant-qual	Quantitative	Qualitative
1. Relevance	2. Effectiveness	3. Efficiency		
1.1. Project Topic Coverage	2.1. Number of successful projects funded 2.2. Relevant KPI-based project objective achievement 2.3. New systems and technologies innovation 2.4. Effective skills and knowledge development 2.5. SME participation and benefits 2.6. Energy use reduction 2.7. Emissions reduction 2.8. Electric and hybrid vehicle penetration 2.9. Material resource use and waste reduction 2.10. Private investment in areas of EGVI project topics 2.11. Effects on participants' own R&I strategies	3.1. Industry and economic grow 3.2. Cost efficiency 3.3. Social benefits i.e. jobs/CO ₂ 3.4. Investment efficiency		
4. Long-term EU Benefits		5. Attractiveness		
4.1. Environmental impact reduction 4.2. Contributions to new standards 4.3. Time-to-market improvement (skills and knowledge) 4.4. Network development		5.1. EGVI communication and outreach 5.2. EGVI attractiveness 5.3. EGVI cross-industry accessibility		
		6. EGVI Added Value		
		6.1. EGVI networking opportunity 6.2. EGVI collaboration process 6.3. EGVI relevance and ambition 6.4. EGVI value add		

Source: SE

Figure 2 - Guiding framework of impact assessment

This guiding framework used quantitative and qualitative approaches to increase the robustness and reliability of the impact assessment. Desktop modelling gathered quantitative data from recognised sources to inform objective achievements. Questionnaires and interviews then built upon this information with more subjective inputs. More details are provided in *Section 3.1.3. Data Gathering*.

3.1.2. Definition of Metrics

For quantitative subcategories of the criteria, relevant and representative metrics were defined and agreed to measure impact. Whereas, for each purely qualitative subcategory, multiple questions were typically created to help structure recipient/interviewee feedback for analysis. To guide those subcategories requiring qualitative and quantitative techniques, typically some inputs were taken from questionnaire or interview responses to inform more quantified analysis.

Quantitative Metrics

In a few instances, subcategories solely utilised quantitative metrics. For example, 2.3. New systems and technologies innovation was supported by an analysis that compared EGVI projects outputs, e.g. energy density kWh/kg, with technology roadmaps and best-in-class production vehicle technology. This also included consideration of drivetrain systems, vehicle efficiency, and power electronics.

Qualitative Metrics

The Attractiveness and EGVI Added Value criteria were based on qualitative feedback from questionnaires and interviews. Multiple questions were used for each subcategory, allowing broad subjective feedback from recipients/interviewees. For example, 5.1. EGVI Communication and Outreach includes the questions:

- Does the EGVI programme encourage a broad enough range of networking, industry and other events to promote their organisation?
- Is the EGVI programme and its value and mission recognised by industry?

Qualitative-Quantitative Metrics

Commonly subcategories required inputs from EGVI participants or other stakeholders to support objective assessment. An example is 2.4. Effective Skills and Knowledge Development, where participants/interviewees feedback on how project developed skills and knowledge have transferred to industry was required e.g. virtual modelling to commercial licensed software. This approach

was critical, as often such information was not available in the public domain.

3.1.3. Data Gathering Methodology

As mentioned, to deliver a higher fidelity of outputs and increased confidence in the analysis, the data gathering process was conducted over three sources. These included

- ▶ **Questionnaire responses**
- ▶ **Interview candidates**
- ▶ **Desktop modelling**

This approach allowed general conclusions of EGVI impact to be assessed from a market and industry viewpoint, then corroborated against broader EGVI participant and EGVI member feedback and, finally, considered in depth during interviews with a range of stakeholders.

▶ **Questionnaire Responses**

A questionnaire was developed to capture feedback to support the relevant assessment criteria. This was shared with all EGVI project coordinators, as well as the EGVI members. Due to the nature of the EGVI programme, it was not possible to reach all project participants directly. However, to increase the range and breadth of stakeholders involved, project coordinators were asked to forward the questionnaire to other relevant participants.

The questionnaire was split into five sections:

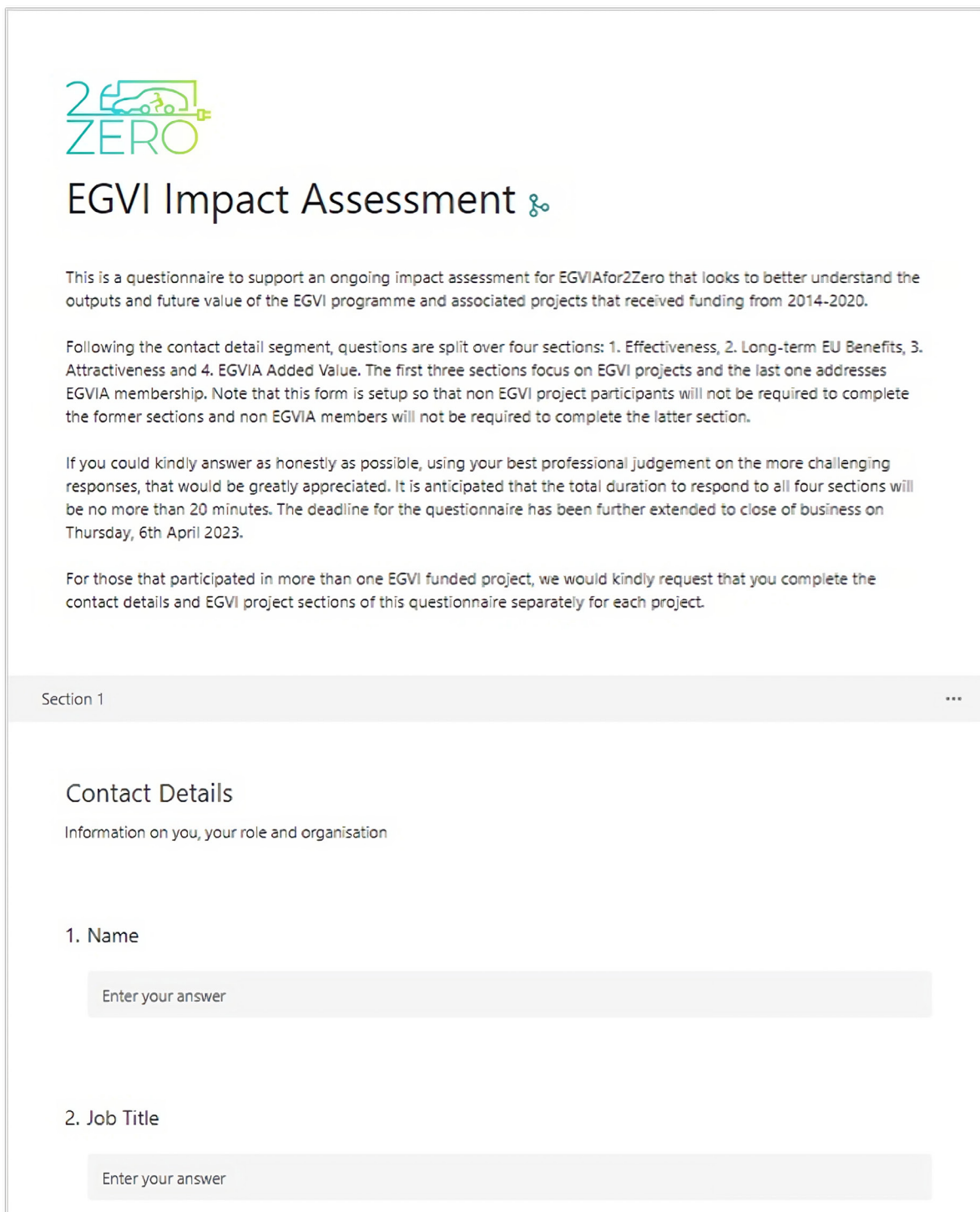
- Contact details
- Effectiveness: EGVI project achievement of proposed and specific objectives
- Long-term EU benefits: EGVI project delivery of long-term benefits to the EU
- Attractiveness: EGVI programme attractiveness to participants
- EGVI added value: EGVI member networking and collaboration benefits

Data has been anonymised but captures each participant and their project, project role and company allowing traceability to each of the EGVI projects. In some cases, participants were active on multiple projects, so feedback was gathered for each instance.

Quantitative and qualitative questions have been included, with the former typically on a Likert Scale, to support statistical analysis. This form of assessment allows trend analysis and objective conclusions to be made, whilst also providing

more depth and specific feedback from participants in longer form answers.

Microsoft Forms was used to complete the data collection process, as it is intuitive, flexible and incorporates tools for response analysis. It also supported the “streaming” of participants based on their experiences, to ensure the relevance of the feedback.



The screenshot displays the 'EGVI Impact Assessment' questionnaire form. At the top left is the '2E ZERO' logo, which features a stylized car icon above the word 'ZERO'. The title 'EGVI Impact Assessment' is followed by a small icon of three connected nodes. The form contains several paragraphs of introductory text explaining the purpose of the questionnaire, the structure of the sections (Effectiveness, Long-term EU Benefits, Attractiveness, and EGVI Added Value), and the deadline for completion (Thursday, 6th April 2023). It also requests that participants complete the form separately for each project if they have participated in more than one. The form is divided into sections, with 'Section 1' highlighted in a grey bar. The first section is titled 'Contact Details' and includes a sub-header 'Information on you, your role and organisation'. It contains two numbered questions: '1. Name' and '2. Job Title', each followed by a text input field with the placeholder 'Enter your answer'.

2E ZERO

EGVI Impact Assessment

This is a questionnaire to support an ongoing impact assessment for EGVIfor2Zero that looks to better understand the outputs and future value of the EGVI programme and associated projects that received funding from 2014-2020.

Following the contact detail segment, questions are split over four sections: 1. Effectiveness, 2. Long-term EU Benefits, 3. Attractiveness and 4. EGVI Added Value. The first three sections focus on EGVI projects and the last one addresses EGVI membership. Note that this form is setup so that non EGVI project participants will not be required to complete the former sections and non EGVI members will not be required to complete the latter section.

If you could kindly answer as honestly as possible, using your best professional judgement on the more challenging responses, that would be greatly appreciated. It is anticipated that the total duration to respond to all four sections will be no more than 20 minutes. The deadline for the questionnaire has been further extended to close of business on Thursday, 6th April 2023.

For those that participated in more than one EGVI funded project, we would kindly request that you complete the contact details and EGVI project sections of this questionnaire separately for each project.

Section 1

Contact Details

Information on you, your role and organisation

1. Name

Enter your answer

2. Job Title

Enter your answer

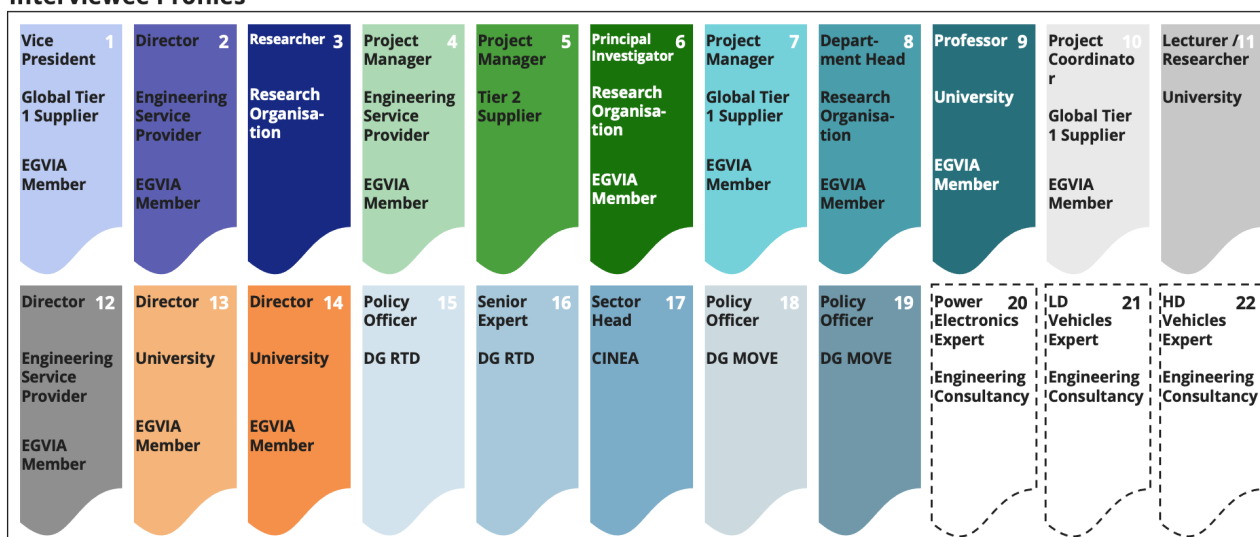
Figure 3 - EGVI impact assessment questionnaire

► Interview Candidates

As part of the impact assessment 22 interviews were completed, 19 of which were with private and public organisations, e.g. research organisations and universities, involved in the cPPP including both EGVI members and non-members. These interviews were conducted mostly in person, e.g. at the Results from Road Transport Research (RTR) Conference 2023, and six were completed remotely using video conferencing tools. They provided individual perspectives on EGVI project success, impacts for participant organisations, broader effects of the programme, and a view on future challenges to the automotive and road transport industry. Three of additional interviews were completed with industry experts to support our desk research.

During the impact assessment, 22 stakeholders were interviewed from a diverse range of backgrounds, 19 of which supported our thematic analysis

Interviewee Profiles



Source: SE, Selected EGVI Participants, Selected EGVI Members

Figure 4 - Interview candidate profiles

► Desktop Modelling Approach

Objective analysis of the impacts of the projects and their outputs were considered against the metrics discussed in *Section 3.1.1. Impact Assessment Framework*. To complete the assessment, a number of data sources were used. For example, in consideration of vehicle production volumes, leading datasets from S&P Global, Off-Highway Research and MarkLines were used to support our expert-backed forecasts.

Desktop modelling also added texture including consideration of best-in-class standards, e.g. battery energy density, and development of technology pathways. This informed the consideration of EGVI project outputs and their impacts on

industry and broader society. Forward-facing forecasts from organisations such as Fraunhofer and the Automotive Propulsion Centre (APC) supported in analysis of relevance, ambition and outputs of specific projects.

Unfortunately in a number of cases it has not been possible to review any official reports or data from EGVl projects due to confidentiality.

► Limitations

There were some limitations that have impacted the approach used in data gathering phase of the project. These limitations include

- Availability of data: Not all project reports and information was available in support of the impact assessment e.g. demonstration of quantified technical achievements against objectives
- Interview and questionnaire bias: Many of the questionnaire recipients and interview candidates were beneficiaries of the EGVl programme, and/or members of EGVIA
- Access to project participants: Typically only coordinators were available to provide feedback on EGVl projects, limiting the range of perspectives and inputs
- Corroboration of data: Some data could not be corroborated and reference to supporting sources of information due to confidentiality considerations e.g. commercialised project outputs

Given these limitations, we have ‘triangulated’ our data points using multiple sources in an effort to ensure the most robust results.

3.2. DATA GATHERING

Data gathering, structuring and visualisation has been completed using the three key sources: 1) questionnaire, 2) interviews, and 3) desktop modelling. High level summaries have been provided in this section.

3.2.1. Questionnaire Inputs

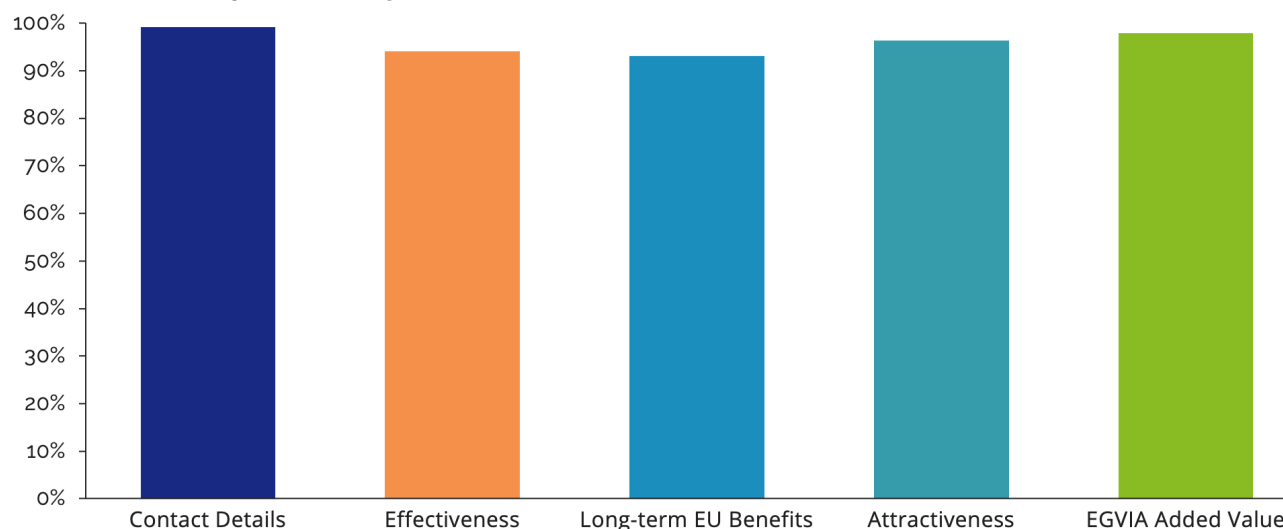
From the 181 stakeholders targeted for participation, including EGVl project coordinators and EGVIA members, 86 completed the questionnaire resulting in a 47.5% response rate. In addition, another seven relevant stakeholders provided inputs bringing the total to 93 of 188 and a 49.5% overall response rate.

There were 99 responses to the questionnaire. The average response rate across

all questions was 96%. The attractiveness and EGVIA added value sections of the questionnaire received the highest response rate with 96% and 98% of participants providing a response respectively. The lowest response rate is seen in the added value section, due to free text fields which did not require a response.

The attractiveness and EGVIA added value sections of the questionnaire received the highest response rate with >93% of participants responding

Questionnaire Response Rate by Section



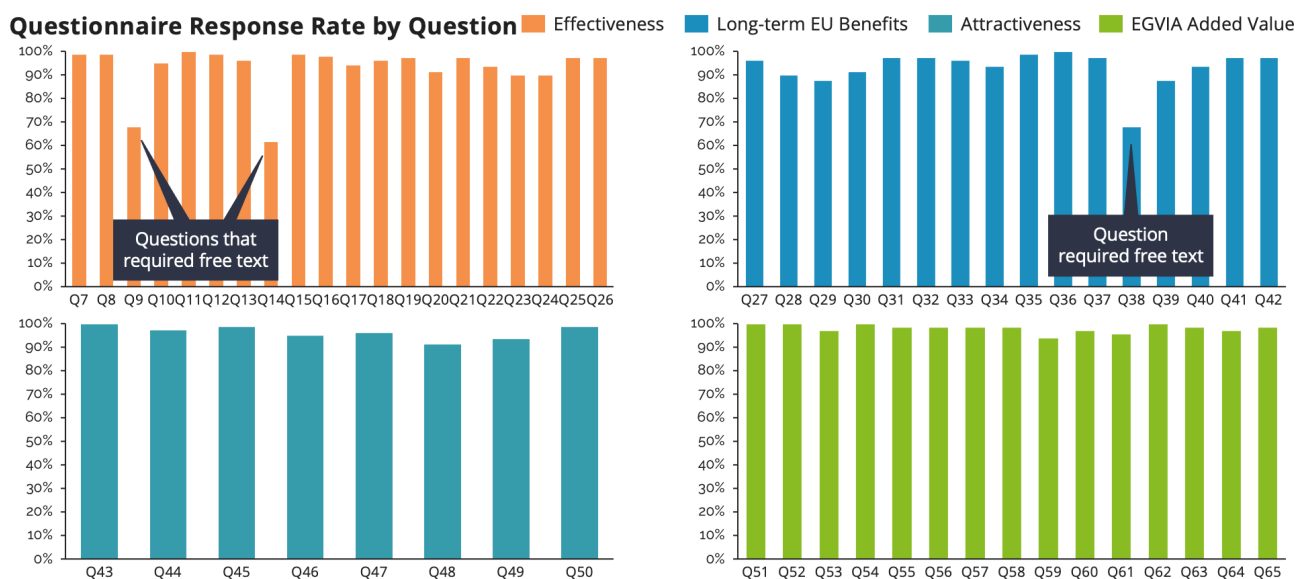
Source: Questionnaire responses

Figure 5 - Questionnaire response rate by section

The questions with the highest response rate were the multiple-choice questions. Average response rate for questions remained at 96%; accounting for multiple choice questions only, the response rate is 97%.

Average response rate for questions remained at 96%; accounting for multiple choice questions only, the response rate is 97%

Questionnaire Response Rate by Question



Source: Questionnaire responses

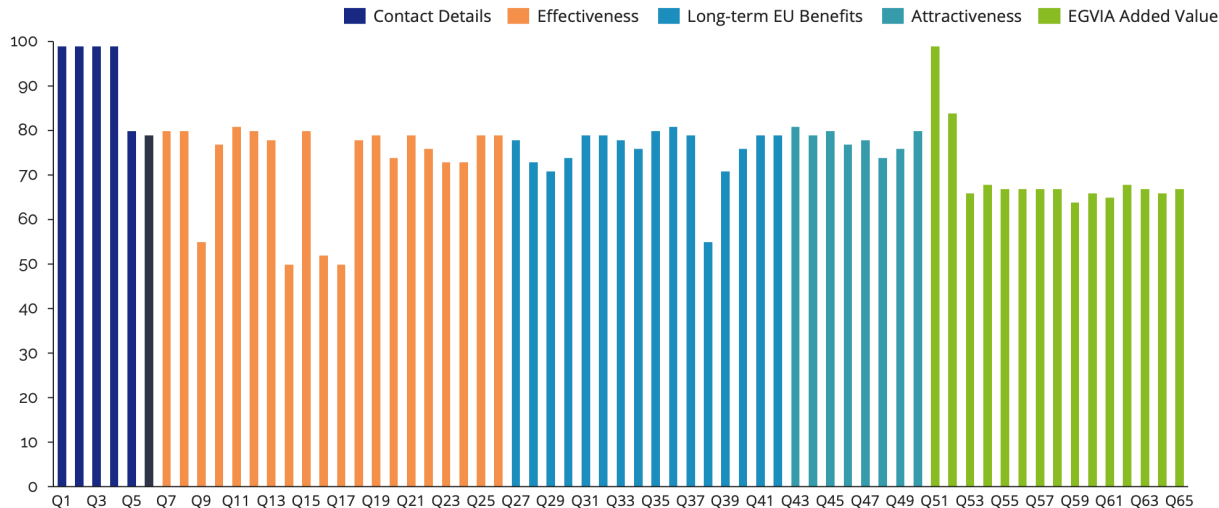
Figure 6 - Questionnaire response rate by question

On average, each question received 75 responses, some questions are preceded by a deterministic question which lowered the number of responses.

Key gaps in the questionnaire analysis have been identified as the free text questions. However, qualitative data capture has also been completed in the interview section of this report.

On average, each question received 75 responses, some questions are preceded by a deterministic question which lowered the number of responses

Questionnaire Response Count



Source: Questionnaire responses

Figure 7 - Questionnaire responses by question

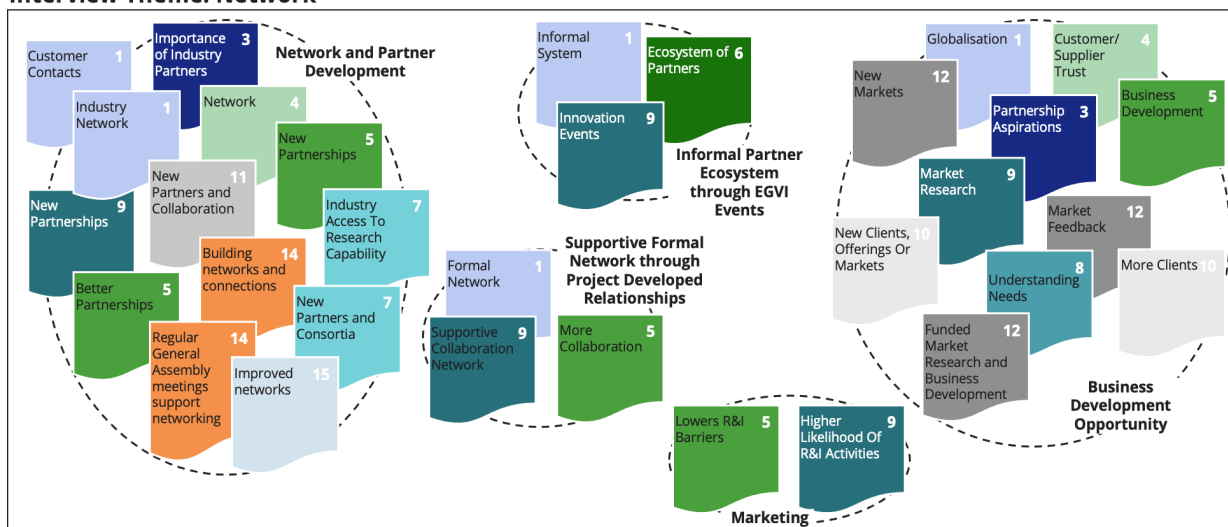
The data points for each question were scored out of 5 to create a quantitative analysis for each section of the questionnaire. The analysis quantified the key success areas according to the questionnaire responses, which were then used to inform the impact assessment of this report. More details of this follow in *Section 3.3.1. Questionnaire*.

3.2.2. Interview Responses

The question responses from interviewees were captured and over 350 keyphrases extracted. From this, a thematic analysis was completed to better understand key outputs and trends. Close to 60 themes were identified, which could be further categorised into 15 metathemes. In addition, insights and recommendations were provided by a number of candidates. Figure 8 highlights an example of the “Network” metatheme mind map. Outputs from the other metathemes can be found in *Section 5.7. Interview Themes*.

Five themes emerge relating to EGVI's *network* with lots of positive feedback, including formal and informal partner development, as well as increase business opportunities

Interview Theme: Network



Source: SE, Selected EGVI Participants, Selected EGVI Members

Figure 8 - Thematic analysis from interview responses

3.2.3. Desktop Modelling Sources

Desktop modelling for the interim report focussed on assessing the deployment of alternative powertrain vehicles like electric and plug-in hybrid systems against EGVI targets and reviewing specific EGVI project outputs with respect to forward-facing roadmaps and state-of-the-art production technologies.

Data from S&P Global has been shown in the figure below, with the 2016 and 2020 targets for electric and hybrid vehicles in the EU highlighted in orange (① : 0.5 million and ② : 5 million electric and hybrid vehicles). As can be seen, the penetration of alternative powertrain vehicles was close to reaching the EGVI aspirations of 5 million in 2020, achieving ~4.6 million units in the EU vehicle parc.

Price and Total Cost of Ownership are a major driver of electric vehicle adoption. EGVI worked to reduce the cost of EV technologies. However, there is still a need for improving the affordability of solutions. More of a direct focus on affordability has been incorporated into the 2Zero initiative – the successor to EGVI – which is funded under the Horizon Europe programme.

BEV and hybrid vehicles in Europe are expected to exceed 50 million before 2030; the alternative powertrain penetration was close to reaching EGVI aspirations of 5 million in 2020

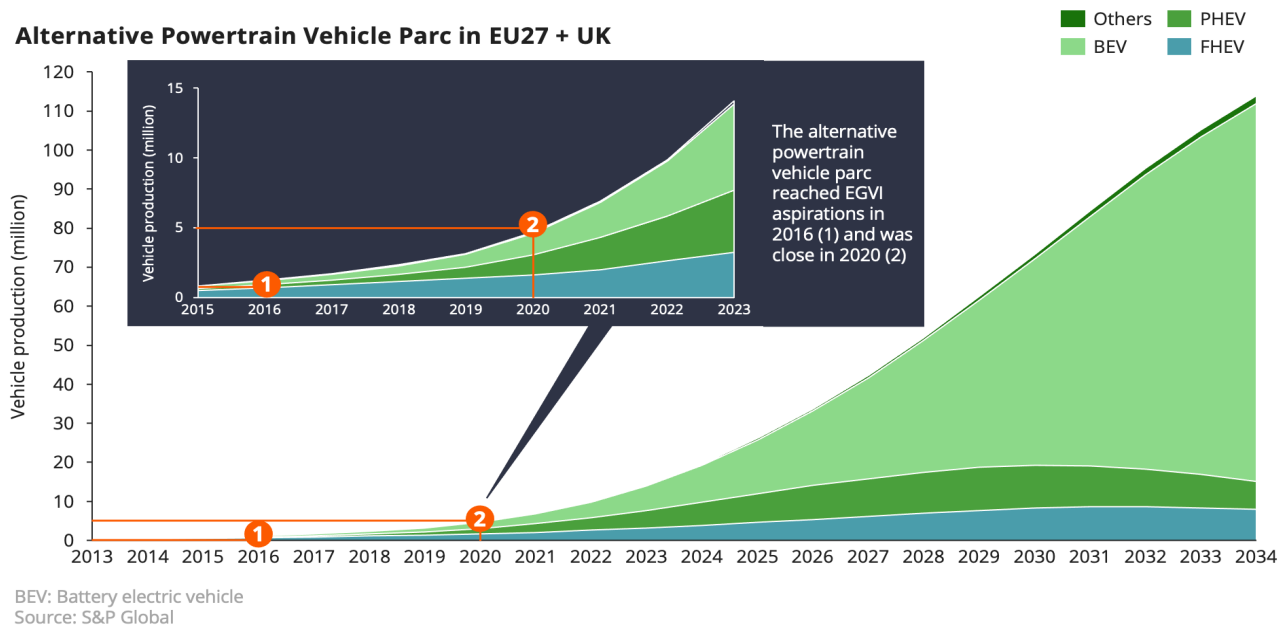


Figure 9 - Alternative powertrain vehicle penetration in the EU27+UK ^[5]

From the availability of project outputs, forward-facing roadmaps and state-of-the-art production technologies datasets were constructed for the following, which are within EGVI scope and seen as technical signposts for green vehicle technology development:

1. Battery pack energy density and cost
2. Battery cell energy density and cost
3. AC-DC inverter power density
4. Vehicle energy efficiency (including passenger car and heavy duty truck)

Roadmaps were baselined prior to 2014 and then adapted to capture updates made by recognised industry forecasters through to 2020. Meanwhile, state-of-the-art technology metrics were taken from the year-on-year developments in production vehicles.

Due to the availability of EGVI technical data in the public domain, 21 projects were used to assess the technical signposts above. Inputs are distributed as shown in **Table 2**. Vehicles covered both passenger cars and heavy-duty segments. A full list of EGVI projects is shown in the *Appendix*.

Table 2 - EGVI projects used to complete output assessment

Technology	Battery Pack	Battery Cell	AC-DC Inverter	Vehicle & integration	
Performance criteria	Energy density, Wh/kg	Energy density, Wh/kg	Cost, €/kWh	Power density, kW/L	Efficiency, l/km
DRIVEMODE				X	
FITGEN				X	
EVC1000				X	
MODULED				X	
THOMSON					X
PARAGEN					X
UPGRADE					X
ECOCHAMPS					X
IMPERIUM					X
OPTITRUCK					X
ORCA					X
LONGRUN					X
AEROFLEX					X
GHOST	X				
IMODBATT	X				
ALISE	X	X			
SPICY		X			
FIVEVB		X	X		
HELIS		X	X		
SPIDER		X			
LISA		X			

3.2.4. Potential Bias of Candidates

Inherently due to the nature of the assessment, many of the questionnaire recipients and interview candidates were beneficiaries of the EGVI programme. As mentioned, some were also members of EGVI organisation. To help mitigate bias, we also conducted interviews with delegates to the European Commission, i.e. Directorate-General for Research and Innovation (DG RTD), to take into consideration their opinions and feedback. By including the public side of the cPPP in the assessment, it was intended that a more balanced perspective of the impact and value of EGVI could be ascertained. Further interviews were also completed with Directorate-General for Mobility and Transport (DG MOVE) and CINEA to broaden the stakeholder engagement.

3.3. DATA ANALYSIS

Data from the three key sources was analysed to develop insights and conclusions for the impact assessment. Data has been cross-referenced to highlight key synergies and discrepancies.

3.3.1. Questionnaire

The questionnaire responses described in *Section 3.1.3. Data Gathering* were analysed to identify quantify key themes, outputs and insights. The answers were scored out of a maximum of 5. The mean average of the answers was calculated to enable comparison of the questions and to identify the key success stories and improvement opportunities. An example of the questionnaire quantification is given below:

- Question:
 - 2.4.3. Has new technical knowledge been captured, documented, and disseminated into public domain that could improve technology applications in industry now or in the future?
- Answers:
 - Yes, multiple directly – 5
 - Yes directly – 3
 - Yes indirectly – 1
 - No – 0
- Mean score:
 - 3.6

Full details of the questionnaire quantification by question, and mean scores, are detailed in the *Appendix*.

From the results of this analysis, there are some strong insights regarding the positive impact of EGVIA and EGVI projects. EGVI value and mission were recognised by industry and participants considered long-term EGVIA membership as part of their pre-competitive R&D collaboration strategy. Additionally, the partnership provided a broad range of networking, industry, and other events to promote a participant's organisation and the EGVIA team and their networking events helped facilitate partner introductions and ongoing communication. The questionnaire also suggested that EGVIA members were clearly aligned on EGVIA objectives and supportive in relevant situations. Participation in EGVI projects allowed stakeholders to progress further with R&D activities, compared to what

would have been possible otherwise given budget constraints.

High-scoring topics, which suggest more direct EGVI impact, are shown below:

- Outreach: Strong communication and outreach, providing a range of events
- Networking: Events helped facilitate partner introductions and ongoing communication
- Investment: EGVI projects have enabled further progress of R&D activities through funding
- Achievement: EGVI projects quantifiably contributed to green vehicle technology integration

The questionnaire results also suggested on aggregate that EGVI project outputs may have played an indirect role in supporting development of current EU regulations or standards, and consensus of industrial R&D strategy was likely to have indirectly influenced current technology compatibility and integration. This may have, and in some instances could still, simplify the route to standardisation. Scoring indicated that respondents were more positive that EGVI outputs could impact future EU regulations and standards. Participating SMEs also saw only a slight improvement in the number of new customers secured through participation in an EGVI project, however, they benefitted significantly from the development of future partnerships and accelerated technology development. It is of note that EGVI is intended to be pre-competitive, so this is not unexpected. Also of note is that only a subset of the projects targeted standardisation. Finally, the questionnaire suggested that the EGVI project was not the main enabler to enter the automotive sector. However, the majority of questionnaire candidates were already active in the automotive sector, due to the focus of EGVI being road transportation decarbonisation, which would have skewed results. In fact 86% of responses said EGVI provides broad enough coverage, to those relevant to, but not yet active in the automotive sector.

Lower scoring topics, which suggest a positive indirect EGVI impact, are shown below:

- Contribution to standards: It was noted project outputs played an indirect role in supporting development of EU standards, with industrial R&D strategy consensus having potential to influence compatibility and integration – providing a route to standardisation; responses indicated that project outputs may also likely influence future regulation and standardisation
- Accessibility: Most EGVI participants predominantly operated in the automotive industry prior to participating in the initiative, as should be expected (skewing scoring to lower output i.e. Question 5.3.2); however, 86% of responses said EGVI provided broad enough outreach to those not yet active in the sector – a key positive advantage of the scheme

EGVI cross-industry accessibility had the greatest range, suggesting that projects provide cross-sector networking but do not necessarily facilitate automotive market entry

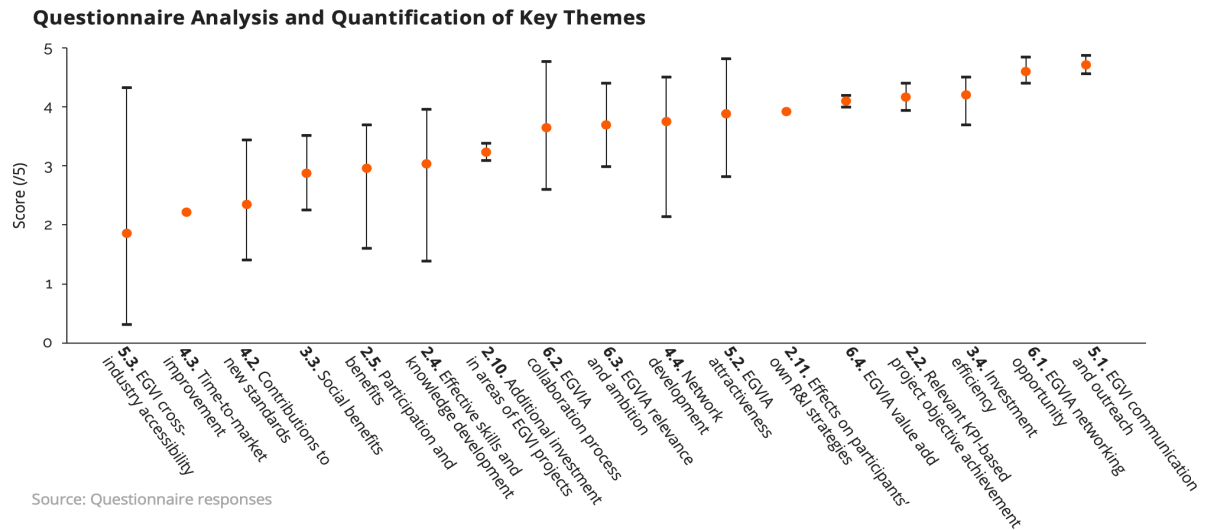


Figure 10 - Questionnaire response scoring and range

Grouping the questionnaire responses by category provides insights into the key themes with respect to the impact assessment. EGVIA value add has the highest median point with majority of the questions scoring highly. This is only answered by EGVIA members and demonstrates the value of the collaboration and networking benefits and the added value of these opportunities. The questionnaire suggests that the EGVI projects are attractive to participants and EGVIA membership is desirable.

EGVIA added value is the highest scoring assessment criteria and suggests project provide strong networking and collaboration opportunities

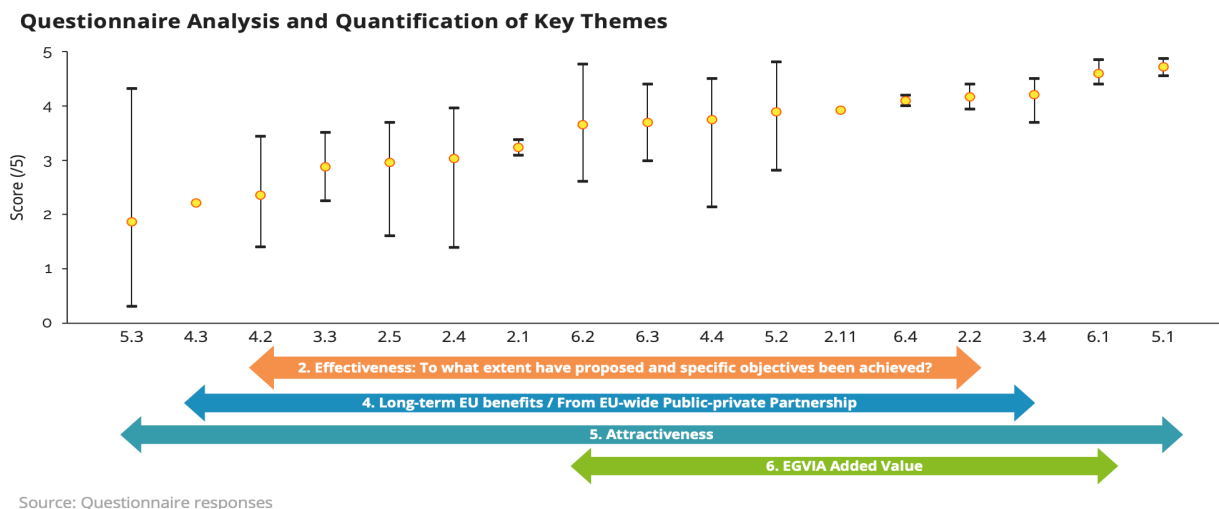


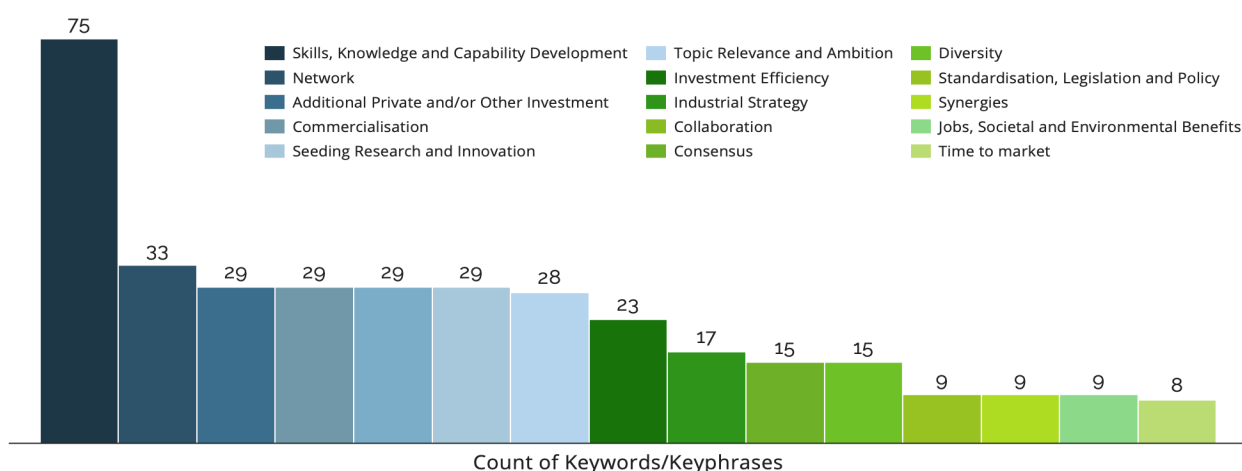
Figure 11 - Questionnaire review against the impact assessment

3.3.2. Interviews

A summary of all 15 metathemes and over 100 themes has been compiled and can be found in *Section 5.7. Interview Themes* of the Appendices. **Figure 12** below shows a visual representation of the outputs. This breakdown and the aforementioned mind maps, which supported its development, made it possible to analyse the data based on the distribution of keyphrases used by interviewees.

***Skills, Knowledge and Capability Development* was critical to many interviewees, with *Network* and *Additional Investment* being the next most commonly mentioned metathemes**

Interview Response Distribution by Metatheme



Source: SE

Figure 12 - Interview response distribution by metatheme

At a high level, the greatest concentration of interview feedback on EGVI benefits was focussed around the following seven metathemes which are shown in descending order:

1. Skills, Knowledge and Capability Development
2. Network
3. Additional Private and/or Other Investment
4. Commercialisation
5. Seeding Research and Innovation
6. Topic Relevance and Ambition
7. Investment Efficiency

The other metathemes are shown below:

8. Industrial Strategy
9. Collaboration
10. Consensus
11. Diversity
12. Standardisation, Legislation and Policy

13. Synergies

14. Jobs, Societal and Environmental Benefits

15. Time to market

Skills, knowledge and capability development was mentioned more than twice as much as the next closest metatheme with 75 total references, hence very effectively meeting this objective. This highlighted how well EGVI supported the growth of these factors through its projects and R&I topic focus. *Workforce skills and training* featured as the key theme (26 references), along with *organisational capability development* (19) and *access to broader EU competence* (15). Other items included *increased knowledge dissemination* (7), *external resource, competence and skill sharing* (6), and *international competence* (2). This clear feedback suggested that the EGVI initiative was most successful in delivering improved skills, knowledge and capability. This links to the following impact assessment success criteria: *Effective Skills and Knowledge Development* (2.4.).

Network was the second most common metatheme (33) and was clearly understood to be an important advantage of EGVI. Both the formal network and informal contacts from EGVI events played a part. The majority of comments related to *network and partner development* (13) and *business development opportunity* (11). Many participants noted how the EGVI networks and partners were often the key reason project teams formed, ensuring that relevant skills and competences were available to deliver objectives. In addition, interviews mentioned *supportive formal network through project developed relationships* (3), *informal partner ecosystem through EGVI events* (3), *marketing* (2), *positive view on non-member support* (1). It was proposed that improved networks led to significantly reduced investment risk for participants due to improved suitability of project partners and their capabilities and experience. This links to the following impact assessment success criteria: *Network Development* (4.4.).

Additional private and/or other investment (29) was a major benefit of EGVI. *Private investment* (18) was the most common category, followed by *privately funded research* (7). Many interviewees noted that private enterprise often provided funding to continue project R&I activities beyond EU-funded projects, either internally or in partnerships. *Further cPPP project funding* (2) to drive technology maturation and commercialisation, *national investment* (1), and *potential private investment* (1) were also discussed. National investment provides some leverage on EU funding but also presents opportunity for growth. Achievement of additional private sector investment improves the overall cost efficiency for the EU, leveraging and scaling the total spent beyond EGVI contributions. This links to the following impact assessment success criteria: *Private investment in areas of EGVI project topics* (2.10.).

Commercialisation (29) was very commonly discussed as an outcome of EGVI

and its projects. Tangible *commercial impact* (18) from project outputs could be verbally confirmed for at least one of the participants, though due to commercial sensitivity, details were not available for disclosure. In some instances, ongoing R&I activities were mentioned as having a *potential commercial impact* (11) at some point in the future. Technologies and solutions brought to market were said to have the biggest impact on society and to have likely led to economic and industry growth. This links to the following impact assessment success criteria: *New Systems and Technologies Innovation* (2.3.), *Industry and Economic Growth* (3.1.), and *Social Benefits* (3.3.).

Seeding research and innovation (29) for low maturity R&I topics was shown a critical EGVI outcome, supporting further market investment and development. *EC funding criticality* (6) was noted, with *potential commercial impact* (6) and *technology maturation* (6) defined as typical project impacts. *Advancement of early-stage research* (3) and *tangible outputs* (4) highlighted how low technology readiness level (TRL) areas were taken through to technology demonstrators. By supporting early-phase R&I, there was more *private resource commitment* (1), higher chances of *research continuation* (1), and *research enablement* (2) that otherwise would not likely have been possible. Seeding R&I topics increases the breadth of new systems and technologies innovation available for industry uptake, increasing the suitability and impact for EU citizens. This links to the following impact assessment success criteria: *New Systems and Technologies Innovation* (2.3.).

Topic relevance and ambition (29) provided the opportunity for respondents to reflect on the funding calls from the perspective of topic coverage and target objective ambitions. The vast majority of responses indicate that EGVI delivers *equitable and relevant R&I calls for industry participants* (20), which is suggestive that research activities are supporting industry and market development. The *European Commission (EC) funding mechanism adaptability and relevance* (5) were also discussed as being adaptable to changing requirements. There was also mention of the partnership's *long-term industry vision and aspiration* (3), and *ambitious industry targets and goals* (1). Broadly it was agreed that the EGVI topics were well-suited to the mission of decarbonising road transport and represented industry targets to an ambitious level. This links to the following impact assessment success criteria: *Project Topic Coverage* (1.1.).

Investment efficiency (28) relates to the manner in which EGVI delivered *investment efficiency* (6) for R&I activities that otherwise may not have been realised. *Risk and cost sharing* (6) was a common advantage of the initiative which was discussed by a number of participants. An interesting comment was *benefits in not achieving project objectives* (6), which captured how learning from “failures” often led to better solutions at a technology and process level. When relevant, interviewees noted that it was typical that *most or all project objectives were achieved* (5). *Research*

enablement (4), and *more robust solutions, greater efficiency and synergy benefits from R&I network activities* (1). High rates of successful projects and outcomes indicated investment efficiency, strengthened through reduced duplication of effort and shared learnings across projects, EGVI and public dissemination. This links to the following impact assessment success criteria: *Number of successful projects* (2.1.), *Relevant KPI-based project objective achievement* (2.2.), *Cost Efficiency* (3.2.) and *Investment Efficiency* (3.4.).

Industrial strategy (23) was raised as being important to provide high-level guidance to industry players to help build confidence in their investment direction, as well as to attract external investment to Europe. The key focus was related to *EU competitiveness and technical leadership* (12) and *EU levelling up* (9). In order to ensure global standing in technology, and EU competitiveness, there needs to be a clear vision. Internally to the EU, it was noted that newer member countries and those conventionally not active in the industry were able to benefit from the knowledge shared in EGVI projects. *Long-term industry vision and aspiration* (2) was another related message from interviewees. Industrial strategy was anecdotally noted to have been influenced by projects that created roadmaps, produced recommendations for standards and generated consensus amongst participants. This links to the following impact assessment success criteria: *Contributions to New Standards* (4.2.).

Collaboration (17) was strong particularly in regard to the working environment created by EGVI. The *unique, innovative and collaborative environment* (14) was mentioned as providing the “safe space” for participants from across the EU, including industry competitors and customers, to work together and harness new perspectives and efficiencies. *External resource, competence and skill sharing* (1) feedback demonstrated how internal gaps in capability can be overcome with the *network and partner development* (1) provided by the partnership. There was also a *positive view on non-member support* (1) for those active in EGVI, but not members within EGVI. Collaboration was said to allow for more streamline use of resources, decrease the time-to-market / time for technology maturation and often developed improved recommendations for standards. This links to the following impact assessment success criteria: *Contributions to New Standards* (4.2.), *Cost Efficiency* (3.2.), *Time-to-market Improvement* (4.3.) and *Investment Efficiency* (3.4.).

Consensus (15) building from projects and collaborations was a key requirement from interviewees. *Industry consensus and organisational direction* (11) was the dominant theme, relating to providing a “pre-legislative” roadmap that lowered market player risk. *Long-term industry vision and aspiration* (3) and *EU vision and aspiration alignment* (1) further highlight this requirement for alignment and consensus. It can be seen that there are overlaps with the industrial strategy metatheme. Agreement between leading industry players was noted to provide

clearer roadmaps to standardisation and consensus, whilst de-risking investments improving efficiencies in delivering project outcomes. This links to the following impact assessment success criteria: *Contributions to New Standards* (4.2.), *Cost Efficiency* (3.2.), *Time-to-market Improvement* (4.3.) and *Investment Efficiency* (3.4.).

Diversity (15) of the project participants was seen as a very strong advantage of the EU-wide nature of the cPPP. The multicultural nature, geographical breadth and broad range of backgrounds of the EGVI participants allowed for *diverse ideas and perspectives* (13), which acted to develop more robust and reliable solutions. This inclusivity also delivered outcomes that were only possible with such a broad range of participants, applicable to more stakeholders and provided greater value and impact to EU citizens. Another positive was that *better industry access and links to academia* (1) could be established driving communication and new information exchange. The requirements of the initiative also meant that *SME funding* (1) supported the participation of smaller enterprises. Multiple factors from the impact assessment framework were influenced by diversity including new systems and technologies innovation, improved networks, time-to-market, and investment efficiencies. This links to the following impact assessment success criteria: *New systems and technologies innovation* (2.3.), *Network Development* (4.4.), *Time-to-market Improvement* (4.3.) and *Investment Efficiency* (3.4.).

Standardisation, legislation and policy (9) feedback related to how standardisation of technology, supporting legislation, and policy frameworks are often aided by EGVI projects. *Technology standardisation* (6) was the main theme from which other benefits became apparent. For example, standardisation of charging networks across the EU would provide a more robust and complete network allowing for a *faster time-to-market* (1) for products and accelerated electric vehicle adoption. However, to do this most efficiently, *robust legislative frameworks developed in parallel to road transport solutions* (2) were required. In developing standards, the consensus was that it was easier to develop effective skills and knowledge, gain investment and cost efficiencies, and decrease time to market along with other benefits. This links to the following impact assessment success criteria: *Effective Skills and Knowledge Development* (2.4.), *Contributions to New Standards* (4.2.), *Cost Efficiency* (3.2.), *Time-to-market Improvement* (4.3.) and *Investment Efficiency* (3.4.).

Synergies (9) was another important topic to interviewees. This included *cross-sector benefits and synergies* (4) that referenced competence built in the automotive industry through inputs from other sectors, e.g. power electronics, to better prepare firms for the electrified vehicle transition. There was also the *more robust solutions, greater efficiency and synergy benefits from R&I network activities* (4) theme, demonstrating how R&I network synergies led to more robust solutions and delivery efficiencies. *Combination of project outputs to deliver synergies and integrated solutions* (1) provides potential to look to cluster project outputs to deliver better integrated solutions. Driven by more interconnected

and communicative networks, synergies were said to offer improved time to market, better efficiencies for investment and skills and knowledge sharing, and more innovative technologies. This links to the following impact assessment success criteria: *New systems and technologies innovation* (2.3.), *Effective Skills and Knowledge Development* (2.4.), *Cost Efficiency* (3.2.), *Network Development* (4.4.), *Time-to-market Improvement* (4.3.), and *Investment Efficiency* (3.4.).

Jobs, societal and environmental benefits (9) incorporated themes including employment, jobs, end user and environmental benefits. *Employment opportunity* (2) in this case encapsulated new hires internally and externally to the industry, as well as the increased employability of university students that have developed skills supporting EGVI projects. *Job creation* (2) directly related to new jobs and greater employment in the EU, whilst *end user benefits from EGVI project outputs* (2) discussed how EGVI impacts always tried to maximise benefits for EU citizens. *Broader societal benefits* (2), e.g. improved air quality, and *environmental benefits* (1), e.g. reduced greenhouse gas emissions, were also noted. Increased employment, new jobs, relevant training – in the existing workforce and in academia – and solutions targeted at maximal positive societal impact to EU citizens were all stated outcomes stemming from EGVI, along with holistic environmental benefits. This links to the following impact assessment success criteria: *Emissions Reduction* (2.7.) and *Social Benefits* (3.3.).

Time to market (8) could be seen as a high priority, particularly for industry participants. It was broadly noted that by having a *faster time to market* (8) for technology and solutions, R&I outputs could reach broader society more efficiently so as to have the greatest impact. This could also provide competitive advantage to the EU industry, with higher levels of competitiveness and technical leadership. Faster time to market provides a plethora of advantages such as faster return on investment, increased impact of solutions, accelerated decarbonisation and a more competitive EU industry. However, the funding mechanism was often not seen as being as fast and dynamic as interviewees felt was required. This links to the following impact assessment success criteria: *Time-to-market Improvement* (4.3.).

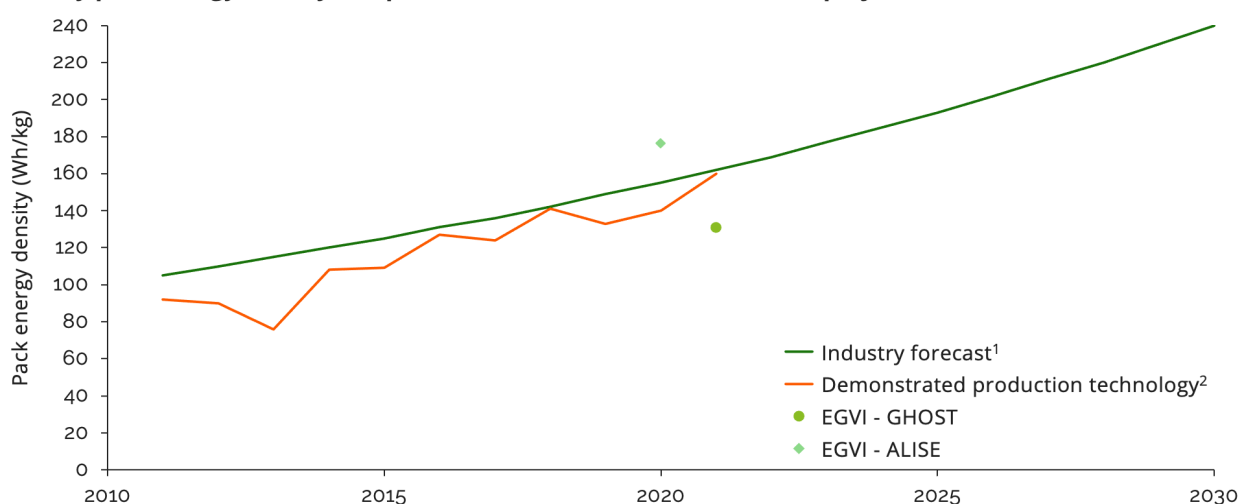
3.3.3. Desktop Modelling

Battery Pack

Battery pack energy density, as targeted by state-of-the-art production technology, has broadly improved in line with forecasts through to 2020. EGVI's project **ALISE** demonstrated class leading outputs on completion. ALISE set ambitious goals and achieved 173Wh/kg energy density - some 30% above production technology. This collective cutting-edge battery pack development path likely created synergies with industry to support *new system and technologies innovation* (2.3.) driving some of the improvements seen today. In addition, by reducing specific energy density, vehicle mass can be decreased which may support *energy use* (2.6.) and *emissions reduction* (2.7.). Lower energy use may also support *electric vehicle penetration* (2.8.).

Battery pack energy density demonstrated by production technology has improved as forecast; EGVI's ALISE project is class leading with outputs ahead of industry expectations

Battery pack energy density comparison (Actual vs. Forecasts vs. EGVI projects)



1) Includes Fraunhofer 2012 and Advanced Propulsion Centre 2021 forecasts; 2) Total Battery Consulting 2019 production data with 2020 forecast
NMC: Nickel manganese cobalt
Source: Fraunhofer, Advanced Propulsion Centre, EGVI, Total Battery Consulting

Figure 13 - Battery pack energy density comparison [6] [7] [8] [9] [10]

Battery Cell

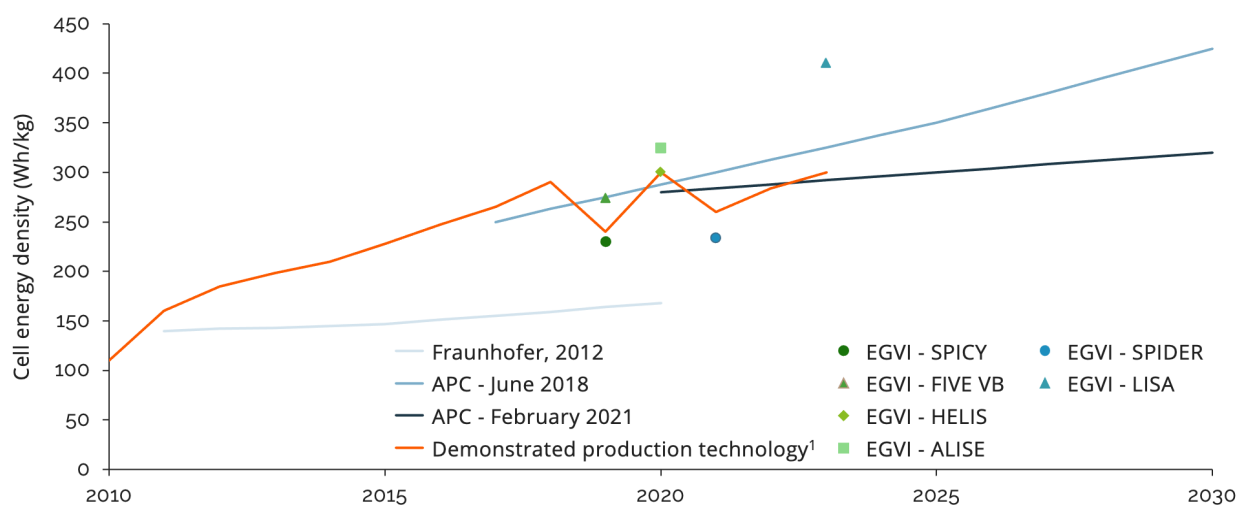
Cell energy density has increased faster than forecast in 2015, though future expectations of a 2018 APC study were adjusted slightly downward in 2021. This could have been due to a shift towards reduced rare earth metal usage and cost-focussed cell production, e.g. Lithium Iron Phosphate (LFP), following supply chain difficulties and geopolitical tensions throughout COVID-19.

Throughout the period to 2020, leading EGVI projects remained on pace or beyond production cell energy density technological developments. Again, outputs from project **ALISE** stand out, but project **LISA** also demonstrated significant advancements in *new system and technologies innovation* (2.3.) via the 18Ah pouch

cell with 410Wh/kg and 450Wh/L. Furthermore, vehicle mass reduction may support *energy use* (2.6.) and *emissions reduction* (2.7.) and subsequently *electric vehicle penetration* (2.8.). Note that not all cell chemistries can be expected to be class-leading in the energy density metric, with the variation of results shown in **Figure 14** likely being impacted by each project's cell material selection e.g. LFP compared to Lithium Nickel Manganese Cobalt Oxide (NMC).

Cell energy density has increased faster than forecast in 2015 and EGVI projects have remained at the leading edge for cell energy density technological developments

Battery cell energy density comparison (Actual vs. Forecasts vs. EGVI projects)



1) BloombergNEF 2020

Source: Fraunhofer, Advanced Propulsion Centre, BloombergNEF, EGVI

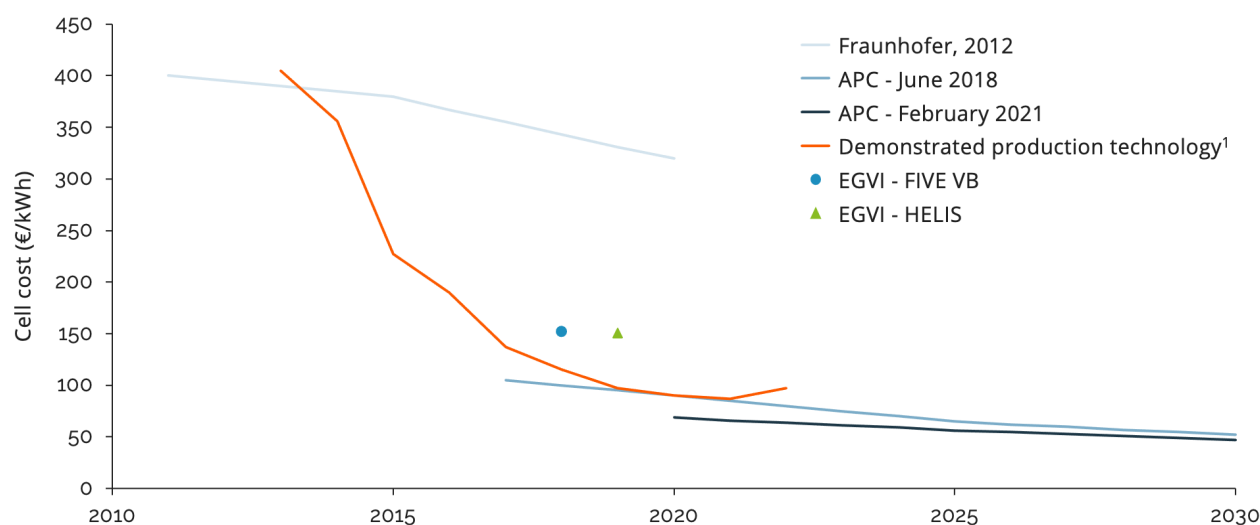
Figure 14 - Battery cell energy density comparison [6] [7] [8] [9] [11] [12]

Cell cost has decreased faster than forecast in 2015, as EV production volumes increased at an accelerated rate to deliver at global scale, and lower cost Chinese players have come to lead the battery cell supply market. However, recently there has been a trend for increasing cell costs due to raw material supply chain constraints and the rising cost of the energy required in manufacturing. These trends would equally impact the cost status of technologies developed in EGVI programmes. Nevertheless, the focus of EGVI projects such as **FIVE VB** and **HELIS** was on performance improvement and not on affordability. In follow-up of these technologies, more focus will be put on affordability.

This is an area that represents potential for development in future programmes, something likely already captured in 2Zero, given that affordability and cost parity will be a significant factor in accelerating *electric vehicle penetration* (2.8.). Ultimately, this will lead to road transportation decarbonisation at least at point of use. In parallel, considerations need to be made to support the “rules of origin” regulations that will require increased battery pack content to be sourced within the EU and partner countries.

Cell cost has decreased faster than forecast due to large global scales, in part due to Chinese entrants, which have increased cost reduction compared to EGVI projects

Battery cell cost comparison (Actual vs. Forecasts vs. EGVI projects)



1) BloombergNEF 2022

Source: Fraunhofer, Advanced Propulsion Centre, Bloomberg, EGVI

Figure 15 - Battery cell cost comparison [6] [7] [8] [9] [11] [13]

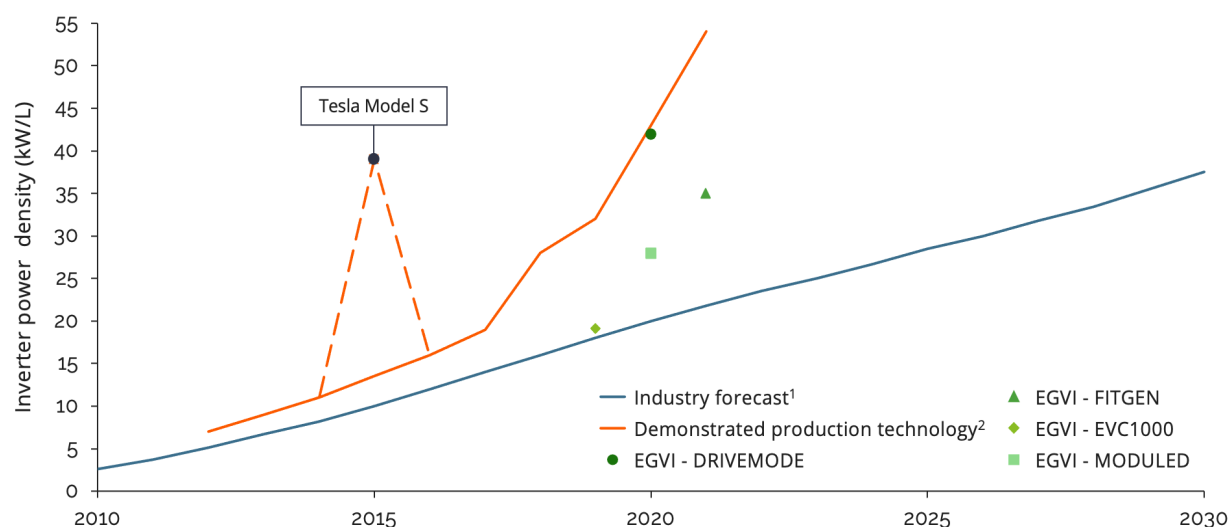
AC-DC Inverter

Inverter power density has improved faster than forecasts. This is largely driven by the adoption of wideband gap semiconductors which, amongst other advantages e.g. higher switching frequencies and downsizing of passive components and packaging space, support the increased uptake of 800V powertrain architectures, leading to a step change in state-of-the-art power density on the market. Roadmaps have now captured the accelerated trend into projections, though it will take a number of years to reach suitable mainstream vehicles and volumes.

Perhaps due to this, and the holistic cooling requirements of such systems, EGVI projects outperformed the Driving Research and Innovation for Vehicle efficiency and Energy Sustainability (USDRIVE) partnership and APC projections but were not ahead of the leading production technologies e.g. the 2015 Tesla Model S. Therefore, there was deemed to be no direct contribution to industrialised inverter power density from the EGVI projects. However, Project **DRIVEMODE** matched commercialised inverter performance from the standpoint of volumetric power density, which may have helped disseminate *new system and technologies innovation* (2.3.) learnings through to completion in 2020. It should be noted that several European suppliers now offer AC-DC inverter systems that are able to meet state-of-the art global standards, demonstrating the progress in the EU and its supply chain.

Inverter power density has improved faster than forecasts and although EGVI projects outperformed forecasts, other commercial technologies are best in class

Inverter power density comparison (Actual vs. Forecasts vs. EGVI projects)



1) Includes USDRIVE 2013 and Advanced Propulsion Centre 2018 and 2021 forecasts; 2) Review of Recent Trends in Design of Traction Inverters for Electric Vehicle Applications," 2021 IEEE 12th International Symposium on Power Electronics for Distributed Generation Systems
Source: USDRIVE, Advanced Propulsion Centre, Department of Energy, IEEE, EGVI

Figure 16 - Inverter power density comparison [7] [8] [9] [11] [14] [15]

Vehicle Energy Efficiency

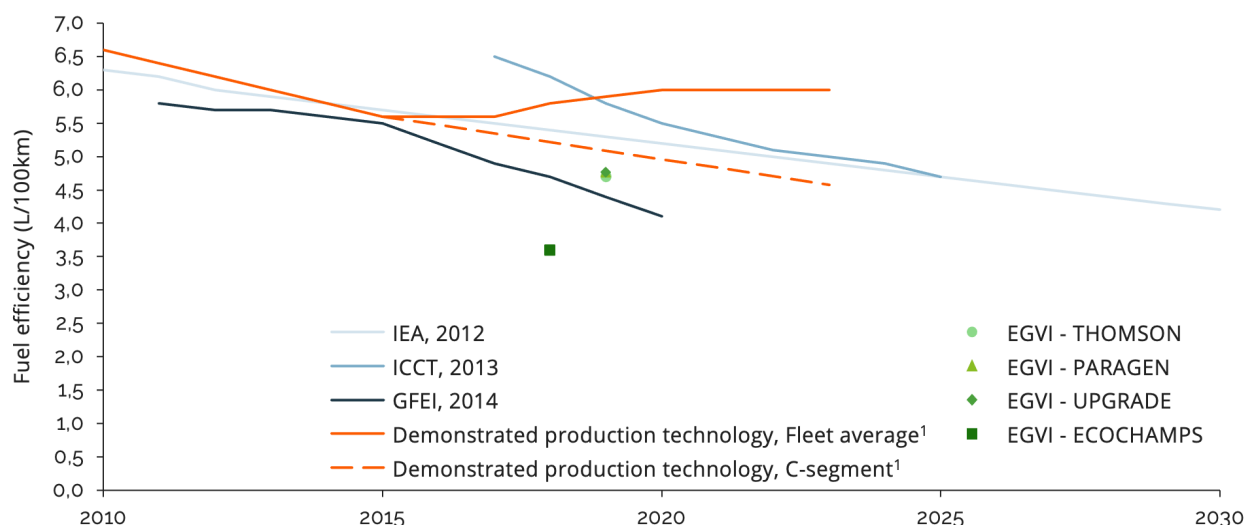
EGVI projects are class leading for vehicle efficiency, outperforming both real-world fleet efficiency and the International Energy Agency (IEA) 2012 efficiency forecast. The four projects assessed focussed on the development and application of new efficient powertrain systems for ICE vehicles such as hybridisation and advanced technologies which may contribute towards *hybrid vehicle penetration* (2.8.). The *new technologies and systems* (2.3.) developed by these projects have contributed to *emissions* (2.7.) and *energy usage reductions* (2.6.) that are mostly in-line with the most optimistic Global Fuel Economy Initiative (GFEI) forecast and exceeded real-world efficiency figures.

Powertrain efficiency improvement has been accompanied by progress on thermal management, lightweighting and aerodynamics.

Using the data and modelling shown in **Figure 17**, a comparison of specific project output efficiency figures to industry forecasts for passenger cars indicates that EGVI delivered median improvements that were several years ahead of market trends.

EGVI projects are class leading for vehicle fuel efficiency, outperforming both real-world fleet efficiency and recent fuel efficiency forecasts

Passenger car fuel efficiency comparison (Actual vs. Forecasts vs. EGVI projects)



1) Global Fuel Economy Initiative 2020

Source: International Energy Agency, Global Fuel Economy Initiative, International Council on Clean Transportation, The Drive, Car and Driver, EGVI

Figure 17 - Passenger car efficiency comparison [8] [9] [16] [17] [18] [19]

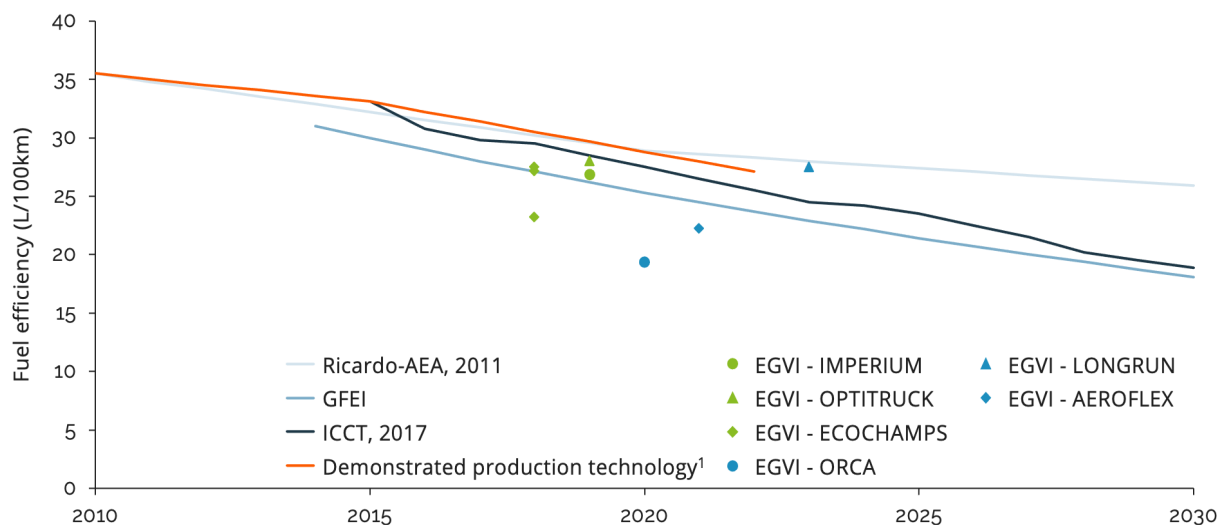
The heavy-duty truck industry is traditionally cautious, and operators are generally risk adverse with a focus on maintaining operating efficiency instead of risking the application of immature technological developments. Therefore, updated forecasts and actual efficiency figures remain relatively unchanged compared to the Ricardo-AEA forecast.

EGVI projects developed class leading technologies for heavy-duty truck efficiency with many projects outperforming industry leaders and forecasts. All the assessed EGVI projects that have an impact of truck efficiency were more efficient than the Ricardo-AEA forecast from 2011. Project **ORCA** is a particular standout and achieved a vehicle efficiency of 19.3L/100km, ~30% less than state-of-the-art in the market in 2020. Additionally, the EGVI projects outperformed updated forecasts and the current best-in-class solutions. This signifies that EGVI projects are contributed to the development of *new systems and technologies* (2.3.), that positively influenced truck efficiency, resulting in a *reduction of emissions* (2.7.) and *energy usage* (2.6.).

By considering project output efficiency figures against industry forecasts for heavy-duty trucks, as shown in **Figure 18**, it could be seen that EGVI delivered median developments that were several years ahead of trends.

EGVI projects are developing class leading technologies for heavy-duty truck fuel efficiency with many projects outperforming industry leaders and forecasts

Heavy-duty truck fuel efficiency comparison (Actual vs. Forecasts vs. EGVI projects)



1) Ricardo-AEA 2011, ICCT 2017, and AfterMarketNews Babcox 2022

Source: Ricardo-AEA, Global Fuel Economy Initiative, International Council on Clean Transportation, Lastauto Omnibus, EGVI, AfterMarketNews Babcox

Figure 18 - Heavy-duty truck efficiency comparison [8] [9] [18] [20] [21]

Economic Value

To quantify the potential economic impact of the EGVI programme, two key hypotheses were used: 1) Accelerated time-to-market and 2) Reduction in non-EU origin battery pack content analysis. These reflect selected competitive advantages that EGVI likely created for the EU, which could lead to ongoing automotive industry revenue growth versus the status quo.

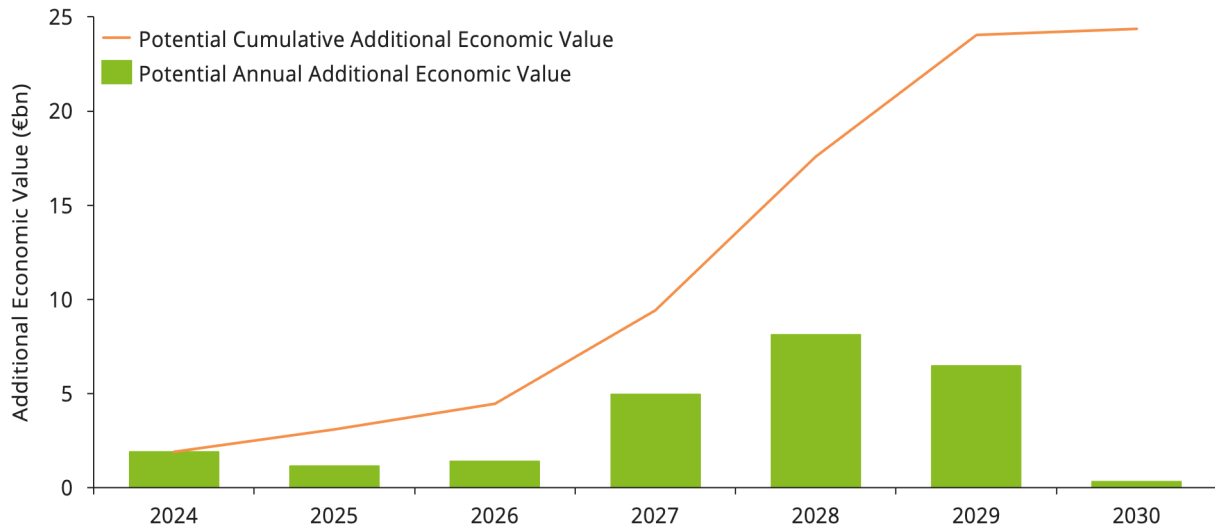
The accelerated time-to-market analysis builds on the feedback from interviewees and questionnaire respondents that EGVI projects deliver, on aggregate, more than 12 months reduced time to market for technologies. Given the assumption that the introduction of only specific vehicle applications is dependent on the readiness of time critical, state-of-the-art systems and components, it is assumed that these advantages can only be realised by fully electric E segment+ passenger cars and heavy duty commercial vehicles. In addition, benefits could only apply to new vehicle programmes, not those already midcycle in production.

Taking a conservative view of a 12-month introduction timing acceleration for modelling purposes, vehicle production volumes are brought forward to recognise the additional revenue potential e.g. current 2024 annual forecasts become those of 2025. By calculating representative vehicle retail prices for each segment and factoring in cost roadmaps for battery packs, including passenger and commercial technologies, values for additional annual and cumulative revenues can be estimated. **Figure 19** shows that in accelerating time-to-market

EGVI could contribute to commercial benefits for the EU of up to €24 billion from 2024 through to 2030.

By accelerating time-to-market EGVI could contribute to commercial benefits of up to c.€24bn through to 2030

Accelerated Time-to-market Analysis¹



¹) Assumes only new vehicle programmes for fully electric vehicles can be brought forward by 12 months
Source: S&P Global, Questionnaire Responses, Interview Feedback, Van Bael & Bellis, POLITICO, FleetNews

Figure 19 - Accelerated time-to-market analysis ^{[5] [22]}

The reduction in non-EU origin battery pack content analysis focuses on the energy storage topic. It considers the potential for growing the EU-based battery component supplier market share by capitalising on state-of-the-art battery skills, technology and capabilities outputs from EGVI. EU legislation is driving a decrease in the maximum non-EU originating material (NOM) present in electric vehicles and a range of other products. There are specific requirements for battery packs. From 70% maximum NOM content today, the cap will fall to 30% of value in 2027 based on the ex-works product price.

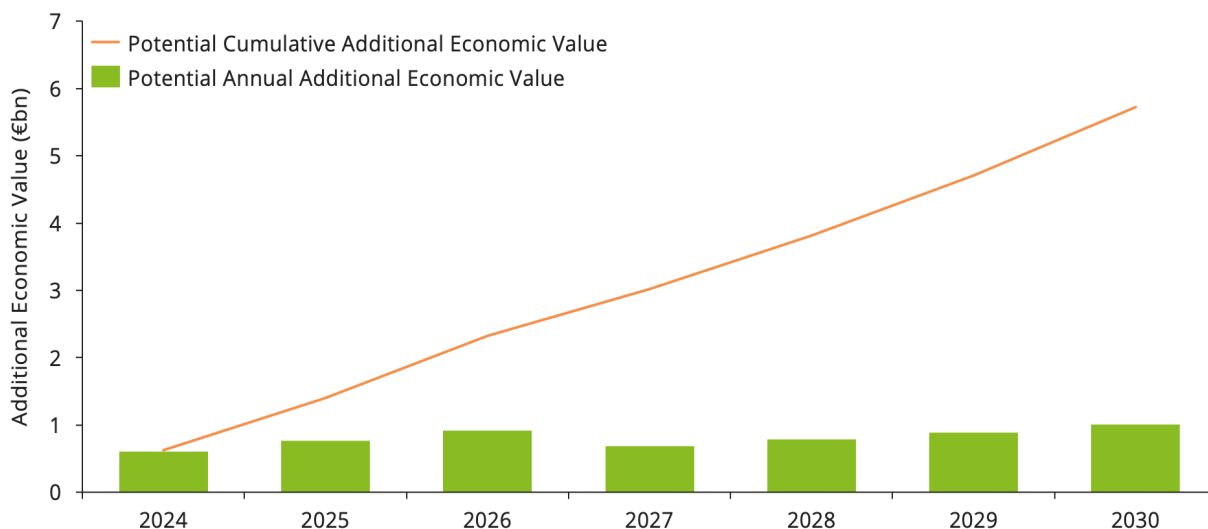
However, these percentages leave significant opportunity to capture more of the market than legislation dictates – particularly given the increasing pressure on maximum NOM decreases. If the EU can offer leading products to satisfy segments sensitive to high battery pack energy density and advanced integration techniques, i.e. E segment+ passenger cars and heavy duty commercial vehicles, then perhaps as much as 90% battery pack value-add revenue can be captured by its supply chain.

An EU revenue uplift can be modelled based on the assumption that only the legislated minimum NOM is currently being produced in the EU, all maximum NOM penalties are avoided by OEMs going forward, and that there is the potential to source up to 90% of battery commodities within the EU due to a technically and commercially competitive supply chain. This would mean the majority of,

but not all, raw or processed materials originate outside the EU, but almost all the remaining value-add is within the EU. The outcome is shown in **Figure 20** and highlights that by onshoring state-of-the-art battery pack demand with EGVI project output contribution, commercial benefits of around €6 billion above the maximum NOM pathway could be realised to 2030.

By onshoring SOTA battery pack demand with EGVI project output contribution, commercial benefits of up to c.€6bn above the maximum NOM pathway could be realised to 2030

Reduction in Non-EU Origin Battery Pack Components Analysis



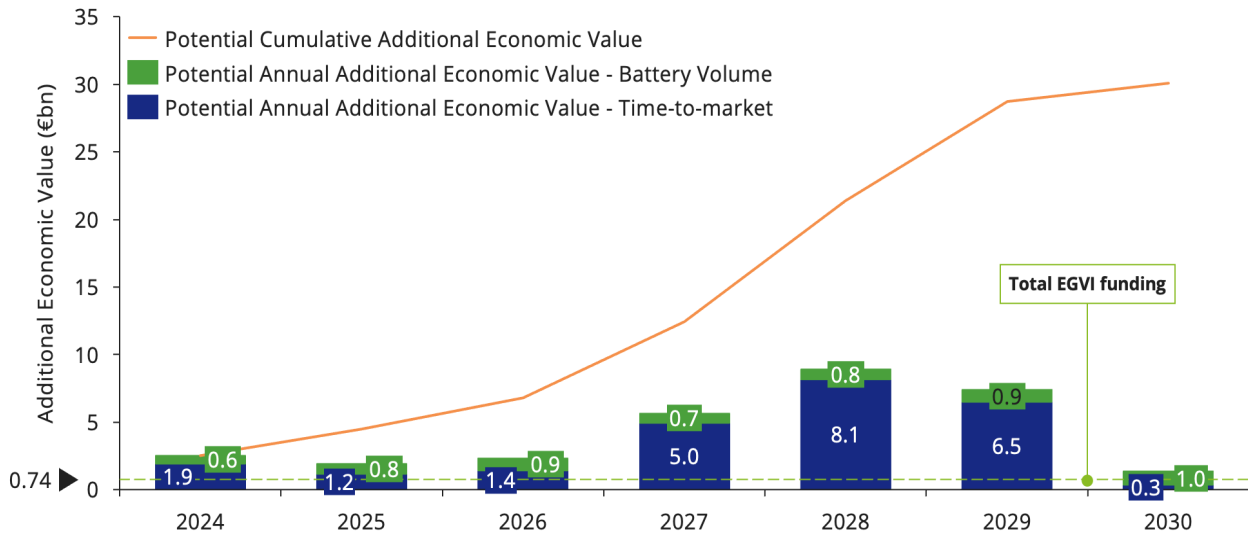
SOTA: State-of-the-art; NOM: Non-EU origin material
Source: S&P Global, Van Bael & Bellis, POLITICO, FleetNews

Figure 20 – Reduction in non-EU origin battery pack content analysis ^{[5] [22]}

In total, the summation of these two analyses indicated that key skills, technologies and capabilities developed in EGVI projects could directly and indirectly contribute to commercial benefits in the EU of up to €30 billion through to 2030, representing a return on EGVI investment of up to 40x (refer to **Figure 21**). For perspective, the upper bounds of return for certain public investment programmes carried out by the UK Government, amongst others, have reached upwards of 30x e.g. the UK Space Agency Copernicus Sentinel programme ^[3]. As a specific example, the UK Government’s proposed subsidy in May 2023 for a major battery manufacturing facility is anticipated to be about €575 million which is forecast to support 9,000 new jobs. This figure is in line with similar work from the IMF ^[4]. It is also expected to generate an economic return on investment of 20-30x over a comparable 6-year time window ^[23]. Therefore, this multiplier of up to 40x is significant and likely captures the upper bound of return to the EU economy from EGVI investment.

The EGVI programme could directly and indirectly contribute to commercial benefits of up to c.€30bn through to 2030, representing a total return on investment of up to c.40x

Economic Value Analysis



Source: S&P Global, Questionnaire Responses, Interview Feedback

Figure 21 - Economic impact assessment ^{[5] [22]}

Societal Value

At a high level, societal value has been assessed as the EGVI projects contribution to job creation and emissions reduction in the EU through to 2030. The job creation assessment builds on the economic value analysis above, whilst the emissions reduction study uses estimated EGVI impacts on vehicle efficiency.

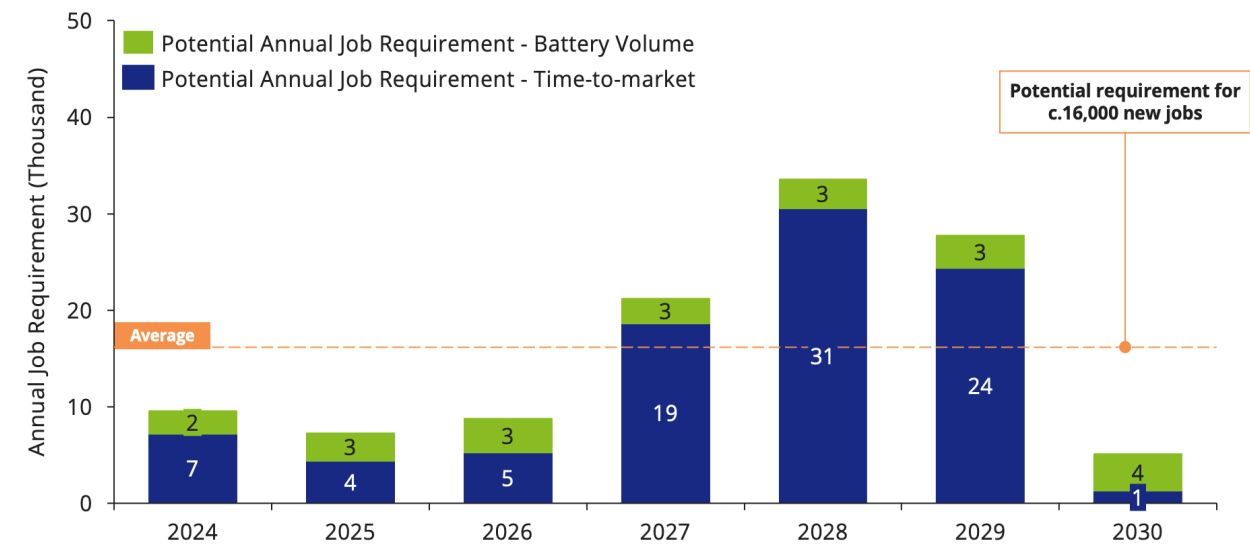
Job creation

The job creation assessment builds on the economic value analysis, modelling new skilled job creation against the aforementioned revenue uplift potential. Using the financial information of a range of relevant automotive firms, from suppliers e.g. Bosch and ElringKlinger to OEMs e.g. Audi and BMW, a ratio of jobs to revenue was developed. This figure was approximately 3.8 employees (#) / €1 million revenue .

As shown in **Figure 22**, using the €30 billion total from above, it was found that there could be a requirement for up to an additional 16,000 (average) jobs in industry from 2024 through to 2030. This figure is based on the average annual demand of the automotive sector across this period. Given that once hired an employee will remain active and be able to support future production requirements, a cumulative annual summation of jobs cannot be used.

EU capability and technology leadership could directly and indirectly contribute to up to an additional c.16,000 jobs in green vehicle technology sectors

Societal Value Analysis



Source: S&P Global, Questionnaire Responses, Interview Feedback

Figure 22 - Societal value from job creation [5]

Emissions Reduction

The emissions reduction analysis considered point of use impacts of improved vehicle efficiency, capturing improvements for both passenger cars and light-duty commercial vehicles, and medium and heavy duty commercial vehicles.

A spread of EGVI project outputs relevant to vehicle efficiency was used to determine the average improvements with a comparison to future forecasts, from leading industry sources such as the IEA, ICCT and GFEI, used as a baseline to determine potential CO₂ emissions reductions with application of EGVI technologies to new vehicle programmes from 2024 as per S&P Global forecasts.

Assumptions were taken for annual mileage expectations, weighted across the vehicle types, and the embedded carbon dioxide in petrol and diesel fuel with basis on data provided by the UK Government and JRC-ERTRAC CO₂ evaluation amongst others; a production volume-weighted 11,700km annual mileage was assumed for light duty vehicles and 45,195km for medium and heavy duty trucks based on data shown in [Table 3](#).

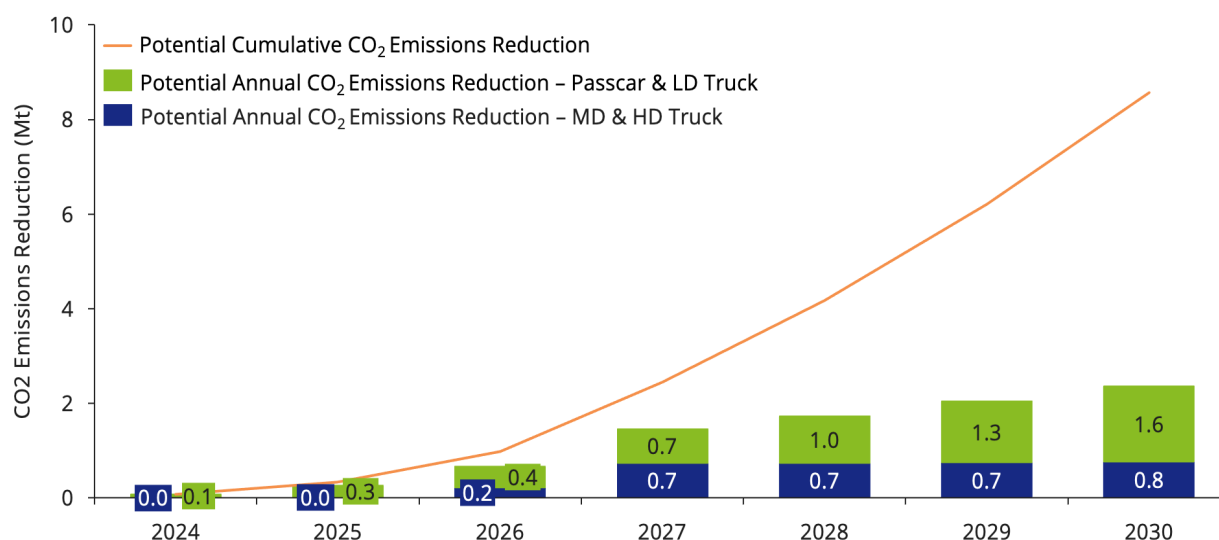
Table 3 - Weighted annual mileage by vehicle class and segment ^{[5] [24]}

Class	Segment	Annual Mileage	Production Share
Light-duty	Passenger car	11,236	85%
	Light commercial vehicle	14,234	15%
	<i>Weighted Average (Total)</i>	<i>11,700</i>	<i>(100%)</i>
Medium- and heavy-duty	Medium-duty commercial vehicle	45,195	10%
	Heavy-duty commercial vehicle	45,195	90%
	<i>Weighted Average (Total)</i>	<i>45,195</i>	<i>(100%)</i>

Figure 23 shows how annual emissions reductions rise to over 2 million tonnes across the forecast period when all passenger cars and commercial vehicles are considered. Through to 2030, the vehicle efficiency improvements demonstrated by EGVI projects could contribute to cumulative point of use CO₂ emissions reductions of up to about 9 million tonnes. This level of reduction is equivalent to taking 6 million passenger cars off the road for one year.

EGVI vehicle efficiency improvements for passenger cars and trucks could contribute to cumulative point of use CO₂ emissions reductions of up to c.9Mt through to 2030

Point of Use Passenger Car and Truck CO₂ Reduction^{1,2,3}



1) Assumes only new vehicle programmes; 2) On-road vehicle programmes only; 3) ICE-based vehicles
Source: S&P Global, KGP, IEA, GFEI, ICCT, Europa, Global Fuel Economy, ICCT, UK Department for Transport, Natural Resources Canada

Figure 23 - Societal value from emissions reduction ^{[5] [16] [17] [18] [25] [26]}

Network Analysis

A key part of the EGVI cPPP, and the supporting association, was the development of effective networks able to yield synergies that lead to delivery of adaptable,

effective and relevant R&D activities in support of road transport decarbonisation.

Extensive analysis has been undertaken in “FUTURE-HORIZON Deliverable D1.3: Report on identifying European academic centres of excellence”, which used 93 H2020 projects including 76 “green vehicles” and 17 “batteries” topics to identify centres of excellence ^[27].

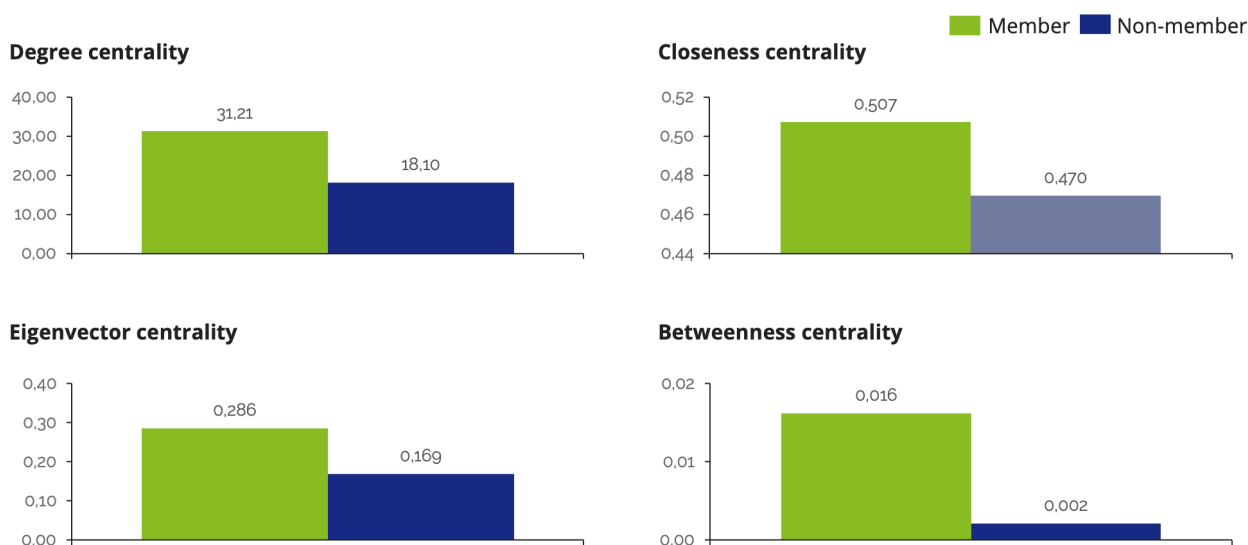
The same dataset has been used to assess the impact of EG VIA on network development within member organisations using the positional indicators of nodes as detailed below

- Degree centrality: Indicates the strength of links between a participant and all the other participants in the network. A high value suggests connections to a large number of actors in the network and better access to information
- Closeness centrality: Indicates the distance of each node from all others. A high value suggests stronger links and improved information flows
- Eigenvector centrality: Indicates node proximity to the core of the network, which is essentially the set of the most active and well-connected and important actors
- Betweenness centrality: Indicates the extent to which a node acts as a connector of other nodes i.e. different groups. A high value means new information may flow through partners who have participated in mutually unconnected projects

Figure 24 demonstrates the outcome of the analysis. Higher scoring across the positional indicators highlights a greater number of connections, improved information flows, and more targeted connection to key actors. Given this information, it can be seen that EG VIA members benefit from a markedly more robust position in the road transportation R&D network than non-members.

Network analysis suggests that EGVIA members benefit from a markedly more robust position in the road transportation R&D network than non-members

Network Analysis for EGVIA Members and Non-members



Source: FUTURE-HORIZON Deliverable D1.3: Report on Identifying European Academic Centres of Excellence

Figure 24 - Network analysis for EGVIA members and non-members ^[27]

Skills Development

A critical theme that has emerged from the interviews and questionnaire is the significant contribution of EGVI to *skills, knowledge and capability development*. It was the most highly mentioned metatheme across the 15 that emerged from interviews, at nearly twice the rate of the second placed metatheme *network*. Meanwhile, the questionnaire respondents gave this topic a strong average score, with all projects noting the benefit of improved skills and knowledge within their team/organisation.

To further detail examples of the truly critical skills developed in EGVI, an analysis of questionnaire responses was completed for the following:

- 2.2.2. Did your project quantifiably contribute to green vehicle technology integration?
- 2.4.1. Have academic or training curricula been developed from this project and deployed by participants?
- 2.4.2. Did your team/organisation gain in skills and knowledge?
- 2.4.3. Has new technical knowledge been captured, documented and disseminated into public domain that could improve technology applications to reduce emissions/energy consumption for road vehicles in industry now or in the future?
- 2.4.4. Were new development methods created that may support the development and adoption of new technologies that reduce emissions/energy consumption for road vehicles?

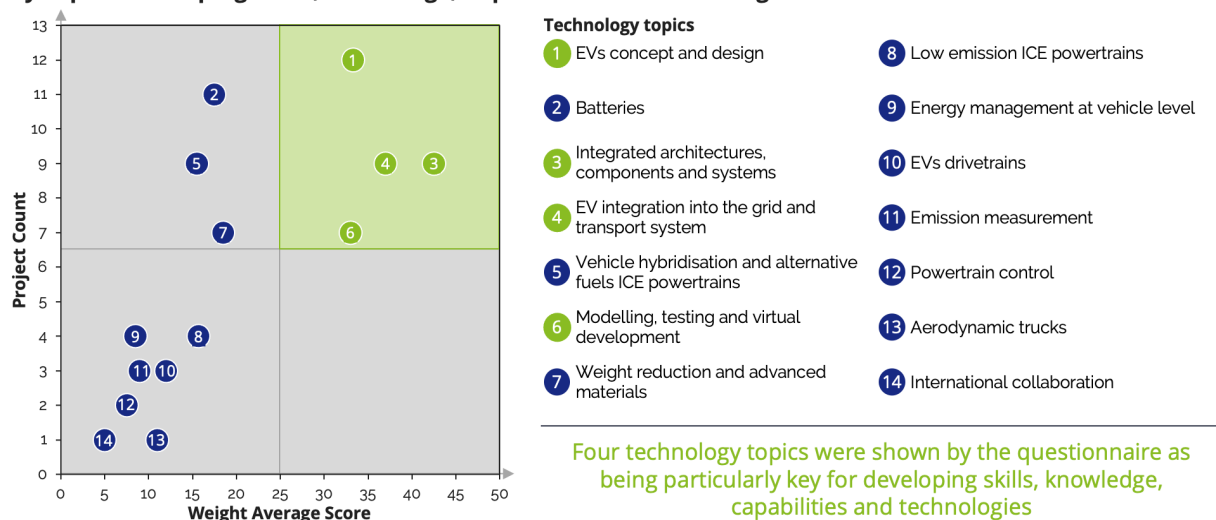
The skills identification analysis considered the specific project of a given participant, the technology topic of this project (refer to **Table 1**) and the average score for the questions above. A weighted average score was then given to each technology topic based on average score and the number of participants. The resulting output is shown in **Figure 25** - Skills development matrix.

Four key skills development topics were clearly identified from the analysis. These are shown in the upper right quadrant of **Figure 25** and include:

1. EV concept and design
2. Integrated architectures, components and systems
3. EV integration into the grid and transport system
4. Modelling, testing and advanced materials

EVs concept & design, integrated architectures, components etc., EV integration to grid & transport system, & modelling, testing & virtual dev'mnt provided key competence increase

Key Topics Developing Skills, Knowledge, Capabilities and Technologies



Source: SE, CORDIS

Figure 25 - Skills development matrix

Across the various EGVl projects in these areas, there were six consistent new core skill areas and capabilities that viewed as being highly valued. These were, in order of prevalence:

1. Medium-temperature thermal systems design and simulation
2. Low-voltage electrical integration
3. Engineering simulation software development
4. Co-simulation, software- and model-in-the-loop development
5. Lifecycle and use case analysis
6. Battery system design and integration

Medium-temperature thermal systems design and simulation skills were developed

through projects such as **QUIET** and **DOMUS** that considered the development of an electric vehicle user-centric design for optimised energy efficiency. QUIET focussed on achieving this via a compact heat pump system that reduced cooling and heating loads in the cabin. DOMUS took more of a holistic approach based on innovative solutions for glazing, seats, insulation and radiant panels. Both projects used a novel design approach, coupled with simulation, to optimise systems including real world validation of numerical modelling.

Low-voltage electrical integration competence was also furthered in delivery of **CEVOLVER** and **RESOLVE** despite the projects having differing topics. CEVOLVER used a user-centric approach to create battery-electric vehicles that were usable for comfortable long day trips, with installed batteries that were dimensioned for affordability. RESOLVE was concerned with developing a range of cost-effective, energy efficient and comfortable ELV using innovative HMI. Each demonstrated electrical integration capabilities for low-voltage systems such as onboard thermal management through heated panels or HMI onboard display and smartphone integration.

Engineering simulation software development was achieved during completion of the **SELFIE** and **ACHILES** projects, both of which were part of the integrated architectures, components and systems technology topic. The former successfully developed the simulation platform derived from the **GHOST** project, using it to model the complete thermal management system. The latter included modelling and control of the powertrain and battery system components, including aging tests for state of charge and state of health software implementation.

Co-simulation, Software- and Model-in the Loop development knowledge and capability were advanced during **XILforEV** and **OBELICS**, both of which were in the technology topic modelling, testing and virtual development. XiLforEV looked at connected and shared X-in-the-loop environment for electric vehicles development to improve the production development process allowing the possibility of remote, distributed and shared experiment. OBELICS developed a framework for the design and testing of electrical powertrains and vehicles, creating models and simulations that include new scalable (real-time capable) models and new testing and safety analysis methods.

Lifecycle and use case analysis skills were developed during the **ASSURED** and **PANDA** projects despite their differing technology topics. ASSURED produced an interoperability concept where different types of medium and heavy duty vehicles can be charged with different charging solutions. PANDA developed a framework for a forward LCA that captures all LCA aspects and considerations within the design phase.

Battery system design and integration capabilities were acquired during

1000kmPLUS and **GHOST**, despite differing technology topic groupings. 1000kmPLUS created a scalable and brand-independent technology platform for key EV elements, showcasing the approach in a test vehicle. GHOST integrated a novel dual battery system into a vehicle demonstrator, which used a cell-to-pack structure with leading cell volume content and lightweight design, along with a modular, energy efficient thermal management architecture.

All of these skills and capabilities can be considered essential for improving EU competitiveness for the future of the automotive industry that is already being disrupted by changes in the technologies, business models and consumer expectations that arise from connected, autonomous, shared and electric vehicles.

3.3.4. Data Analysis Review

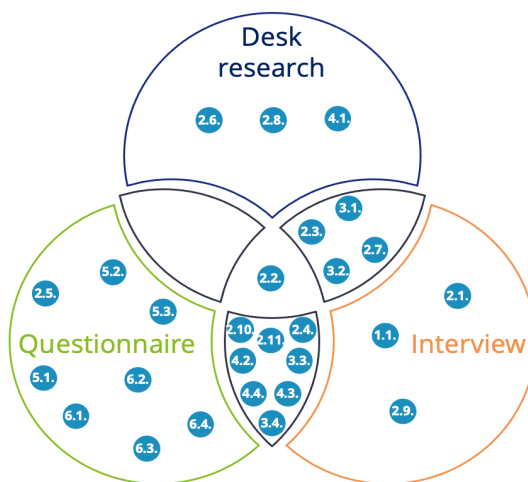
The three data sources: 1) questionnaire, 2) interviews and 3) desk research can be cross-referenced to highlight key synergies or discrepancies in the data collected. By cross-referencing in this way, the most important and valuable benefits of the EGVI projects and the target areas for further development could be identified.

The Venn Diagram shown in **Figure 26** illustrates that all 27 success criteria have been assessed. 12 success criteria have data points from 2 sources, 1 data point has 3 sources and the remaining 14 success factors have data from a single source.

12 success criteria have data points from 2 sources, 1 data point has 3 sources, and the remaining 14 success factors have data from a single source

Data Source Consistency and Validation

- The three data sources have been cross-referenced to highlight key synergies or discrepancies in the data collected
- By cross-referencing in this way, the most important and valuable benefits of the EGVI projects could be identified
- The Venn Diagram captures the 27 success criteria that have been assessed in the study
- 12 success criteria have data points from 2 sources, 1 data point has 3 sources, and the remaining 14 success factors have data from a single source



Source: SE

Figure 26 - Success criteria cross-reference

In this section of the impact assessment, only areas where the impact assessment criteria data sources overlap were considered. This was to provide an alignment between the data sources, confirming consistencies and differences. The 14 success criteria only assessed through a single data source have not been included in the analysis.

Consistent Themes

There were eight consistent themes perceived as EGVI's strengths. Interviews and desk research agreed that *new systems and technologies*, and *emissions reduction* were essential outputs. Interviews and the questionnaire both suggested that the initiative led to *effective skills and knowledge development*, *private/additional investment in areas of EGVI projects*, *network development*, *investment efficiency*, and *time-to-market improvement*. All three data sources also showed *relevant KPI-based project objective achievement* was common across projects. More details are shown below:

1. **New systems and technologies (2.3.)** were highlighted as a significant impact of EGVI, as shown by interview comments in the commercialisation metatheme. Interviewees giving high-level examples for production implementation of systems and technologies outputs from projects. Desk research supported this insight for technical performance characteristics of the battery pack and cell energy density, and passenger car and heavy-duty vehicle efficiency
2. **Emissions reduction (2.7.)** was discussed by a few interview participants as a positive EGVI impact, specifically in relation to broader societal benefits such as air quality improvement and reduced greenhouse gas emissions. The modelling in this report suggests project outputs are delivering these effects, with vehicle efficiency focussed projects delivering significant improvements versus industry in passenger cars and heavy-duty trucks e.g. project **ECOCHAMPS** and **OPTITRUCK**
3. **Relevant KPI-based project objective achievement (2.2.)** scores highly from questionnaire responses at 4.4. Many participants agree that the EGVI project met objective targets and thus quantifiably contributed to green vehicle technology integration. Interviews also corroborated this outlook, with many candidates referencing all or most project objectives as being achieved, something contributing to the overall EGVI investment efficiency. From desk research, battery pack and cell energy density, and passenger car and heavy-duty vehicles vehicle efficiency reach KPI goals
4. **Effective skills and knowledge development (2.4.)** was scored at an average of 3.0. Participating organisations directly gained skills and knowledge from EGVI projects. These learnings have also been captured and documented in the public domain, which offers potential for technology improvement in the

future. The questionnaire also suggests that there were some academic and/or training curricula developed and deployed from EGVI project outputs. Skills, knowledge and capability development was also the most highly referenced interview metatheme, with EGVI seen as a major contributor to improvement of these aspects in the EU. Improvements in industry consensus was referenced as allowing better training and development of employees and students. Synergies of shared project outputs, teams and the professional relationships built in EGVI also led to more effective skill and knowledge sharing across participants

5. Private/additional investment in areas of EGVI project topics (2.10.)

received a questionnaire score of 3.2, which suggests EGVI projects enabled longer term working partnerships between participants e.g. shared research or pilot studies. However, it was noted that these prolonged or extended partnerships were not necessarily a direct result of EGVI participation. Additionally, after EGVI project completion participants have often contributed further into relevant project topic areas, although typically to a lesser extent than EGVI funding. In interviews, the metatheme of additional private and/or other investment received the third highest number of responses with focus heavily around private investment and privately funded research. Many interviewees noted that private enterprise often provided funding to continue project R&I activities, either internally or in partnerships with others. National government investments also contributed, though to a less significant level, supporting continued research in certain topic areas

6. Network development (4.4.) scored well in the questionnaire at 3.8.

This indicates that EGVI membership directly enabled expansion of an organisation's professional network, within the EU supply chain, both during the project and after project completion. Network was the second most common metatheme and was seen by the interviewees as a major benefit of participating within EGVI. Both the formal and informal contacts, often established during EGVI events, contributed to this network. In addition, the business development opportunities commonly stemmed from these expansions of professional contacts. Networks were noted as being fundamental to the successful delivery of project objectives

7. Investment efficiency (3.4.) had strong positive feedback from the

questionnaire at 4.2. EGVI projects have generally directly enabled organisations to progress further with R&D activities than what would have been possible otherwise given financial constraints. Additionally, project outputs and learnings enabled participants to be more targeted with future R&D and indirectly benefitted return on investment. As an output from interviews, investment efficiency was also of high importance. EGVI funding was highlighted as a major enabler of R&D activities that might otherwise not

have been completed. Barriers to participation were reduced through cost and risk sharing between project partners. As well as this, shared learnings, including failures, helped to disseminate outputs and efficiencies amongst all participants

8. **Time-to-market improvement (4.3.)** was one of the lowest scores in the questionnaire at a total of 2.2, though this result is skewed due to the scoring methodology for this question. Despite this, participants estimate that EGVI projects contributed to a ~12-month improvement in time to market on average, a significant positive impact. Interview inputs related to the time to market metatheme were the least frequently mentioned of all categories, perhaps indicating that this was not perceived as a major advantage of EGVI participation. Potentially this could be due to the additional time and effort required to support EGVI project participation. However, an acceleration in the commercialisation and realisation of benefits was of importance to interviewees

There were two consistent themes perceived as opportunities for improvement of future programmes:

1. **New systems and technologies (2.3.)** feedback from interviewees noted that there was potential for improvement in project topic scope to more directly address cost reduction within electric vehicles, thereby encouraging mass market adoption of decarbonised road transportation. Output from the desk research seemingly reflected this point, with battery cell costs realised in certain EGVI projects, e.g. project HELIS, not meeting state-of-the-art production figures or those of updated forecasts. However, battery cell cost was not an objective of EGVI
2. **Social benefits (3.3.)** received an average score of 2.9 from questionnaire respondents. This suggests that EGVI is likely to have a long-term positive influence on employment figures within the EU. However, retraining opportunities offered by projects beneficiaries for their own employees – particularly those related to decarbonisation topics – were perceived as unlikely, despite a number of participant organisations planning to expand operations in these areas prior to 2030. From interview analysis the jobs, societal and environmental benefits metatheme was also one of the least commonly mentioned. Despite this, desktop modelling indicated that there could be the potential for EGVI's legacy to generate a requirement for up to 16,000 (average) skilled jobs within the EU by 2030 due to increased associated value-add revenue. It is possible that the less tangible and transparent relationship between EGVI projects and EU employment could impact perceived benefits

Inconsistent Themes

Only one theme, relating to new regulations and standards, appeared to demonstrate minor inconsistencies between the questionnaire respondents and interview candidates. Though both suggested that EGVI contributed to EU standards, the interviews suggested a more significant contribution than the questionnaire:

1. Contributions to new standards (4.2.) scored an average of 2.4 in the questionnaire, with the sub-question on supporting developed/in development standards achieving 1.4. Though this was one of the lower scores, a more in depth review showed that ~33% of participants perceived that projects have supported development of current EU standards. In fact, over 50% of respondents believed project outputs, e.g. frameworks or whitepapers, could contribute to future EU standards. Additionally, many also thought establishment of consensus on organisational R&D strategies could be indirectly attributed to EGVI. Interview analysis was more strongly supportive of EGVI's contributions. Four metathemes were identified that linked to standards including industrial strategy, collaboration, consensus, and standardisation, legislation and policy. The overarching insight was that projects influenced standard development significantly, for example, through indirect contributions through frameworks and white papers or by establishing industrial consensus in R&D roadmaps

This minor difference was perhaps due to the questionnaire and interview participants' differing positions and experiences within EGVI and the broader EU governing bodies, with certain individuals – particularly those interviewed – having a greater visibility of the long-term contributions of EGVI to new standards. Outputs make it clear that EGVI made, and continues to make, strong contributions to EU standardisation.

Triangulating sources in this way has demonstrated the robustness of the approach, with most cross-referenced data points showing consistency of insights.

3.4. IMPACT ASSESSMENT FINDINGS

3.4.1. Relevance

Relevance of EGVI's Work Programmes and R&D investments to meeting societal needs was ensured through its robust processes and procedures, coupled with typically ambitious project objectives and deliverables. Many projects led to measurable advances in technology performance levels in areas that were critical to solving the automotive industry's challenges and technical barriers to adoption.

Relevant topic selection relied on development of Work Programmes, a process that was shared between the public and private sides of the cPPP. A broad range of stakeholders representing the whole value chain, including key members of industry and ETPs, provided input into a central research and innovation reference document that highlighted critical topics. This was then reviewed and downselected by the EC in a holistic and inclusive process. Consequently, EGVI and its value and mission were recognised by industry, according to over 90% of questionnaire respondents. In addition, nearly 99% of companies representing the private side of the partnership, believed that R&I priorities had been at least partially covered by the EGVI Work Programmes. It should be noted that EGVI included 14 technology topic clusters over 85 projects, covering aspects from electrification, aerodynamics, and vehicle concept and design, to improvement in transition-ICE powertrain.

Project objectives and deliverables were also considered ambitious by questionnaire respondents, with over 98% of EGVI members saying targets were as required or, in some cases, even above expectations. This was also reflected in the level of EGVI projects reaching predefined KPIs and goals. Whilst over 50% fully achieved original objectives, some 40% perceived that objectives were "mostly" reached, indicating that participants could have been stretched in meeting the aspirations set by EGVI.

Measurable advances in technology have been shown by many projects, as compared to forward-facing technology roadmaps and state-of-the-art production systems and components. Vehicle efficiency improvements, a critical aspect of decarbonising road transportation, was demonstrated for passenger cars by **PARAGEN** and **UPGRADE**, and heavy-duty vehicles by **ECOCHAMPS** and **ORCA** (refer to **Figure 17** and **Figure 18**). Other projects looked to reduce barriers to EV adoption, with particular emphasis – for example – on increasing range and the availability of charging infrastructure through better interoperability;

two technical aspects that are often noted by consumers as the major hurdles to EV adoption, outside of acquisition costs ^[28].

A perfect example of the correct targeting of EGVI Work Programmes, the **OPTEMUS** project focussed on improving A-segment passenger EV range to alleviate range anxiety, a key barrier to mass market adoption, achieving and demonstrating at least a 30% real world driving range increase. The result was a set of mature technologies, with a clear route to timely commercialisation by participants, that will likely realise R&D benefits in society.

RELEVANCE

Common and consistent themes related to Relevance identified in research:

- Project scope was well allocated and targeted from the perspective of both EGVI members and non-members
- Projects typically delivered on the right KPI-based objectives based on interview and questionnaire feedback, generally achieving measurable advances in technology performance areas that support industry growth
- However, relatively long periods to project start - *related to EU funding mechanisms* - may have limited the technical impacts of some projects, and some objective targets could have been more ambitious e.g. AC-DC inverter power density
- An increased focus on battery cell cost may have yielded further advancement in this field, and hence supported faster and greater adoption of electric vehicles, but this was outside of the remit of EGVI

3.4.2. Effectiveness

EGVI's effectiveness was most critically marked in the pre-competitive development of new technologies that furthered state-of-the-art performance, the building of skills, knowledge and capability, and the reduction of emissions e.g. through improved vehicle efficiency. Data suggests that EGVI demonstrated integration of more than 35 innovative technologies in green vehicles and mobility system solutions, with more than 20 relating to innovative powertrain systems and technologies.

New technologies outputs from EGVI furthered the state-of-the-art performance across selected core technology pathways for battery packs, cells and vehicle efficiency – based on desktop analysis and modelling. EGVI projects demonstrated battery energy density improvements of more than three times, and cost savings of more than 50%, against the 2009 baseline. This exceeded specific goals to achieve a battery energy density increase of more than two times, and cost savings of more than 20-30%. More broadly, questionnaire respondents reported achieving the integration of more than 35 innovative technologies in green vehicles and mobility system solutions. Given that this figure probably understates overall achievements, there is a high likelihood the challenging original goals of the programme were achieved. Meanwhile, the penetration of alternative powertrain vehicles was close to reaching the EGVI aspirations of 5 million in 2020, achieving ~4.6 million units in the EU vehicle parc ^[5].

The **DOMUS** project was particularly effective for green vehicle technology rollout and skills development; new cabin components, systems, and control strategies were developed for energy efficient, safe and comfortable future electric vehicles, maturing technologies for commercialisation through the critical high-risk stages. Its outputs led to commercial projects as well as related investment in facilities, which in turn likely led to the creation of new skilled jobs within the EU.

Interviews highlighted how critical EGVI was to building skills, knowledge and capability in the EU. Some 75 keyphrases were captured supporting this claim, the most commonly mentioned by some margin, at over 20% of the total keyphrase count. Participant organisations typically noted a direct output of projects being gains in skills and knowledge, capture and public dissemination of technical knowledge, and the creation of new development methods. All of this could support the advancement and adoption of new technologies that reduce emissions and energy consumption for road vehicles. It was also suggested by ~77% of participants that academic or training curricula were developed and deployed from project outputs either directly or indirectly.

EFFECTIVENESS

Common and consistent themes related to Effectiveness identified in research:

- Development and deployment of new technologies by delivering simulation or physical demonstrators for the majority of project technology topic areas, delivering integration of more than 35 innovative technologies into green vehicles and mobility system solutions
- Directly developing vital skills, knowledge, and capability across focus technology topic areas, building overall EU competence and indirectly supporting academic/training curricula
- Road transport decarbonisation with improved vehicle efficiency demonstrated e.g. THOMSON or AEROFLEX
- Demonstrated battery energy density of more than three times, and cost savings of more than 50%, compared to the 2009 baseline, exceeding the original objectives
- EGVI contributed to the achievement of ~4.6 million electrified vehicles in the road-going vehicle parc by 2020

3.4.3. Efficiency

Efficiency was one of the leading outcomes of EGVI. By enabling more and better-targeted R&D activities, projects were very likely to have improved the time-to-market capability for advanced products by more than 12 months. This is likely to both directly and indirectly contribute to EU commercial benefits with a value of up to €30 billion additional gross value-added revenue through to 2030, representing a return on investment of up to 40x from the total cPPP funding. This potential economic growth represents a significantly better return on investment than other major investment projects, and is towards the top of the recognised potential range.

As mentioned, societal benefits, in particular those related to employment, could be attributable to EGVI projects and associated outputs. This study indicated that ~77% projects directly or indirectly positively influenced long term employment figures. In addition, outputs suggested that ~37% of project participants hired permanent staff directly as a result of EGVI. Further to this, modelling has shown that based on the up to €30 billion total from the economic analysis, there could be a requirement for an additional 16,000 jobs in EU industry from 2024 through to 2030.

Long-term working relationships and synergies were established throughout projects, often leading to further interaction beyond project completion on related opportunities according to over 80% of respondents. In some cases, these relationships led to shared research and pilot studies supported by private investment. For example, commercial projects followed from **DOMUS** and plans for commercialisation were developed by participants in **OPTEMUS**.

EGVI often acted as a research enabler, ensuring progression of R&D further than would have been possible without additional support and funding. Over 95% of respondents believed that participation within the initiative allowed them to advance activities further than otherwise would have been possible. Private investment also directly supported EGVI activities based on the structure of the cPPP agreements; whilst this is not a significant multiplier, private entities contributed upwards of €100 million in total in EU-funded projects under the partnership. Meanwhile, ~96% of participants believe shared project learnings and synergies lead to a higher spending efficiency and enabled more targeted future R&D activities. Altogether, this supports a better return for all parties involved and the EU more broadly.

As an example of a project that likely led to strongly positive return-on-investment, **CEVOLVER** sought to improve user confidence in EVs through demonstration of improved functionalities, energy efficiency and affordability in a user centric design. It achieved its objectives, producing two demonstrators that incorporated

synergies from other H2020 projects, i.e. **OPTEMUS** project heat pump system, and a novel user-centric approach to deliver energy savings. Impacts showcased capable and mature technology at a vehicle level, with better functionalities and energy efficiency, closing the gap to commercialisation whilst using EGVI project synergies to deliver outputs with high R&D efficiency.

EFFICIENCY

Common and consistent themes related to Efficiency identified in research:

- EU commercial benefits with a value of up to €30 billion additional gross value-added revenue through to 2030; this corresponds to a requirement of up to 16,000 additional jobs
- EGVI projects have enabled longer-term working partnerships between participants e.g. shared research or pilot studies
- Enabling organisations to progress R&D activities further than would have been possible otherwise given financial constraints, whilst project outputs and learnings enabled participants to be more targeted with future R&D and indirectly benefitted return on investment

3.4.4. Long-term EU Benefits

Long-term EU benefits from EGVI can be seen first and foremost in the creation of a EU-wide networking platform. This supported long-term working relationships and synergies, which streamlined R&D activities, boosting industry technical competitiveness within the EU. Network development also helped participants to form a more robust and diverse automotive and transport industry, creating intangible benefits that endured beyond the duration of the initiative. A multitude of views, diverse knowledge and experience was brought together in EGVI projects in a way that would not otherwise have been possible.

This was further reflected in the feedback from the interview analysis, with *network* being the second most mentioned, and thus important, theme. The majority of organisations, some 72%, said that participating in an EGVI project or being an EGVI member directly expanded their professional network in the EU supply chain. These networks also supported EU levelling up as ~85% suggested that similar R&D activities to those on EGVI projects would only be, at best, partially possible at a national level. The particular incremental value of EU-wide collaboration was highlighted as a strong positive.

For SMEs, access to niche and specific capabilities not available on a national level was of particular importance, as typically they have less geographical reach and operational footprint. EGVI had a specific objective to ensure SME participated in the programme. Out of 1507 total participations, including duplicates where companies were involved in more than one project, there were 256 attributed to SMEs. In addition, out of 85 projects there were 73 that involved SMEs.

Feedback from interviewees and questionnaire respondents also indicated that EGVI delivered, on aggregate, more than 12 months reduced time to market for new technologies. Some ~17% even suggested this could be more than 24 months. A faster time-to-market capability within the EU contributes not only to quicker realisation of the positive impacts of new, low emission technologies but also provides quicker realisation of early stage and impactful research outputs.

The support of standardisation and policy development was a commonly mentioned benefit of the EGVI programme. Five interviewees mentioned contributions to aiding, for example, the rollout of pan EU charging technologies. This relationship created a feedback loop from EGVI to policy, catalysing the recognised and actionable vehicle targets seen today. Though only ~33% of participants perceived that EGVI projects directly supported development of current EU standards, over 50% of respondents believed projects outputs, e.g. frameworks or whitepapers, contributed to future EU standards.

A great example of EGVI's contribution to this area was the **AEROFLEX** project,

which created recommendations for new industry standards, and demonstrated transport efficiency gains in heavy-duty vehicle segments. Another example involved collaboration between the **FIVE-VB**, **eCAIMAN** and **SPICY** projects, leading to the submission of a joint white paper on battery cell test standardisation that was presented during Transport Research Arena (TRA) 2018 in Vienna. Both recommendations, and white papers supporting new industry standards, contributed to the development of EU regulations through knowledge sharing. They have been an essential catalyst to define the recognised industry approaches and targets seen today, and will continue to evoke productive change in the future.

Holistic reduction of transport emissions can also be seen with the improvement of vehicle efficiency of ICE based powertrains in projects such as **ECOCHAMPS** and **ORCA**. Commercialisation of this type of technology will likely help to improve state-of-the-art vehicle performance in the market and, ultimately, fleet average emissions as innovations reach more mainstream applications over time. Many of the technology topics included in EGVI were focused on increasing EV performance, which likely helped or will help to incentivise EV adoption, whilst others looked to improve vehicle design and concepts improving overall road transport efficiency. Topics on future materials and more efficient manufacturing processes could also have an impact on reducing energy usage – further reducing emissions.

LONG-TERM EU BENEFITS

Common and consistent themes related to long-term EU benefits identified in research:

- EGVI created a very strong R&D network for EU supply chain players, delivering increased robustness and competitiveness across the automotive and even adjacent industries compared to what would have been possible at a national level
- EGVI projects typically improved time-to-market capability by ~12 months for relevant technology and systems, likely increasing EU competitiveness in a rapidly changing global industry
- Network analysis showed that EGVI members – usually the more experienced industry players - took a more central and pivotal role in industry development, technology consensus and R&D strategy, which likely helped to define a highly relevant set of R&D topics within EGVI, and thus better support a transition to lower-carbon transport

3.4.5. Attractiveness

The strong perceived attractiveness of EGVI was, in part, linked to the success of networking aspects of the partnership and the positive benefits seen by participants. This included a broad range of networking events, conferences and activities, along with outreach efforts to attract new, capable participants from non-automotive sectors. Meanwhile, the clarity of communication and overall value and missions of the initiative were well known and recognised by industry and its key players.

Inclusive events bringing together key stakeholders were a critical part of network formation. EGVI was and is recognised as encouraging a broad enough range of networking, industry and other events to promote their organisation by ~98% of respondents. Examples of such events included the RTR and TRA conferences. In addition, close relationships and links between EGVI and other partnerships and agencies helped to broaden the range of options and exposure of participants.

Meanwhile, the programme worked to ensure that a breadth of participants were included from SMEs to multinationals. Participants were not just from an automotive background, but also featured those with relevant capabilities and experience from other sectors. From questionnaire analysis, over 85% perceived that EGVI successfully reached relevant, non-automotive organisations. By ensuring this exposure in the pre-competitive stage of R&D, it could mean that more robust green vehicle technology comes to market, accelerating decarbonisation of road transport.

EGVI's values and mission, i.e. to promote European research and innovation in order to improve the energy efficiency of road vehicles and expedite the transition to alternative powertrains, was reportedly widely recognised by industry with ~91% being aware of these aspirations. It should also be noted that cPPPs were originally established – in part – to help create the link between academic and industry R&D, to ensure that solutions not only deliver innovation but also have industrial or commercial applicability – allowing realisation of benefits and overcoming the “valley of death” of innovation. Evidence suggests that EGVI achieved this goal.

ATTRACTIVENESS

Common and consistent themes related to Attractiveness identified in research:

- Multiple events were organised throughout the EGVI programme to support networking amongst participants and the wider industry, which actively promoted the cPPP and its objectives/achievements
- A breadth of capabilities and experience were ensured through the inclusion of SMEs and non-automotive industry participants via a broad outreach programme
- It appears that the value and mission of EGVI met the needs and requirements of industry, as the initiative was well recognised and considered attractive to many stakeholders

3.4.6. EG VIA Added Value

EG VIA added value captures the manner in which EG VIA, the association forming the private side of the cPPP, was seen to be a critical driver and advantage of the EG VI programme. Success in this area was demonstrated from extensive feedback on the importance of EG VIA membership to long-term pre-competitive R&D collaboration strategy of the broader EG VI participant base. Further development and extension of a reliable and trusted network was cited as a key factor, assuring wide cross-industry collaboration even above and beyond that from EG VI. Network analysis conducted as part of the **FUTURE-HORIZON** project highlighted that EG VIA members were likely to have a greater number of connections, improved information flows, and more targeted connections to key actors in industry than non-members. This demonstrates how EG VIA helps to support expansion of professional networks and the creation of a more robust EU supply chain.

Additionally, project participants did mostly agree that there is a clear and simple process in place to support collaboration with the European Commission services during Work Programme drafting activities, which may have helped to define EG VI topics and ambitions to best serve societal interests.

EG VIA – now EG VIAfor2Zero – was cited as being a highly valued association, with membership reportedly warranting inclusion in the long-term pre-competitive R&D collaboration strategy of over 95% of respondents. In addition, some ~71% said that they considered EG VIA more attractive than other similar industry groups. A small majority even suggested a preference for collaboration with members over non-members.

The questionnaire highlighted that ~91% of participants thought EG VIA allowed more cross-industry collaborations than otherwise would have been achieved. This was helped by a good level of exposure to both public and private partners and the involvement of broad enough range of industries, companies and public bodies within the association according to participants.

Further to EG VI, additional opportunity for network development was provided by EG VIA. Networking events organised by the association and their dedicated team, helped with facilitation of multiple partner introductions and ongoing communications according to ~97% of respondents. Some 91% also reported that membership helped develop even more robust and reliable networks of trusted collaborators than would have been achieved from just the EG VI programme participation. Network analysis appeared to corroborate this finding, highlighting that EG VIA members were likely to have a greater number of connections, improved information flows, and more targeted connection to key actors in industry than non-members.

As an example in point, the **ASSURED** project featured 46 stakeholders from 12 EU countries, including SMEs, research organisations, academic institutions and private entities. This diversity broadened existing knowledge and also brought new perspectives to the achievement of challenging project objectives that improved the integration of electric commercial vehicle charging infrastructure into urban environments.

EGVIA ADDED VALUE

Common and consistent themes related to EGVIA added value identified in research:

- Over 95% of participants believed that the value of EGVIA membership warranted its inclusion in their long-term pre-competitive R&D collaboration strategy
- Cross-industry collaborations were part of the professional network expansion within EU supply chains and were directly enabled by EGVIA
- Networking events were organised and partner introductions and ongoing communications were ably facilitated by the EGVIA team

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5. APPENDIX

5.1. EGVI PROJECT LIST

Table 4 - EGVI project list

Family Grouping	Focus Area	Project
Electrification and batteries	1. Batteries	SPICY
		FIVE VB
		eCAIMAN
		HELIS
		ALISE
		GHOST
		ImodBATT
		IMAGE
		SPIDER
		Si-DRIVE
		LISA
	2. Modelling, testing and virtual development	OBELICS
		DEMOBASE
		HIFI ELEMENTS
		PANDA
		UPSCALE
		VISION-xEV
		XILforEV
	3. Energy Management	JOSPEL
		OSEM EV
		OPTEMUS
		XERIC
	4. EVs drivetrains	MODULED
		DRIVEMODE
		ReFreeDrive
	5. EVs Concept & Design	ESPRIT
		WEEVIL
		RESOLVE
		Silver Stream

Alternative fuels, hybridisation and low emission powertrains		EU-Live
		Quiet
		DOMUS
		URBANIZED
		Multi-Moby
		DREEM
		LEONARDO
		REFLECTIVE
	6. EV integration into the grid & transport system	EVERLASTING
		NEMO
		Electrific
		ASSURED
		ELVITEN
		STEVE
		USER-CHI
		INCIT-EV
	7. Integrated architectures, components and systems	eCharge4Drivers
		SYS2WHEEL
		EVC1000
		TELL
		1000kmPLUS
		SELFIE
		CEVOLVER
		i-HeCoBatt
	8. Hybridisation and alternative fuels powertrains	ACHILES
		FITGEN
		GASON
		ECOCHAMPS
		HDGAS
		THOMSON
		ORCA
		ADVICE
	9. Low emission ICE powertrains	COLHD
		LONGRUN
		PHOENICE
		PAREGEN
	10. Powertrain control	DIEPER
		UPGRADE
		EAGLE
		IMPERIUM
		OPTITRUCK

Transversal topics	11. Emission measurement	DOWNTOTEN
		Sureal 23
		PEMS4NANo
	12. Aerodynamic trucks	AEROFLEX
	13. Weight reduction and advanced materials	ALLIANCE
		LOCOMATECH
		REVOLUTION
		ALMA
		Fatigue4Light
		LEVIS
		FLAMINGo
International collaboration	14. International collaboration	SOLUTIONSPlus
Other	15. Other	ERA-NET EMEurope
		FUTURE-RADAR
		FUTURE-HORIZON

5.2. QUESTIONNAIRE SUMMARY

# Success Criteria Name	Question	Scoring
1. Relevance: Were specific objectives suitably aligned to Horizon 2020 goals and ambitious enough? Did the correct projects get chosen and prioritised to deliver the specific objectives? - Not applicable		
2. Effectiveness: To what extent have proposed and specific objectives been achieved?		3.5
2.2. Relevant KPI-based project objective achievement		4.2
2.2.1.	To what degree did your project achieve its original objectives? "Fully - 5, mostly - 3, partially - 1, not at all - 0"	3.9
2.2.2.	Did your project quantifiably contribute to green vehicle technology integration? "Yes physically - 5, yes in simulation - 3, no - 0"	4.4
2.2.3.	<i>Do you have any feedback related to your project's achievement of objectives?</i> Text box	N/A
2.4. Effective skills and knowledge development		3.0
2.4.1.	Have academic or training curricula been developed from this project and deployed by participants? "Yes multiple directly - 5, yes directly - 3, yes indirectly - 1, no - 0"	1.4
2.4.2.	Did your team/organisation gain in skills and knowledge? "Yes multiple directly - 5, yes directly - 3, yes indirectly - 1, no - 0"	4.0
2.4.3.	Has new technical knowledge been captured, documented and disseminated into public domain that could improve technology applications in industry now or in the future? "Yes multiple directly - 5, yes directly - 3, yes indirectly - 1, no - 0"	3.6

2.4.4.	Were new development methods created that may support the development and adoption of new technologies that reduce emissions/energy consumption for road vehicles? "Yes multiple directly - 5, yes directly - 3, yes indirectly - 1, no - 0"	3.2
2.4.5.	<i>Can you comment on any knowledge transfer, or new academic or training curricula that have resulted from your project?</i> Text box	N/A
2.5. Participation and benefits		3.0
2.5.1.	Did your project include SMEs as participants? "Yes - 5, no - 0"	3.3
2.5.2.	For the participant SMEs, did the EGVI project allow them to achieve more than they could have independently? Including financially, from sharing resources or other derisking investment	3.3
2.5.2.1.	Financially "Fully - 5, mostly - 3, partially - 1, not at all - 0"	3.7
2.5.2.2.	Sharing resources "Fully - 5, mostly - 3, partially - 1, not at all - 0"	3.3
2.5.2.3.	Derisking investment "Fully - 5, mostly - 3, partially - 1, not at all - 0"	2.8
2.5.3.	For the participant SMEs, how have they benefitted from the project outputs? Including technology commercialisation, secured customers, accelerated technology development, built future partnerships, increased resources based on project funding "Transformationally, significantly, slightly, not at all"	2.7
2.5.3.1.	Technology commercialisation "Transformationally, significantly, slightly, not at all"	2.3
2.5.3.2.	Secured customers "Transformationally, significantly, slightly, not at all"	1.8
2.5.3.3.	Accelerated technology development "Transformationally, significantly, slightly, not at all"	3.1

2.5.3.4.	Built future partnerships "Transformationally, significantly, slightly, not at all"	3.4
2.5.3.5.	Increased resources based on project funding "Transformationally, significantly, slightly, not at all"	2.9
2.5.4.	For non-SME participants, did the EGVI project allow them to achieve more than they could have independently? Including financially, from sharing resources or other derisking investment "Fully, mostly, partially, not at all"	3.0
2.5.4.1.	Financially "Fully - 5, mostly - 3, partially - 1, not at all - 0"	3.0
2.5.4.2.	Sharing resources "Fully - 5, mostly - 3, partially - 1, not at all - 0"	3.3
2.5.4.3.	Derisking investment "Fully - 5, mostly - 3, partially - 1, not at all - 0"	2.7
2.5.5.	For non-SME participants, how have they benefitted from the project outputs? Including technology commercialisation, secured customers, accelerated technology development, built future partnerships, increased resources based on project funding "Transformationally - 5, significantly - 3, slightly - 1, not at all - 0"	2.5
2.5.5.1.	Technology commercialisation "Transformationally - 5, significantly - 3, slightly - 1, not at all - 0"	2.2
2.5.5.2.	Secured customers "Transformationally - 5, significantly - 3, slightly - 1, not at all - 0"	1.6
2.5.5.3.	Accelerated technology development "Transformationally - 5, significantly - 3, slightly - 1, not at all - 0"	3.1
2.5.5.4.	Built future partnerships "Transformationally - 5, significantly - 3, slightly - 1, not at all - 0"	3.2
2.5.5.5.	Increased resources based on project funding "Transformationally - 5, significantly - 3, slightly - 1, not at all - 0"	2.7

2.10. Private/additional investment in areas of EGVI projects		3.2
2.10.1.	Have participant organisations contributed further private/additional investment in the project topic or supporting areas following EGVI project completion? "Yes more than EGVI project funding - 5, yes less than EGVI project funding - 3, no - 0"	3.1
2.10.2.	Have any longer term working agreements between participants been developed following EGVI project completion? E.g. shared research, pilot studies, other EU- or national funded projects, or other activities "Yes as a direct result - 5, yes not as a direct result - 3, no - 0"	3.4
2.11. Effects on participants' own R&I strategies		3.9
2.11.1.	Did the project fit into your predefined R&I strategy as a continuation of internal development activities or was it seen as a way to test higher risk or more innovative solutions that were not covered internally? "Continuation, exploratory, other"; "other" to have text input option	N/A
2.11.2.	How much have the project results been integrated in your predefined R&I strategy? "Significantly - 5, partially - 3, not at all - 0"	3.9
3. Efficiency: Could the specific objectives have been delivered at lower cost, reduced time or higher quality?		3.5
3.3. Social benefits		2.9
3.3.1.	Do you think that your project is likely to positively influence long term employment figures within the EU? "Yes directly - 5, yes indirectly - 3, no - 0, unsure - 0"	2.8
3.3.2.	Did any project participants hire permanent staff as a result of the EGVI project? "Yes directly - 5, yes indirectly - 3, no - 0"	2.9
3.3.3.	Have project participants announced retraining opportunities for employees to support future company operations? Particularly in light of decarbonisation topics, skills transition and long term growth aspirations "Yes - 5, no - 0"	2.3
3.3.4.	Are any participant companies anticipating related operational expansion prior to 2030? This could include new facilities, capacity expansions or in-housing of new competence "Yes - 5, no - 0"	3.5

3.4. Investment efficiency		4.2
3.4.1.	Do participants get better return on investment during EGVI projects than they would independently? Please also consider reduced duplication of efforts between participants in your answer "Yes directly - 5, yes indirectly - 3, no - 0"	3.7
3.4.2.	Has your organisation been able to progress further with R&D activities through participation in EGVI projects than would have been possible otherwise given budget constraints? "Yes directly - 5, yes indirectly - 3, no - 0"	4.5
3.4.3.	Has the output of the project or associated learnings enabled you or other participant organisations to be more targeted or effective with R&D in the future? "Yes directly - 5, yes indirectly - 3, no - 0"	4.4
4. Long-term EU benefits		3.1
4.2. Contributions to new standards		2.4
4.2.1.	Do you believe that any EU regulations or standards that have been developed or are in development have been supported by outputs of your EGVI project? "Yes multiple - 5, yes one - 3, no - 0"	1.4
4.2.2.	Did outputs of the project lead to frameworks, white papers etc. that could potentially influence the development of future EU standards? "Yes multiple - 5, yes one - 3, no - 0"	2.2
4.2.3.	Has a consensus been developed amongst the project participants that may influence independent company R&D strategies, leading to improved technology compatibility and integration efficiency? "Yes directly - 5, likely indirectly - 3, no - 0"	3.4
4.3. Time-to-market improvement		3.2
4.3.1.	Do you believe that participation in your EGVI project has contributed to a faster time-to-market for a technology, process or other deliverable for participants or broader EU community? "Not at all - 0, less than 6 months - 1, 6-12 months - 3, 12-24 months - 4, more than 24 months - 5"	3.2

4.4. Network development		3.8
4.4.1.	As applicable, has being an EGVI member or participating in an EGVI project expanded your professional network in the EU supply chain? "Yes directly - 5, yes indirectly - 3, no - 0, not a member - 0"	4.2
4.4.2.	Have you remained in contact with fellow project participants following project completion? "Yes on related opportunities - 5, yes on unrelated opportunities - 3, no - 0"	4.5
4.4.3.	Were connections made with other EGVI projects and participants during project delivery? "Yes - 5, no - 0"	4.3
4.4.4.	Have new related connections been made following, and as a result of, the project? "Yes - 5, no - 0"	4.2
4.4.5.	Has the EGVI programme made it easier to conduct research with international partners within the EU? "Fundamentally - 5, significantly - 3, partially - 1, not at all - 0"	3.2
4.4.6.	Would you have been able to carry out a similar project with national partners only? "Fully - 0, mostly - 1, partially - 3, not at all - 5"	3.7
4.4.7.	If Work Programmes in the area of green vehicles and decarbonisation would be defined and organised without the support of the EGVI partnership (e.g. via non PPP-related Horizon 2020/ Horizon Europe Work Programmes), how much impact would this have on your organisation? "Fundamentally - 5, significantly - 3, partially - 1, not at all - 0"	2.1
4.4.8.	Can you comment on the network development benefits of EGVI project participation? Text box	N/A
5. Attractiveness		3.5
5.1. EGVI communication and outreach		4.7
5.1.1.	Does the EGVI programme encourage a broad enough range of networking, industry and other events to promote their organisation? "Yes - 5, no - 0"	4.9
5.1.2.	Is the EGVI programme and its value and mission recognised by industry? "Yes - 5, no - 0"	4.6

5.2. EG VIA attractiveness		3.9
5.2.1.	Are you considering EG VIA membership in the long term as part of your pre-competitive R&D collaboration strategy? "Yes - 5, no - 0"	4.8
5.2.2.	Is EG VIA membership more attractive to your organisation than other similar industry groups? "Yes - 5, no - 0"	4.0
5.2.3.	Do you view EG VIA members in a more positive light than non-members when it comes to collaboration opportunities? "Yes - 5, no - 0"	2.8
5.3. EG VI cross-industry accessibility		1.9
5.3.1.	Does the EG VI programme provide broad enough outreach to those relevant but not necessarily yet active within EG VI-related industry? "Yes - 5, no - 0"	4.3
5.3.2.	Did you predominantly operate outside of the automotive industry before participating in an EG VI project? "Fully - 5, mostly - 3, partially - 1, not at all - 0"	0.9
5.3.3.	Was your EG VI project the main enabler for you entering the automotive industry? "Yes - 5, no - 0, not applicable - 0"	0.3
6. EG VIA value add		4.0
6.1. EG VIA networking opportunity		4.6
6.1.1.	Did the EG VIA team and their networking events help in facilitation of multiple partner introductions and ongoing communication? "Yes - 5, no - 0"	4.8
6.1.2.	Did being an EG VIA partner provide the opportunity to establish a reliable network and ecosystem of trusted collaborators that would not otherwise have been? "Yes - 5, no - 0"	4.6
6.1.3.	Do you have a good level of exposure to both public and private partners within EG VIA? "Yes, no"	4.4
6.1.4.	Does EG VIA include a broad enough range of industries, companies and public bodies to support your requirements? "Yes - 5, no - 0"	4.6
6.1.5.	Did networking in the context of a public-private partnership like EG VI support relevant cross-industry collaborations that may have otherwise not happened? "Yes - 5, no - 0"	4.6

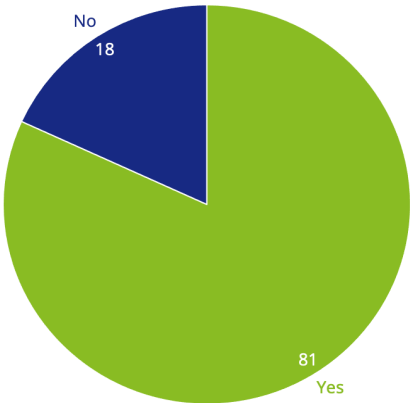
6.2. EG VIA collaboration process		3.7
6.2.1.	Were the EG VIA team able to guide, support and intermediate the collaboration process? "Fully - 5, mostly - 3, partially - 1, not at all - 0"	3.1
6.2.2.	Was there a clear and simple process in place to support collaboration with the European Commission services while drafting the Work Programmes? "Yes - 5, no - 0"	4.1
6.2.3.	In the context of EGVI, to what extent have your concerns, issues and questions been addressed/answered by the European Commission? "Fully - 5, mostly - 3, partially - 1, not at all - 0"	2.6
6.2.4.	Were EG VIA partners clearly aligned on EG VIA objectives and supportive in relevant situations? "Yes - 5, no - 0"	4.8
6.3. EG VIA relevance and ambition		3.7
6.3.1.	To what extent have R&I priorities of EG VIA members have been covered in the EGVI Work Programmes? "Fully - 5, mostly - 3, partially - 1, not at all - 0"	3.0
6.3.2.	How do you consider the overall level of ambition of EGVI topics? "Too much - 0, enough - 5, too little - 0"	4.4
6.4. EG VIA value add		4.1
6.4.1.	Were EG VIA able to use past experience to help with overall ease of networking or collaboration? "Yes directly - 5, yes indirectly - 3, no - 0"	4.2
6.4.2.	Have you extended your R&I network, as a result of EG VIA membership? "Yes directly - 5, yes indirectly - 3, no - 0"	4.0

5.3. QUESTIONNAIRE RESPONSE ANALYSIS

EGVI project achievement of proposed and specific objectives

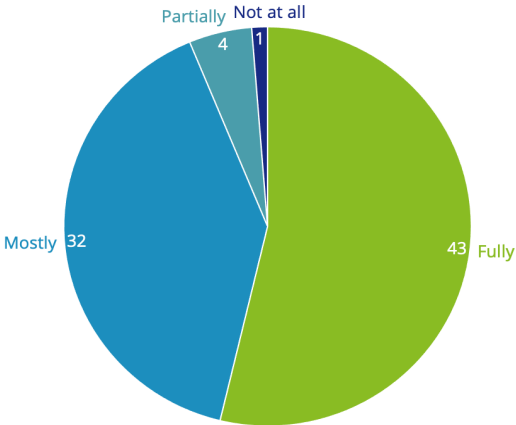
Effectiveness

Did your organisation participate in any EGVI funded projects from 2014-2020?



Source: Questionnaire responses

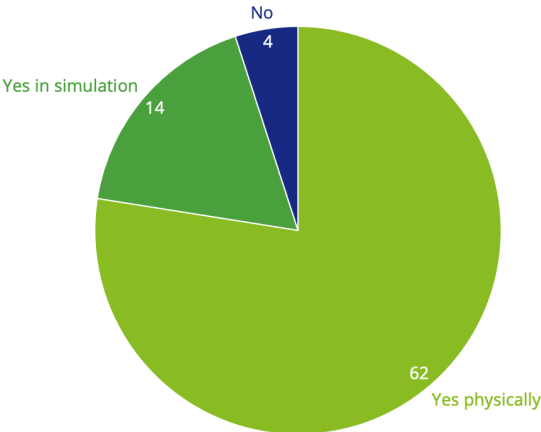
2.2.1. To what degree did your project achieve its original objectives?



EGVI project achievement of proposed and specific objectives

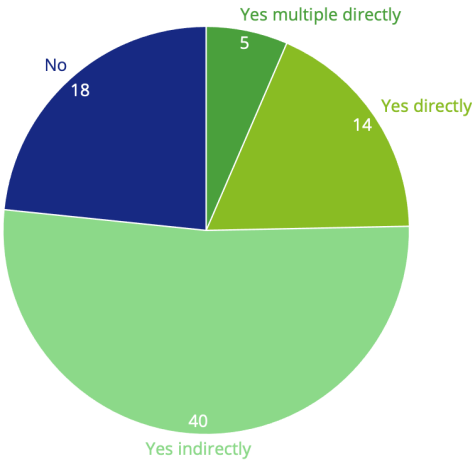
Effectiveness

2.2.2. Did your project quantifiably contribute to green vehicle technology integration?



Source: Questionnaire responses

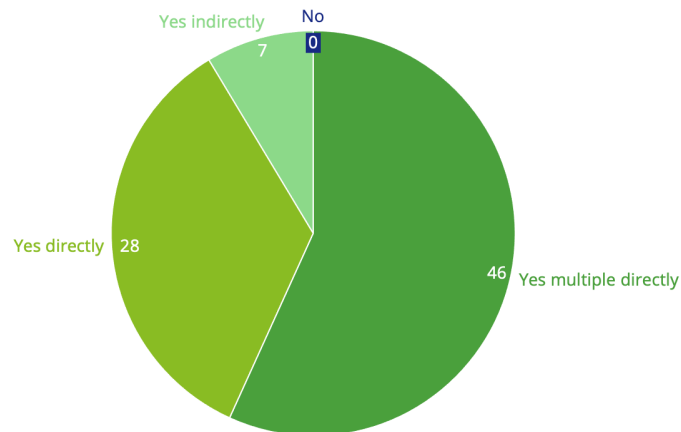
2.4.1. Have academic or training curricula been developed from this project and deployed by participants?



EGVI project achievement of proposed and specific objectives

Effectiveness

2.4.2. Did your team/organisation gain in skills and knowledge?

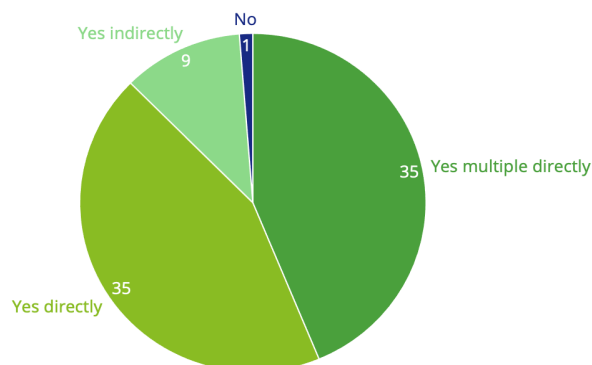


Source: Questionnaire responses

EGVI project achievement of proposed and specific objectives

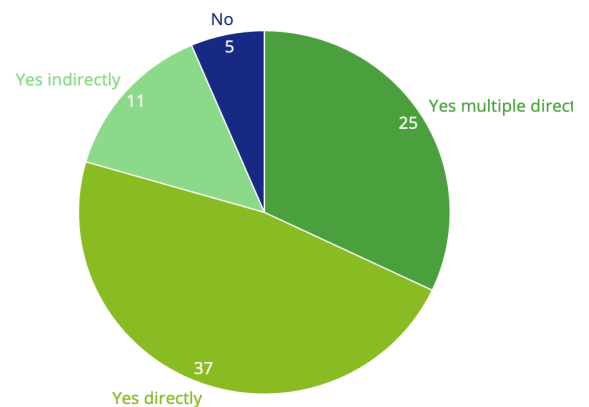
Effectiveness

2.4.3. Has new technical knowledge been captured, documented and disseminated into public domain that could improve technology applications to reduce emissions/energy consumption for road vehicles in industry now or in the future?



Source: Questionnaire responses

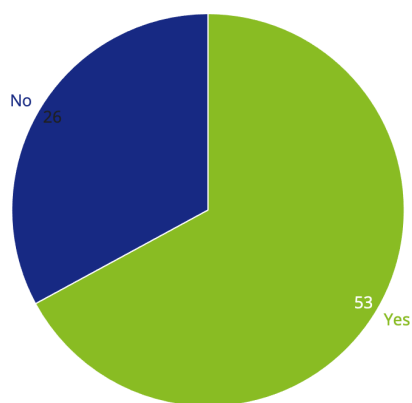
2.4.4. Were new development methods created that may support the development and adoption of new technologies that reduce emissions/energy consumption for road vehicles?



EGVI project achievement of proposed and specific objectives

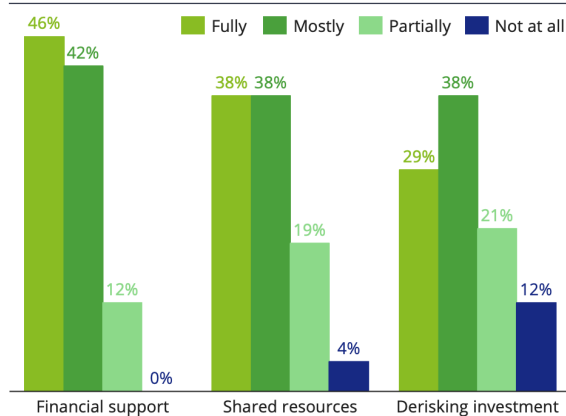
Effectiveness

2.5.1. Did your project include SMEs as participants?



1) Rounded figures may not add to 100%
Source: Questionnaire responses

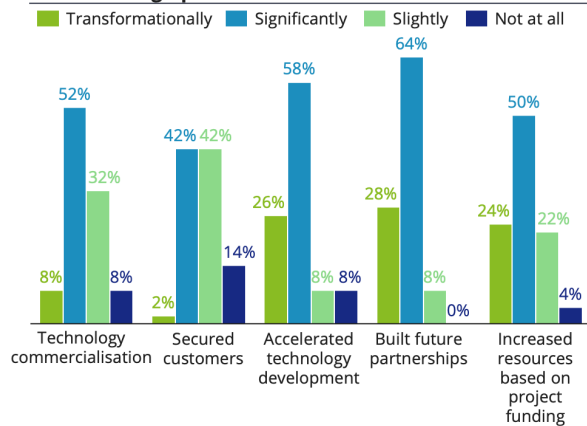
2.5.2. For the participant SMEs, did the EGVI project allow them to achieve more than they could have independently? Please consider the following options¹



EGVI project achievement of proposed and specific objectives

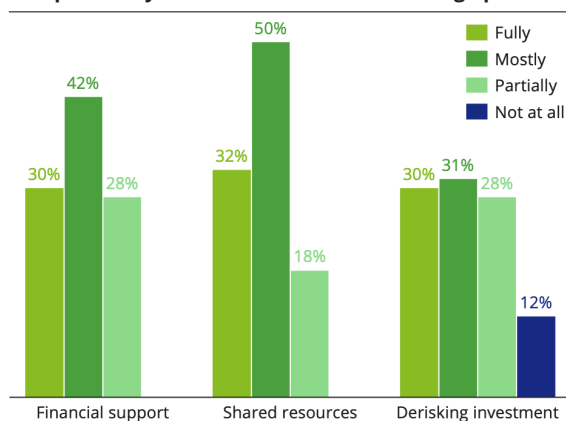
Effectiveness

2.5.3. For the participant SMEs, how have they benefitted from the project outputs? Please consider the following options¹



1) Rounded figures may not add to 100%
Source: Questionnaire responses

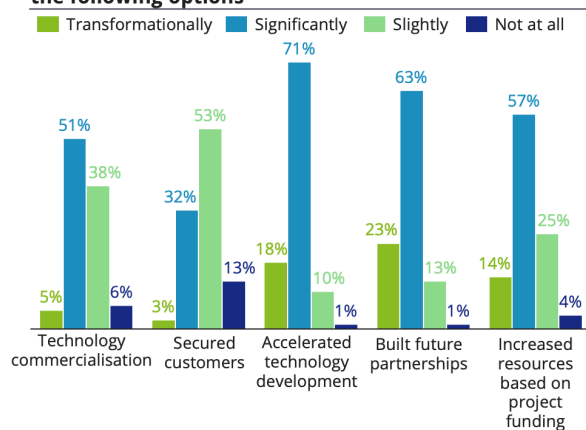
2.5.4. For non-SME participants, did the EGVI project allow them to achieve more than they could have independently? Please consider the following options¹



EGVI project achievement of proposed and specific objectives

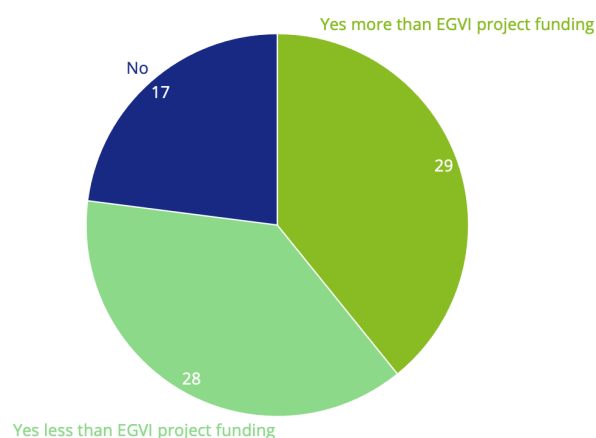
Effectiveness

2.5.5. For the participant non-SMEs, how have they benefitted from the project outputs? Please consider the following options¹



1) Rounded figures may not add to 100%
Source: Questionnaire responses

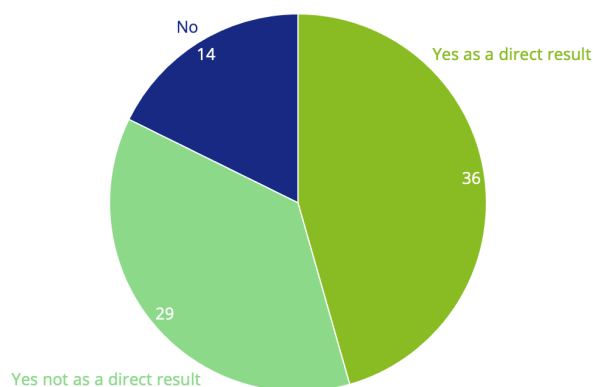
2.10.1. Have participant organisations contributed further private/additional investment in the project topic or supporting areas following EGVI project completion?



EGVI project achievement of proposed and specific objectives

Effectiveness

2.10.2. Have any longer term working agreements between participants been developed following EGVI project completion? E.g. shared research, pilot studies, other EU- or national funded projects, or other activities

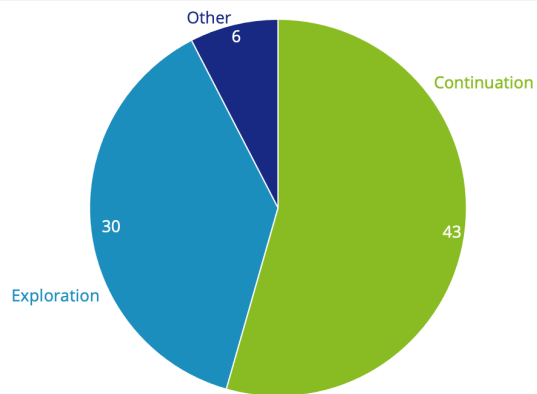


Source: Questionnaire responses

EGVI project achievement of proposed and specific objectives

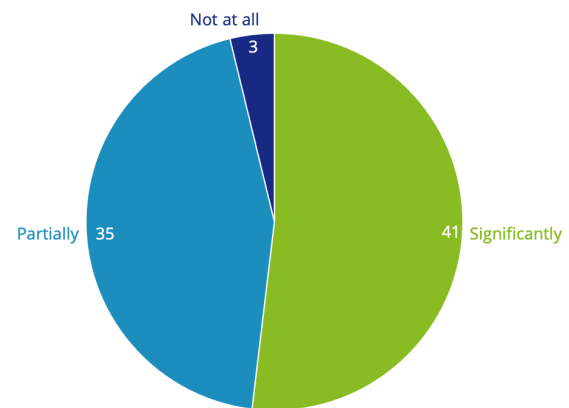
Effectiveness

2.11.1. Did the project fit into your predefined R&I strategy as a continuation of internal development activities or was it seen as a way to test higher risk or more innovative solutions that were not covered internally?



Source: Questionnaire responses

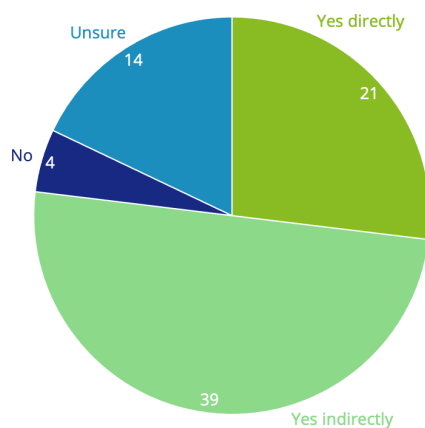
2.11.2. How much have the project results been integrated in your predefined R&I strategy?



EGVI project outputs that impacted efficiency with regards to long term employment figures and project participant hiring activities

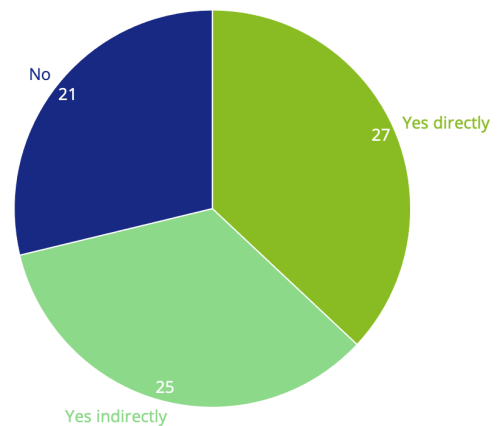
Efficiency

3.3.1. Do you think that your project is likely to positively influence long term employment figures within the EU?



Source: Questionnaire responses

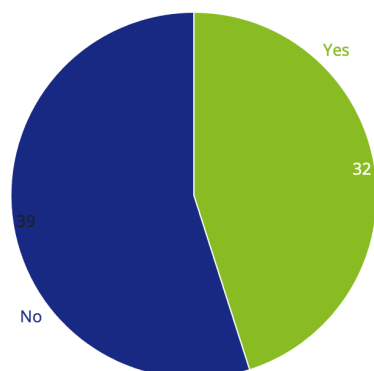
3.3.2. Did any project participants hire permanent staff as a result of the EGVI project?



EGVI project outputs that impacted efficiency with regards to retraining opportunities and operational expansion of participant organisations

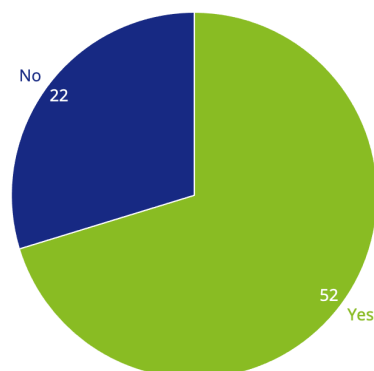
Efficiency

3.3.3. Have project participants announced retraining opportunities for employees to support future company operations? Particularly in light of decarbonisation topics, skills transition and long term growth aspirations



Source: Questionnaire responses

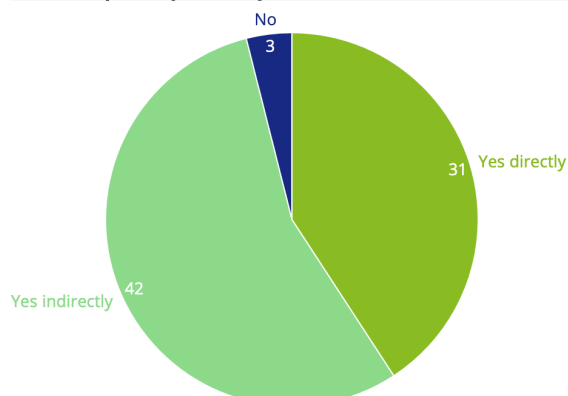
3.3.4. Are any participant companies anticipating related operational expansion prior to 2030? This could include new facilities, capacity expansions or in-housing of new competence



EGVI project outputs that impacted efficiency with regards to return on investment and R&D activity progression

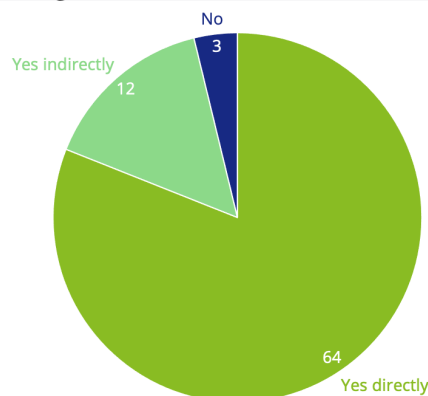
Efficiency

3.4.1. Do participants get better return on investment during EGVI projects than they would independently? Please also consider reduced duplication of efforts between participants in your answer



Source: Questionnaire responses

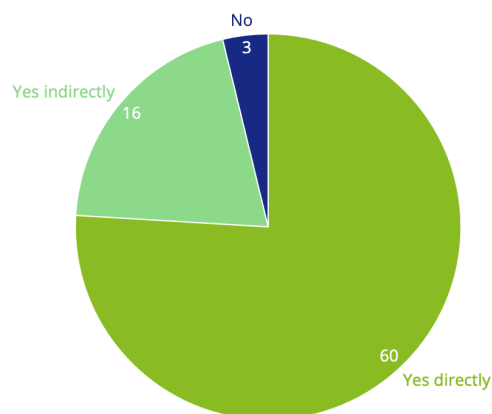
3.4.2. Has your organisation been able to progress further with R&D activities through participation in EGVI projects than would have been possible otherwise given budget constraints?



EGVI project outputs that impacted efficiency with regards to potentially enabling more targeted or effective R&D in the future

Efficiency

3.4.3. Has the output of the project or associated learnings enabled you or other participant organisations to be more targeted or effective with R&D in the future?

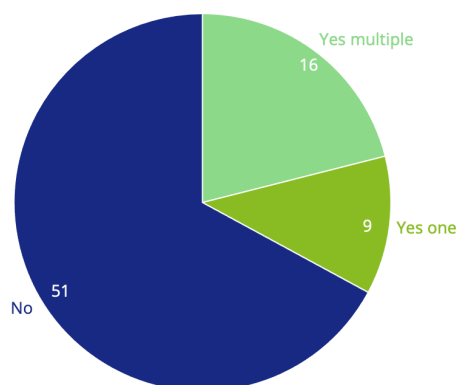


Source: Questionnaire responses

EGVI project outputs value add to the EU and the value add from an EU-wide Public Private Partnership

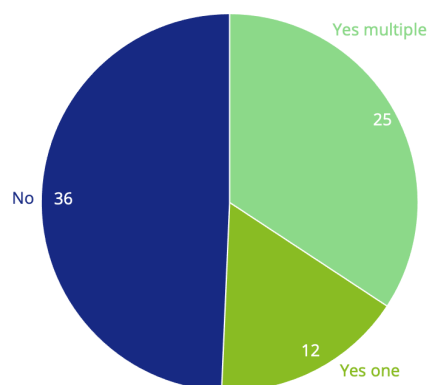
Added Value to the EU / From EU-wide Public Private Partnership

4.2.1. Do you believe that any EU regulations or standards that have been developed or are in development have been supported by outputs of your EGVI project?



Source: Questionnaire responses

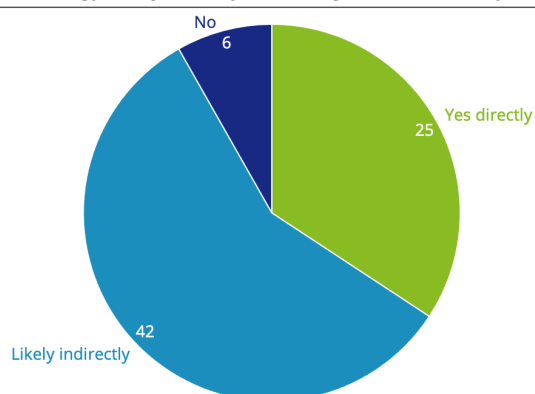
4.2.2. Did outputs of the project lead to frameworks, white papers etc. that could potentially influence the development of future EU standards?



EGVI project outputs value add to the EU and the value add from an EU-wide Public Private Partnership

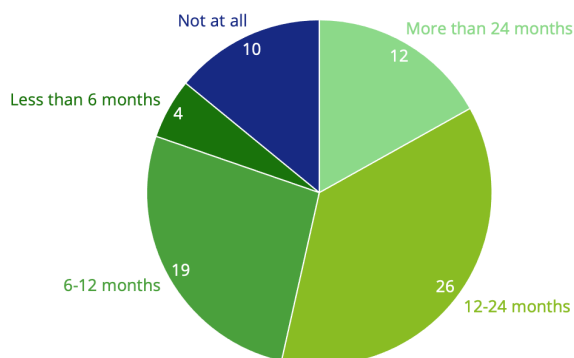
Added Value to the EU / From EU-wide Public Private Partnership

4.2.3. Has a consensus been developed amongst the project participants that may influence independent company R&D strategies, leading to improved technology compatibility and integration efficiency?



Source: Questionnaire responses

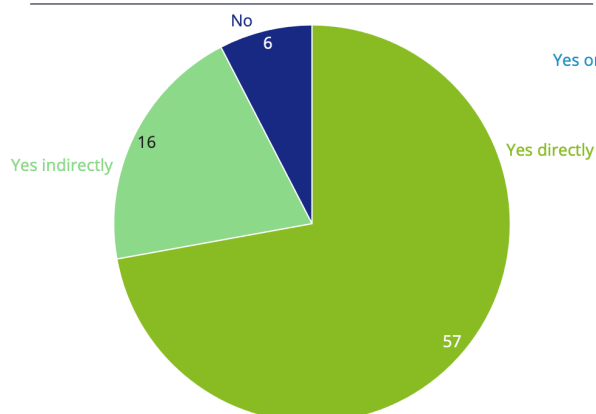
4.3.1. Do you believe that participation in your EGVI project has contributed to a faster time-to-market for a technology, process or other deliverable for participants or the broader EU community?



EGVI project outputs value add to the EU and the value add from an EU-wide Public Private Partnership

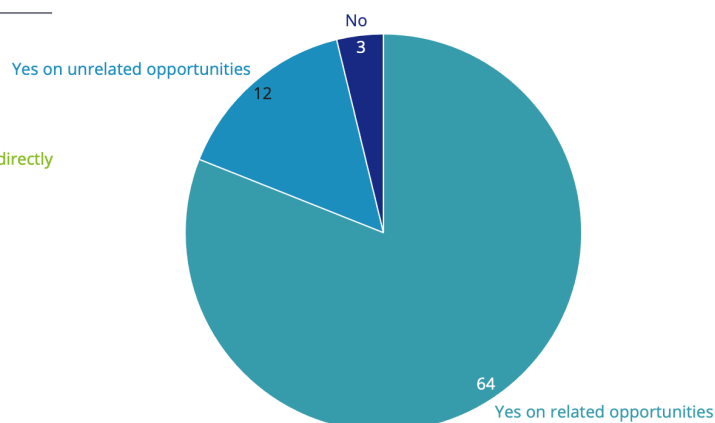
Added Value to the EU / From EU-wide Public Private Partnership

4.4.1. As applicable, has being an EGVI member or participating in an EGVI project expanded your professional network in the EU supply chain?



Source: Questionnaire responses

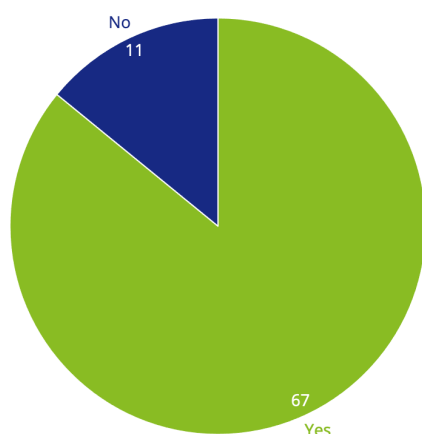
4.4.2. Have you remained in contact with fellow project participants following project completion?



EGVI project outputs value add to the EU and the value add from an EU-wide Public Private Partnership

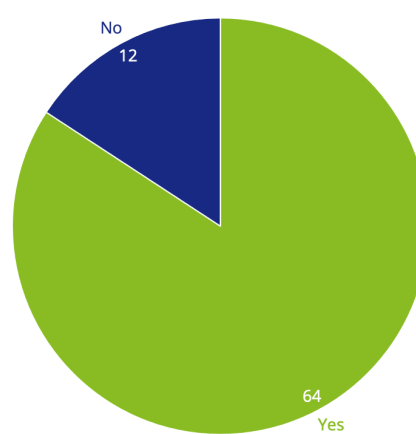
Added Value to the EU / From EU-wide Public Private Partnership

4.4.3. Were connections made with other EGVI projects and participants during project delivery?



Source: Questionnaire responses

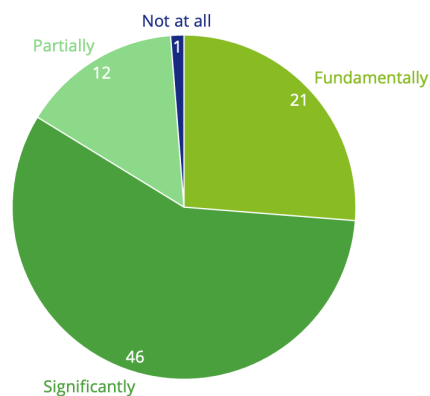
4.4.4. Have new related connections been made following, and as a result of, the project?



EGVI project outputs value add to the EU and the value add from an EU-wide Public Private Partnership

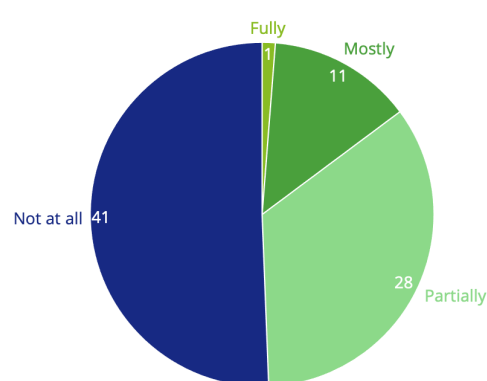
Added Value to the EU / From EU-wide Public Private Partnership

4.4.5. Has the EGVI programme made it easier to conduct research with international partners within the EU?



Source: Questionnaire responses

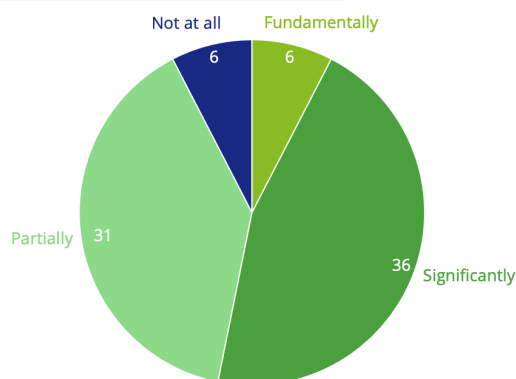
4.4.6. Would you have been able to carry out a similar project with national partners only?



EGVI project outputs value add to the EU and the value add from an EU-wide Public Private Partnership

Added Value to the EU / From EU-wide Public Private Partnership

4.4.7. If work programmes in the area of green vehicles and decarbonisation would be defined and organised without the support of the EGVI partnership (e.g. via non PPP-related Horizon 2020/ Horizon Europe Work Programmes), how much impact would this have on your organisation?

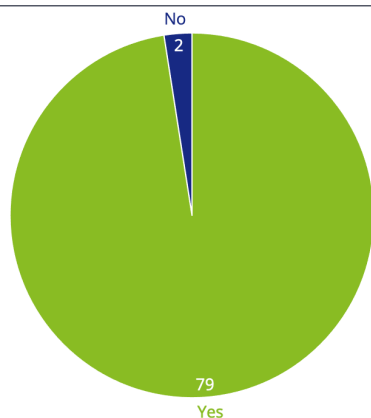


Source: Questionnaire responses

EGVI programme attractiveness to participants

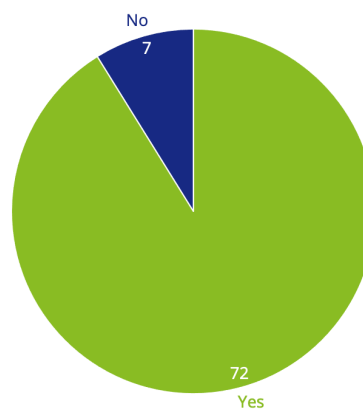
Attractiveness

5.1.1. Does the EGVI programme encourage a broad enough range of networking, industry and other events to promote their organisation?



Source: Questionnaire responses

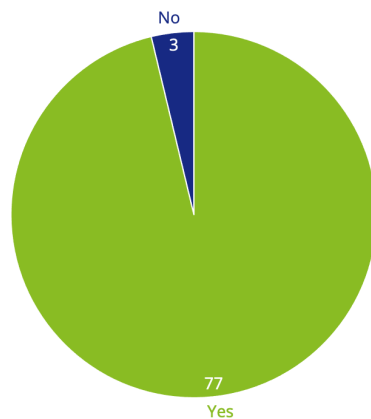
5.1.2. Is EGVI programme and its value and mission recognised by industry?



EGVI programme attractiveness to participants

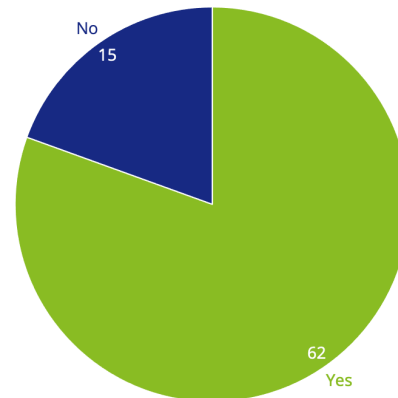
Attractiveness

5.2.1. Are you considering EGVI membership in the long term as part of your pre-competitive R&D collaboration strategy?



Source: Questionnaire responses

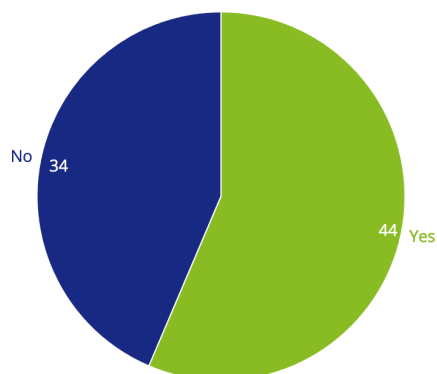
5.2.2. Is EGVI membership more attractive to your organisation than other similar industry groups?



EGVI programme attractiveness to participants

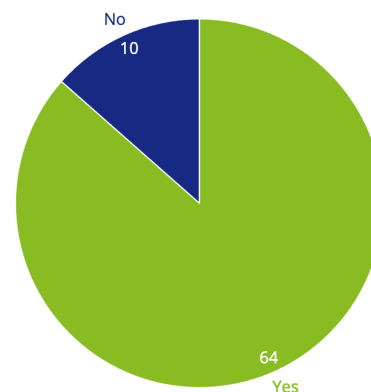
Attractiveness

5.2.3. Do you view EGVI members in a more positive light than non-members when it comes to collaboration opportunities?



Source: Questionnaire responses

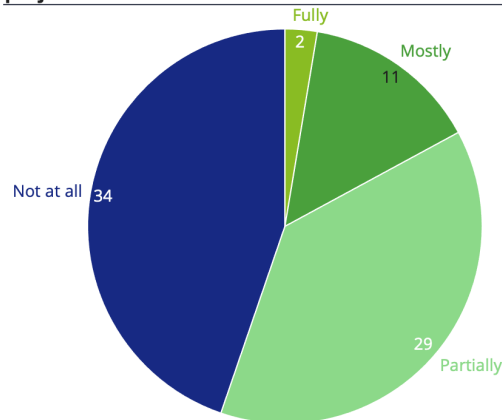
5.3.1. Does the EGVI programme provide broad enough outreach to those relevant but not necessarily yet active within EGVI-related industry?



EGVI programme attractiveness to participants

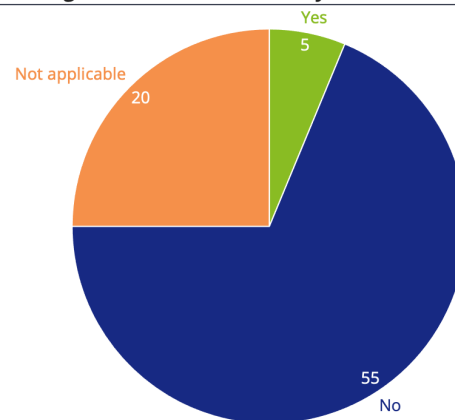
Attractiveness

5.3.2. Did you predominantly operate outside of the automotive industry before participating in an EGVI project?



Source: Questionnaire responses

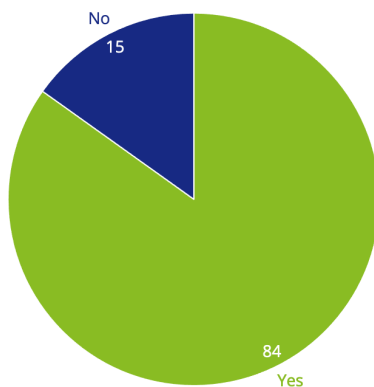
5.3.3. Was your EGVI project the main enabler for you entering the automotive industry?



EGVIAfor2Zero member networking and collaboration benefits

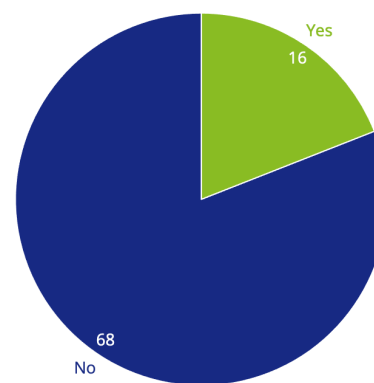
Ease of Implementation

Are you an EGVIA member?



Source: Questionnaire responses

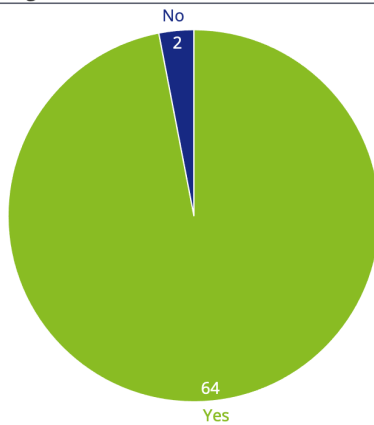
Have you already completed this questionnaire for another EGVI project or in response to better understanding EGVIA membership benefits?



EGVIAfor2Zero member networking and collaboration benefits

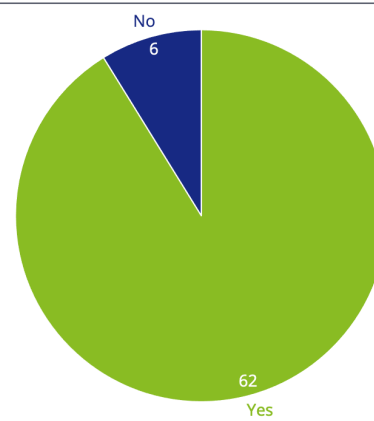
Ease of Implementation

6.1.1. Did the EGVIA team and their networking events help in facilitation of multiple partner introductions and ongoing communication?



Source: Questionnaire responses

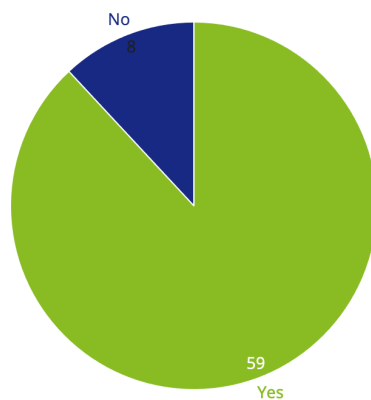
6.1.2. Did being an EGVIA partner provide the opportunity to establish a reliable network and ecosystem of trusted collaborators that would not otherwise have been?



EGVIAfor2Zero member networking and collaboration benefits

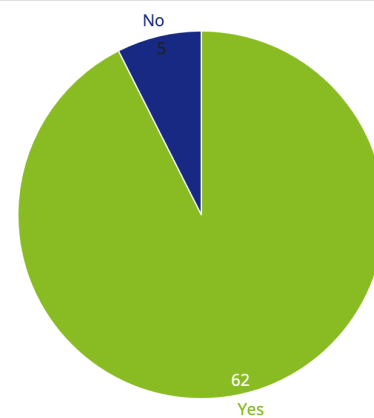
Ease of Implementation

6.1.3. Do you have a good level of exposure to both public and private partners within EGVIA?



Source: Questionnaire responses

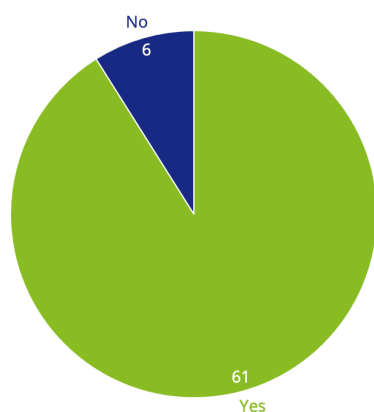
6.1.4. Does EGVIA include a broad enough range of industries, companies and public bodies to support your requirements?



EGVIAfor2Zero member networking and collaboration benefits

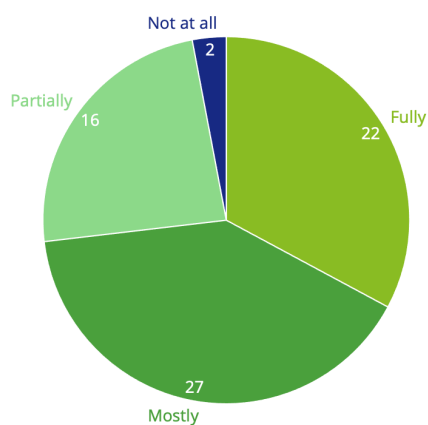
Ease of Implementation

6.1.5. Did networking in the context of a public-private partnership like EGVI support relevant cross-industry collaborations that may have otherwise not happened?



Source: Questionnaire responses

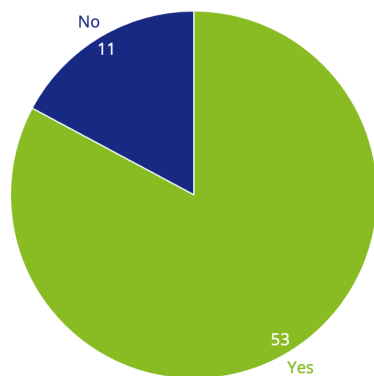
6.2.1. Were the EGVIA team able to guide, support and intermediate the collaboration process?



EGVIAfor2Zero member networking and collaboration benefits

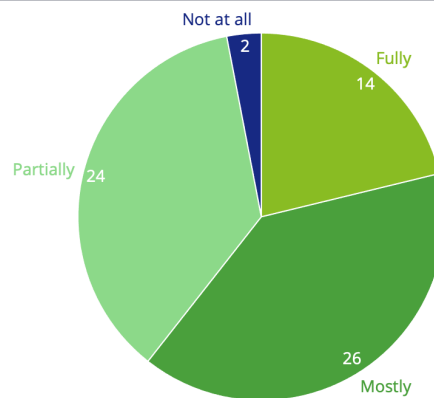
Ease of Implementation

6.2.2. Was there a clear and simple process in place to support collaboration with the European Commission services while drafting the Work Programmes?



Source: Questionnaire responses

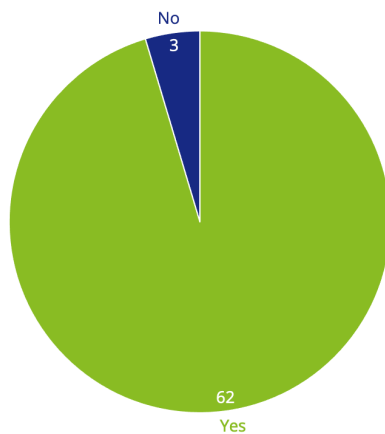
6.2.3. In the context of EGVI, to what extent have your concerns, issues and questions been addressed/answered by the European Commission?



EGVIAfor2Zero member networking and collaboration benefits

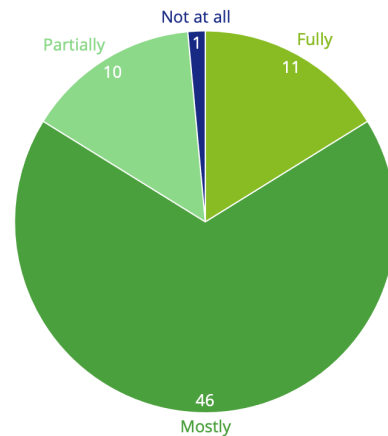
Ease of Implementation

6.2.4. Were EGVIA partners clearly aligned on EGVIA objectives and supportive in relevant situations?



Source: Questionnaire responses

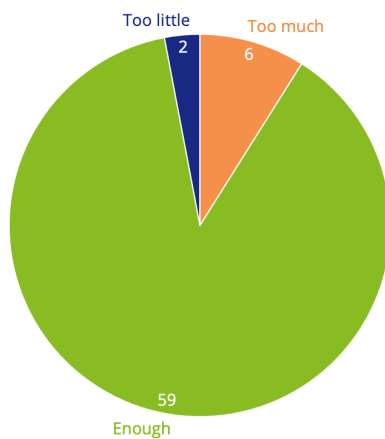
6.3.1. To what extent R&I priorities of EGVIA members have been covered in the EGVIA Work Programmes?



EGVIAfor2Zero member networking and collaboration benefits

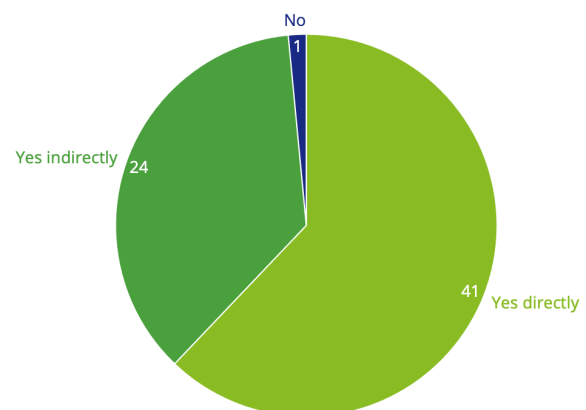
Ease of Implementation

6.3.2. How do you consider the overall level of ambition of EGVIA topics?



Source: Questionnaire responses

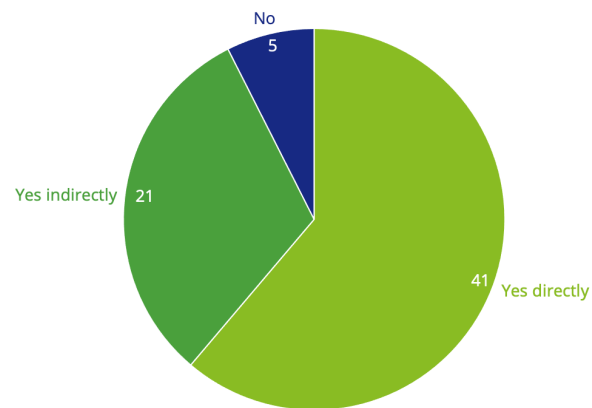
6.4.1. Were EGVIA able to use past experience to help with overall ease of networking or collaboration?



EGVIAfor2Zero member networking and collaboration benefits

Ease of Implementation

6.4.2. Have you extended your R&I network, as a result of EGVIA membership?



Source: Questionnaire responses

5.4. QUESTIONNAIRE TECHNOLOGY TOPIC AND PROJECTS MAPPING

On average, interviewees believe that a substantial level of green vehicle technology integration and associated skills and knowledge have been generated by EGVI

Technology Topic Breakdown

Technology Topic	Responses, #	2.2.2. Average ¹	2.4.2. Average ²	2.4.3. Average ³	2.4.4. Average ⁴	Average
International collaboration	1	5.0	5.0	5.0	5.0	5.0
Weight reduction & advanced materials	4	5.0	5.0	4.5	4.0	4.6
Emission measurement	2	4.0	4.0	5.0	5.0	4.5
Integrated architectures, components & systems	10	4.8	4.6	4.0	3.6	4.3
Energy management at vehicle level	2	5.0	5.0	4.0	3.0	4.3
EV integration into the grid & transport system	9	4.8	3.7	4.1	3.9	4.1
EVs drivetrains	3	5.0	3.0	3.7	4.3	4.0
Low emission ICE powertrains	4	5.0	3.5	3.5	3.7	3.9
Powertrain control	2	4.0	4.0	5.0	2.0	3.8
Vehicle concept & design	9	5.0	4.1	2.7	3.0	3.7
Modelling, testing & virtual development	9	3.7	4.3	3.4	3.2	3.7
Aerodynamic trucks	3	5.0	3.0	3.0	3.7	3.7
Vehicle hybridisation & alt fuel ICE powertrains	5	4.6	3.8	3.4	0.6	3.1
Batteries	6	2.2	3.7	3.3	2.5	2.9

1) Did your project quantifiably contribute to green vehicle technology integration?; 2) Did your team/organisation gain in skills & knowledge?; 3) Has new tech. knowledge been documented/disseminated publicly that may improve industry tech. applications now/in the future?; 4) Were new development methods created that may support the development/adoption of new technologies that reduce road vehicle emissions/energy consumption?

EGVI demonstrated integration of more than 35 innovative technologies in green vehicles and mobility system solutions, >20 relating to innovative powertrain systems and technologies

Technology Integration: Questionnaire Analysis¹ (1/3)

Integration Target	Technology Topic	Project
Innovation areas	EV integration into the grid & transport system	USER-CHI
Innovation areas	Batteries	FiveVB
Innovation areas	EV integration into the grid & transport system	INCIT-EV
Innovation areas	EV integration into the grid & transport system	eCharge4Drivers
Innovation areas	EVs drivetrains	Refreedrive
Innovation areas	Modelling, testing and virtual development	OBELICS
Innovation areas	EV integration into the grid & transport system	ASSURED
Innovation areas	Batteries	iModBatt
Innovation areas	EVs drivetrains	ModulED
Innovative powertrain	Modelling, testing and virtual development	XILforEV
Innovation areas	Integrated architectures, components and systems	SELFIE
Innovation areas	EV integration into the grid & transport system	ELVITEN
Innovation areas	Integrated architectures, components and systems	FITGEN
Innovative powertrain	Integrated architectures, components and systems	EVC1000

1) As demonstrated by questionnaire responses only
Source: Questionnaire

EGVI demonstrated integration of more than 35 innovative technologies in green vehicles and mobility system solutions, >20 relating to innovative powertrain systems and technologies

Technology Integration: Questionnaire Analysis¹ (2/3)

Integration Target	Technology Topic	Project
Innovative powertrain	Aerodynamic trucks	AEROFLEX
Innovative powertrain	Vehicle Concept & Design	ESPRIT
Innovative powertrain	Integrated architectures, components and systems	1000kmPLUS
Innovative powertrain	Vehicle hybridisation and alternative fuels ICE powertrains	GasOn
Innovative powertrain	Integrated architectures, components and systems	CEVOLVER
Innovative powertrain	Vehicle Concept & Design	RESOLVE
Innovative powertrain	Vehicle Concept & Design	Multi-Moby
Innovative powertrain	Energy Management at vehicle level	Optemus
Innovative powertrain	Vehicle Concept & Design	DOMUS
Innovative powertrain	Vehicle hybridisation and alternative fuels ICE powertrains	LONGRUN
Innovative powertrain	Vehicle Concept & Design	QUIET
Innovative powertrain	Powertrain control	optiTRUCK
Innovative powertrain	Vehicle hybridisation and alternative fuels ICE powertrains	ADVICE
Innovative powertrain	Weight reduction and advanced materials	ALMA

1) As demonstrated by questionnaire responses only
Source: Questionnaire

EGVI demonstrated integration of more than 35 innovative technologies in green vehicles and mobility system solutions, >20 relating to innovative powertrain systems and technologies

Technology Integration: Questionnaire Analysis¹ (3/3)

Integration Target	Technology Topic	Project
Innovative powertrain	International Collaboration	SOLUTIONSplus
Innovative powertrain	Integrated architectures, components and systems	ACHILES
Innovative powertrain	Vehicle hybridisation and alternative fuels ICE powertrains	ECOCHAMPS
Innovative powertrain	Modelling, testing and virtual development	PANDA
Innovative powertrain	Integrated architectures, components and systems	ACHILES
Innovative powertrain	Weight reduction and advanced materials	ALLIANCE
Innovative powertrain	Weight reduction and advanced materials	LoCoMaTech
Innovative powertrain	Weight reduction and advanced materials	Fatigue4Light

From questionnaire respondent's feedback, more than 35 innovative technologies in green vehicles and mobility system solutions were integrated and physically demonstrated in EGVI

1) As demonstrated by questionnaire responses only
Source: Questionnaire

5.5. INTERVIEWEE QUESTION TEMPLATES

Table 5 - Project participants and private side partners

Question	Response	Keywords / tags
What projects have you been involved with during the EGVI programme? What role have you taken on these projects?		
Were the projects a success and why? Did they achieve all of their objectives?		
Have the projects and their outputs been a success for your organisation? Have outputs been commercialised?		
Have outputs resulted in organisational growth? Revenue/funding, employees, capabilities?		
Have projects resulted in further internal research? Have other cPPP funded projects followed from these EGVI projects? E.g. Horizon Europe		
Was the support and funding from EGVI critical to the research being completed? Could you have done it without EGVI?		
How the multinational nature of the EGVI programme a significant contributor to the projects' success? How did having multinational partners provide a benefit beyond national research programmes?		
How does EU funded research benefits others in the EU?		
Did being an EGVI member provide the opportunity to establish a reliable network and ecosystem of trusted collaborators that would not otherwise have been? Have you extended your R&I network, as a result of EGVI membership?		
To what extent have R&I priorities of EGVI members have been covered in the EGVI Work Programmes?		
What have been the biggest challenges facing the automotive and road transport industries over the last decade? What are the biggest challenges you see facing the automotive and road transport industry currently?		

Table 6 - European Commission and public side partners

Question	Response	Keywords / tags
What has your involvement been with EGVI and how do you interface with the contractual Public-Private Partnership (cPPP)? Is this an interaction through DG RTD or do you have more of a direct link?		
Do you believe that this mechanism, e.g. interacting with EGVI through a DG RTD gatekeeper, is an effective and efficient way to best implement EU-funded projects? Are there any potential opportunities for improvements or issues with the approach?		
Do you believe there is enough collaboration across the European Technology Platforms, cPPPs and other bodies to support holistic automotive and road transport solutions?		
If you are able to comment, what would you say is the success criteria for an EGVI project? How does this success impact your goals and aspirations?		
How important do you think that commercialisation is to the value and impact of EU-funded projects such as EGVI or others in your remit?		
Do EU-funded projects often result in privately funded research? Do you see there being an important scaling effect from cPPP funded projects to increase overall investment totals? Is there a part to play for "continuation projects" in EU-funding mechanisms?		
Was the support and funding from Horizon 2020, through the cPPP mechanism, e.g. EGVI, critical to the research being completed? Could it have been completed without such funding?		
To what extent and in what way do you believe that Work Programmes reflect the needs of industry and society more generally? Are you able to comment on EGVI specifically? What would you like to see more of from similar programmes in the future?		
Who is the beneficiary of EGVI EU-funded projects?		
How does the multinational nature of the cPPPs contribute to overall programme impact in the EU? What benefits are there beyond national research programmes?		
How important are cPPPs for the ongoing competitiveness and development of the EU in terms of research and innovation? How do the cPPPs support DG goals and aspirations in a general sense? If possible, any specific EGVI feedback would be appreciated		

5.6. INTERVIEW OUTPUT SUMMARY

Table 7 -Thematic interview analysis with metathemes and themes

#	Metathemes and Themes	Keyphrase Count
1	Skills, Knowledge and Capability Development	75
	Access to Broader EU Competence	15
	External Resource, Competence and Skill Sharing	6
	Increased Knowledge Dissemination	7
	International Competence	2
	Organisational Capability Development	19
	Workforce Skills and Training	26
2	Network	33
	Business Development Opportunity	11
	Informal Partner Ecosystem through EGVI Events	3
	Marketing	2
	Network and Partner Development	13
	Positive View on Non-Member Support	1
	Supportive Formal Network through Project Developed Relationships	3
3	Additional Private and/or Other Investment	29
	Further cPPP Project Funding	2
	National Investment	1
	Potential Private Investment	1
	Private Investment	18
	Privately Funded Research	7
4	Commercialisation	29
	Commercial Impact	18
	Potential Commercial Impact	11
5	Seeding Research and Innovation	29
	Advancement of Early Stage Research	3
	EC Funding Criticality	6
	Potential Commercial Impact	6
	Private Resource Commitment	1
	Research Continuation	1
	Research Enablement	2
	Tangible Outputs	4
	Technology Maturation	6

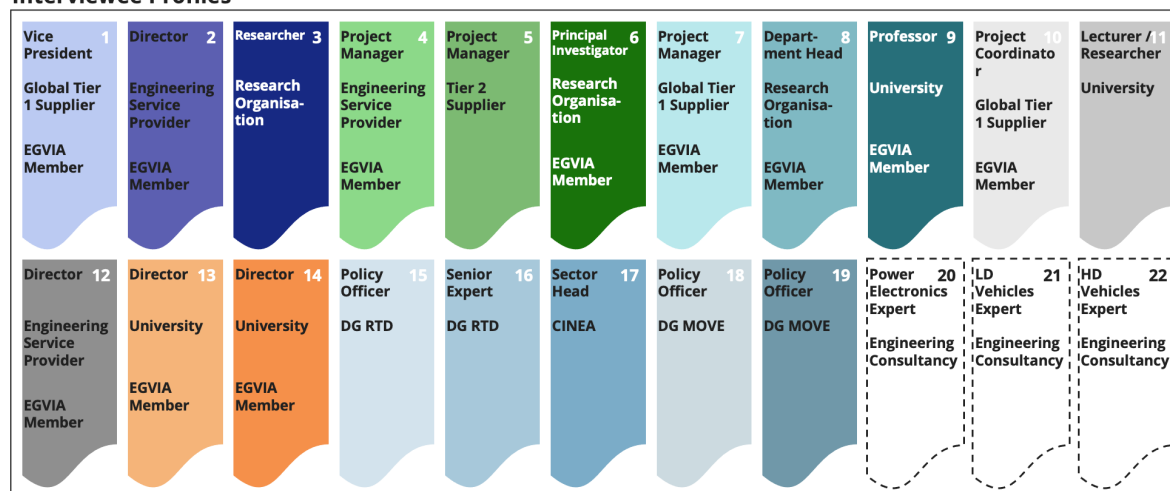
6	Topic Relevance and Ambition	29
	Ambitious Industry Targets and Goals	1
	EC Funding Mechanism Adaptability and Relevance	5
	Equitable and Relevant R&I Calls for Industry Participants	20
	Long-term Industry Vision and Aspiration	3
7	Investment Efficiency	28
	Benefits in Not Achieving Project Objectives	6
	Investment Efficiency	6
	More Robust Solutions, Greater Efficiency and Synergy Benefits from R&I Network Activities	1
	Most or All Project Objectives Achieved	5
	Research Enablement	4
	Risk and Cost Sharing	6
8	Industrial Strategy	23
	EU Competitiveness and Technical Leadership	12
	EU Levelling Up	9
	Long-term Industry Vision and Aspiration	2
9	Collaboration	17
	External Resource, Competence and Skill Sharing	1
	Network and Partner Development	1
	Positive View on Non-Member Support	1
	Unique, Innovative and Collaborative Environment	14
10	Consensus	15
	EU Vision and Aspiration Alignment	1
	Industry Consensus and Organisational Direction	11
	Long-term Industry Vision and Aspiration	3
11	Diversity	15
	Better Industry Access and Links to Academia	1
	Diverse Ideas and Perspectives	13
	SME funding	1
12	Standardisation, Legislation and Policy	9
	Faster Time-to-Market	1
	Robust Legislative Frameworks Developed in Parallel to Road Transport Solutions	2
	Technology Standardisation	6
13	Synergies	9
	Combination of Project Outputs to Deliver Synergies and Integrated Solutions	1
	Cross-sector Benefits and Synergies	4
	More Robust Solutions, Greater Efficiency and Synergy Benefits from R&I Network Activities	4

14	Jobs, Societal and Environmental Benefits	9
	Broader Societal Benefits	2
	Employment Opportunity	2
	End User Benefits from EGVI Project Outputs	2
	Environmental Benefits	1
	Job Creation	2
15	Time to market	8
	Faster Time-to-Market	8

5.7. INTERVIEW THEMES

During the impact assessment, 22 stakeholders were interviewed from a diverse range of backgrounds, 19 of which supported our thematic analysis

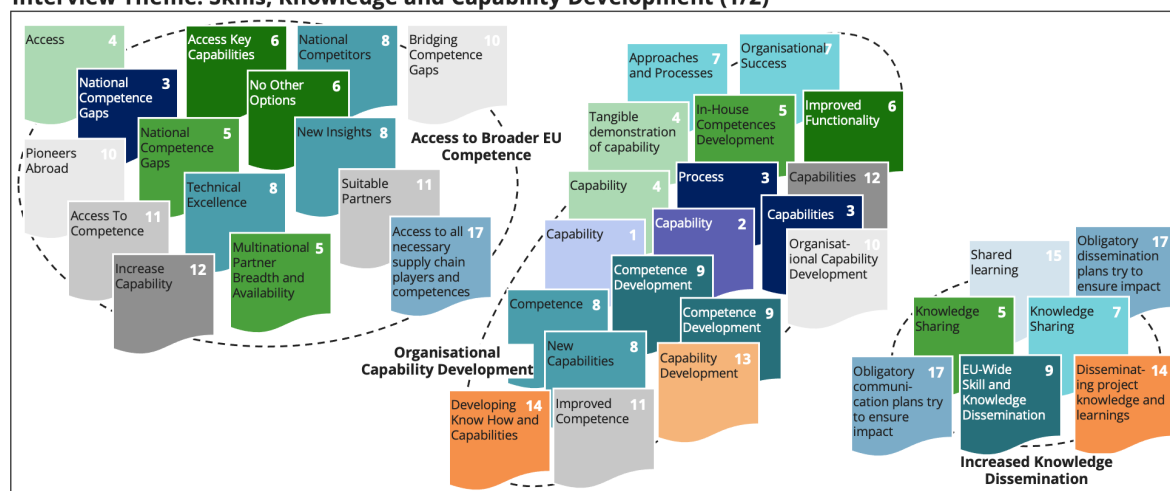
Interviewee Profiles



Source: SE, Selected EGVI Participants, Selected EG VIA Members

Six themes form the *skills, knowledge and capability development* metatheme including development of organisational capability, increased knowledge dissemination...

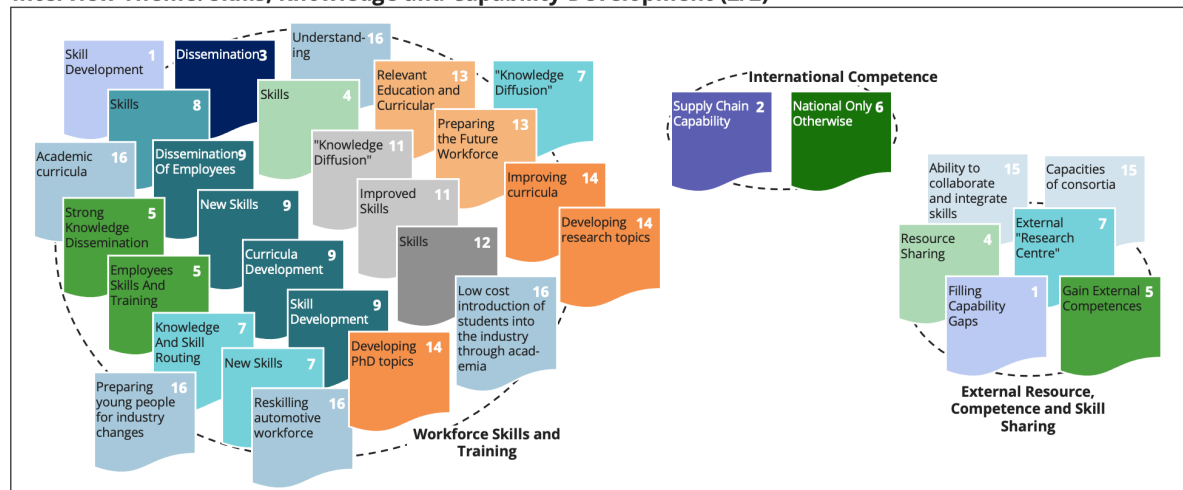
Interview Theme: Skills, Knowledge and Capability Development (1/2)



Source: SE, Selected EGVI Participants, Selected EG VIA Members

...workforce skills and training, as well as access to external resource, competence and skills specifically between EU countries

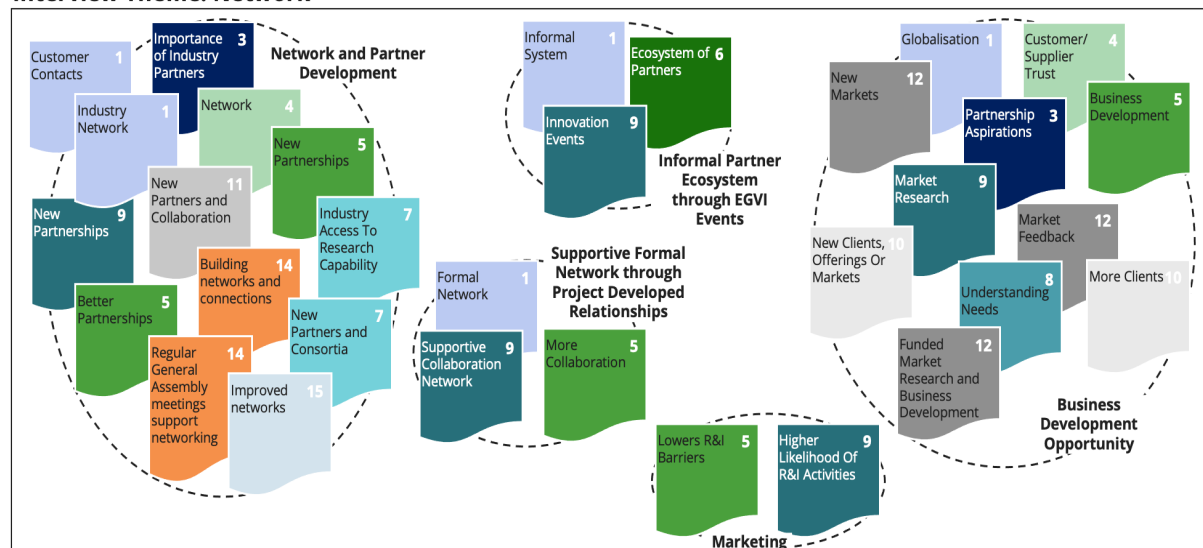
Interview Theme: Skills, Knowledge and Capability Development (2/2)



Source: SE, Selected EGVI Participants, Selected EGVI Members

Five themes emerge relating to EGVI's *network* with lots of positive feedback, including formal and informal partner development, as well as increase business opportunities

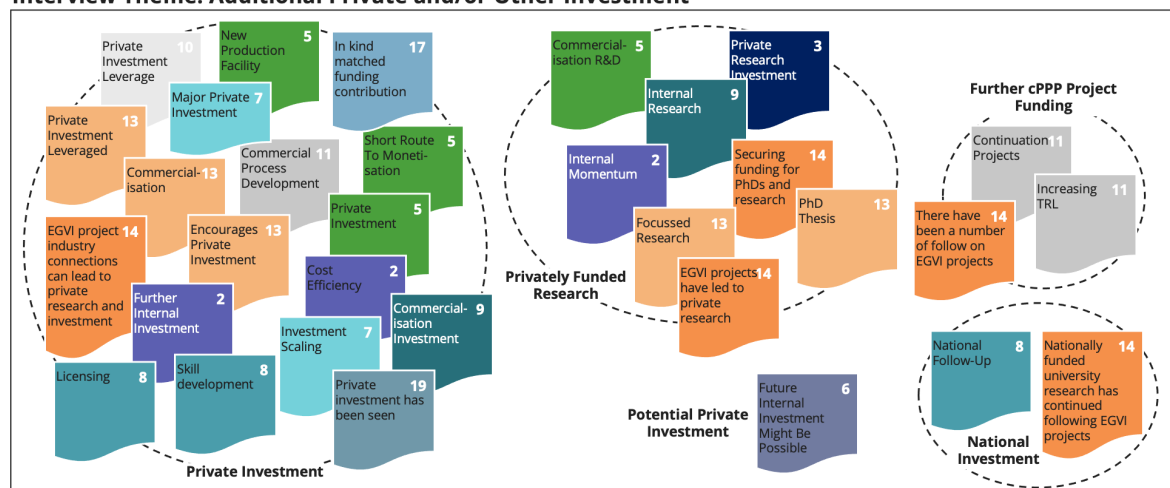
Interview Theme: Network



Source: SE, Selected EGVI Participants, Selected EGVI Members

Five themes highlight how EGVI led to *additional private and/or other investment* from either organisations, national governments or further cPPP funding

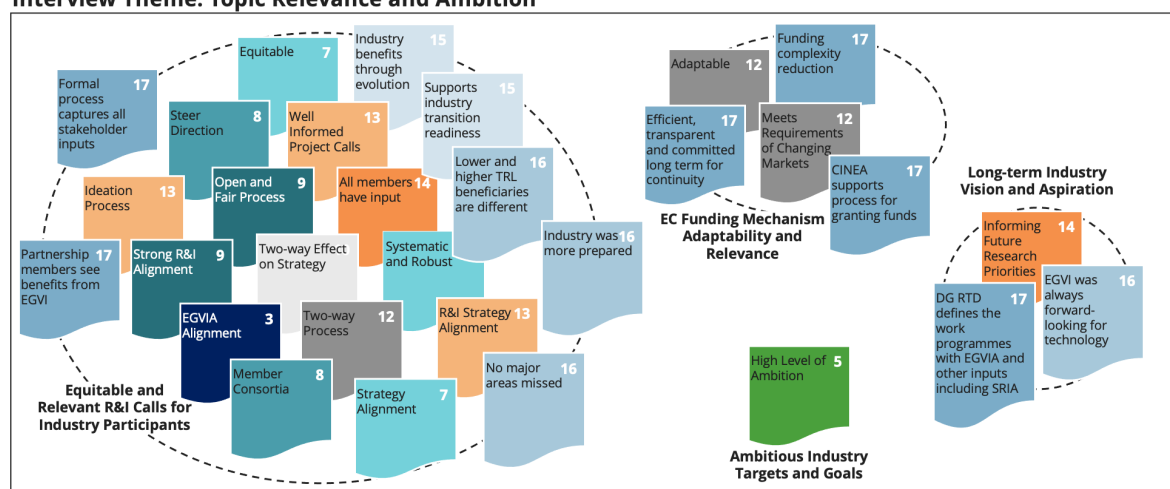
Interview Theme: Additional Private and/or Other Investment



Source: SE, Selected EGVI Participants, Selected EGVI Members

Four themes demonstrate how EGVI helped support the relevance of EGVI funding calls and developed appropriately ambitious topic goals

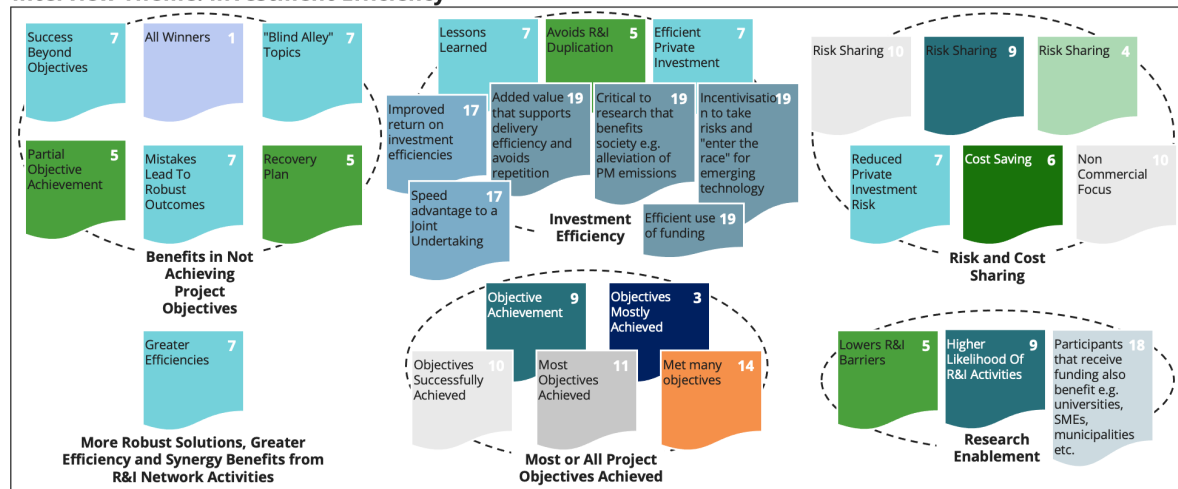
Interview Theme: Topic Relevance and Ambition



Source: SE, Selected EGVI Participants, Selected EGVI Members

Six themes link to *investment efficiency* either directly, e.g. projects achieving objectives, or indirectly e.g. developing key learnings not captured in project objectives

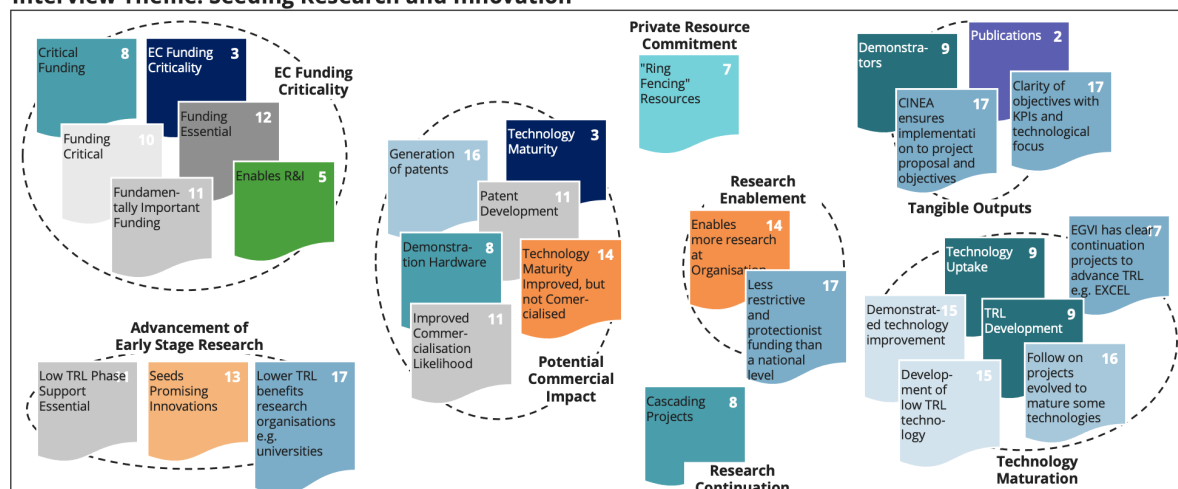
Interview Theme: Investment Efficiency



Source: SE, Selected EGVl Participants, Selected EGVIA Members

Eight themes relate to *seeding R&I*, highlighting EC funding criticality in enabling research and maturing technologies, which often furthers the chance of commercialisation impact

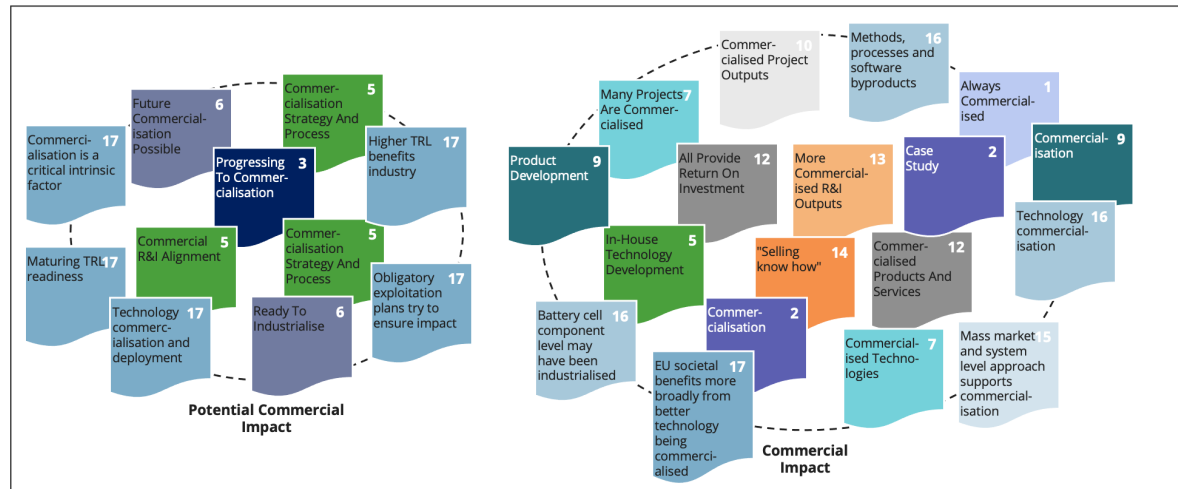
Interview Theme: Seeding Research and Innovation



Source: SE, Selected EGVl Participants, Selected EGVIA Members

Two themes related to *commercialisation*, depending on technology maturity, either there was actual commercialisation or there was future potential following EGVI projects

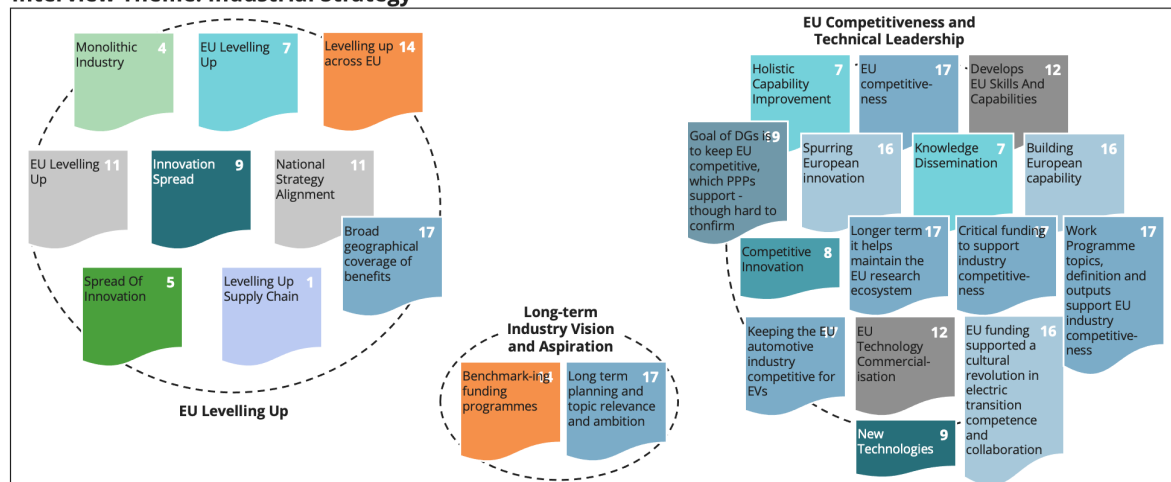
Interview Theme: Commercialisation



Source: SE, Selected EGVI Participants, Selected EGVI Members

Three themes were apparent that related to *industrial strategy* from EU levelling up, long-term industry vision and aspiration, and overall EU competitiveness and technical leadership

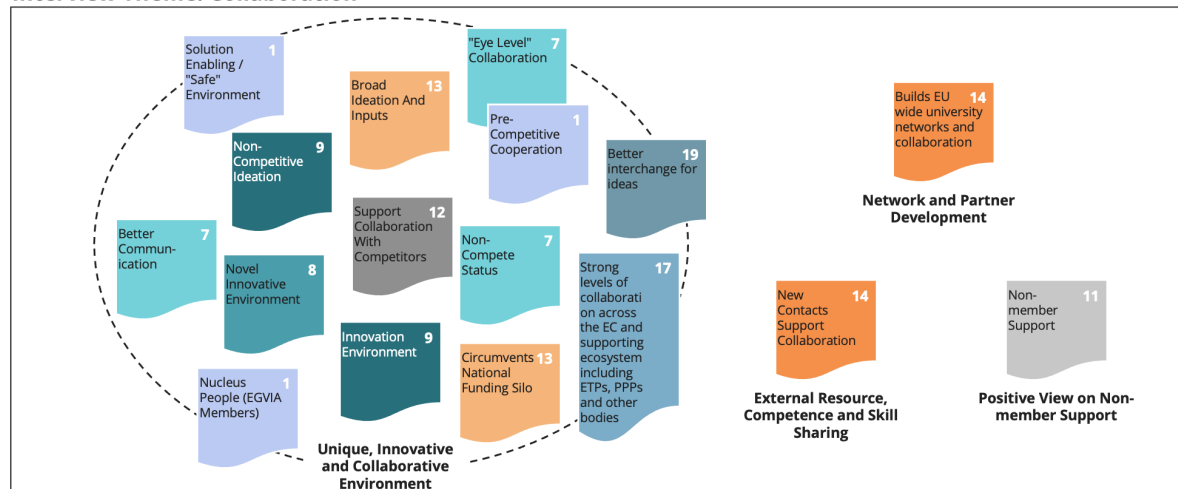
Interview Theme: Industrial Strategy



Source: SE, Selected EGVI Participants, Selected EGVI Members

Four themes related to *collaboration*, including a unique environment, skill sharing, partner networks, and non-member support as benefits

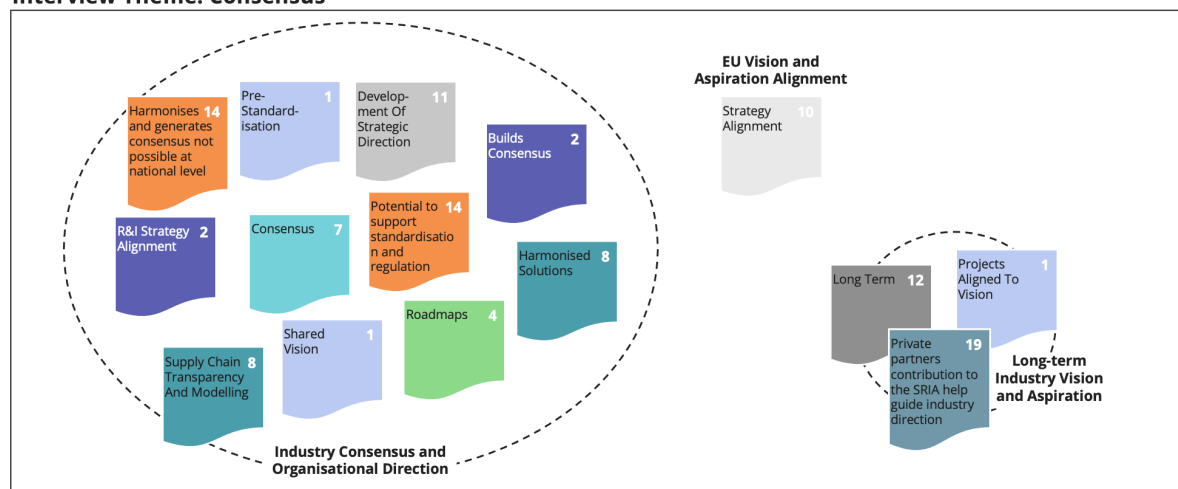
Interview Theme: Collaboration



Source: SE, Selected EGVIA Participants, Selected EGVIA Members

Three themes associated to *consensus* became apparent, showing links from industry aspiration to consensus and beyond to a broader EU vision

Interview Theme: Consensus

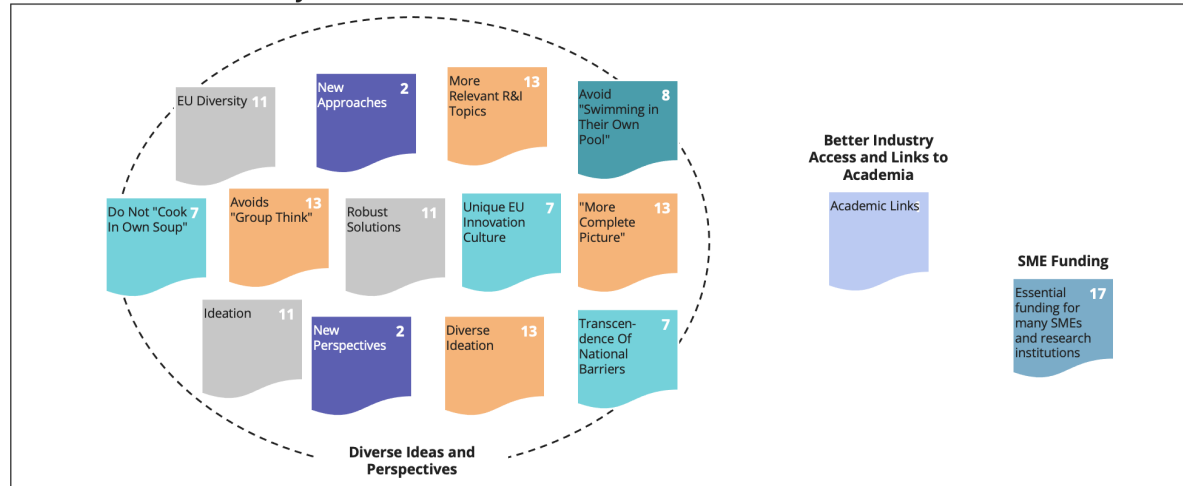


Source: SE, Selected EGVIA Participants, Selected EGVIA Members



Three themes reference *diversity* benefits including the availability of diverse ideas and perspectives, better industry links to academia and SME funding

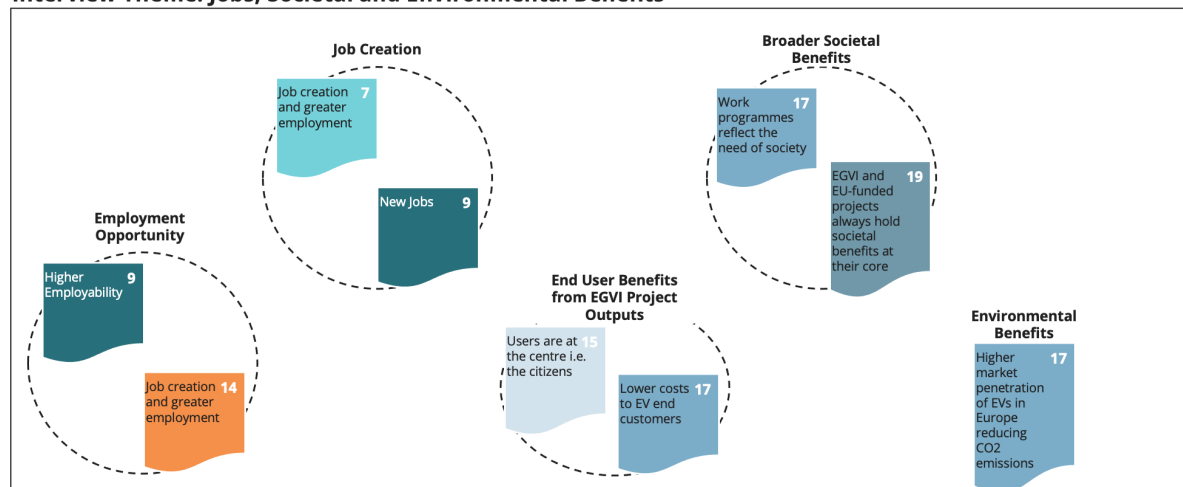
Interview Theme: Diversity



Source: SE, Selected EGVI Participants, Selected EGVI Members

Employment opportunity, job creation, end user benefits, and broader societal and environmental benefits are captured in *jobs, societal and environmental benefits* metatheme

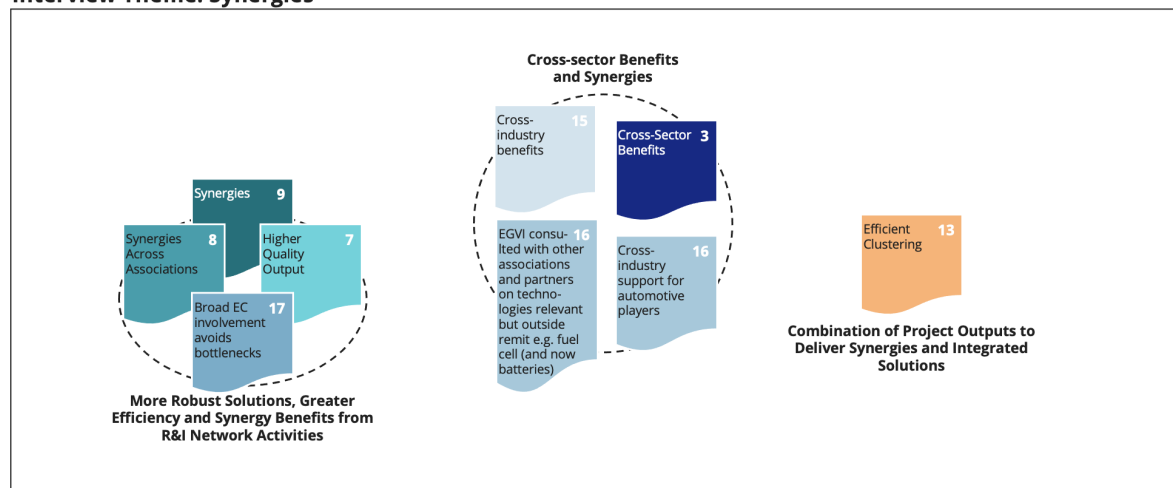
Interview Theme: Jobs, Societal and Environmental Benefits



Source: SE, Selected EGVI Participants, Selected EGVI Members

Three themes address *synergy* benefits of EGVI in developing robust and efficient solutions, cross-project integrated solutions and cross-sector applicability of project outputs

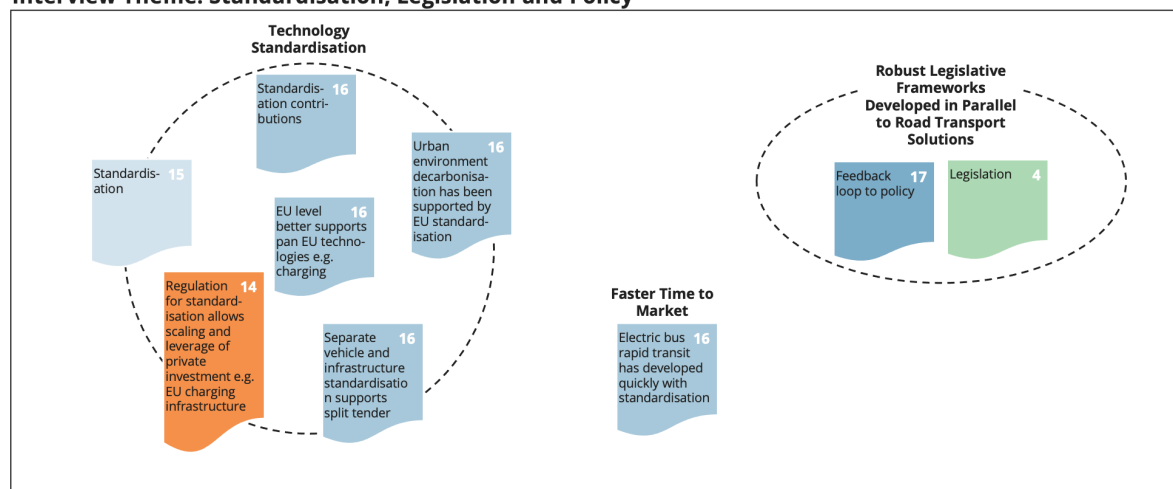
Interview Theme: Synergies



Source: SE, Selected EGVI Participants, Selected EGVI Members

Three themes feature in the *standardisation, legislation and policy* metatheme incl. benefits of parallel legislative and transport solution development and impact on time to market

Interview Theme: Standardisation, Legislation and Policy

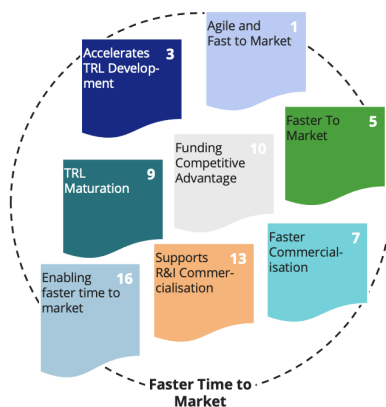


Source: SE, Selected EGVI Participants, Selected EGVI Members




The faster *time to market* often achieved by the EGVI programme was noted as accelerating TRL development, supporting commercialisation and funding competitive advantage

Interview Theme: Time to Market



Source: SE, Selected EGVI Participants, Selected EGVI Members

5.8. ILLUSTRATIVE SUCCESS STORIES

	<p>OPTEMUS exceeded its stated objectives, delivering a real world capability demonstration; commercialisation plans developed with technology reaching TRL 6</p>
OBJECTIVES	
<ul style="list-style-type: none"> ➤ Technical targets: Energy consumption reduction of 30% for component cooling and 50% for passenger comfort ➤ Economic targets: 8.7 MWh energy savings per A-segment vehicle lifetime which saves roughly €1,500 for the customer ➤ Lower exhaust gas and noise pollution in urban areas 	
SUCCESSSES	
<ul style="list-style-type: none"> ★ Objectives exceeded in real world for driving range, component cooling, passenger comfort and traction energy consumption ★ Technology maturity increased through to TRL 6 with plans for commercialisation developed by participants ★ Private research continuation and further developments to project outputs in other applications e.g. Fast Track to Innovation programme (EU programme) ★ Supported further research developments in DOMUS and SELFIE ★ Led to further research funded at a national level i.e. mobileM 	
KEY TOPICS	<p>Real world range improvements, energy savings, commercialisation, follow on projects, cost savings, demonstrator, objectives achieved, further research projects</p>
QUANTIFIED ACHIEVEMENTS	<ul style="list-style-type: none"> ➤ At least 30% real driving range increase ➤ Energy consumption decreases of <ul style="list-style-type: none"> ➤ At least 32% for component cooling ➤ At least 60% for passenger comfort ➤ 15% for traction



AEROFLEX met objectives, creating recommendations for standards and demonstrating transport efficiency gains including cross-sector applications

OBJECTIVES

- Characterise the European freight transport market and trends
- Develop trucks with reduced drag, better cost effectiveness etc.
- Demonstrate aerodynamics and energy management improvements
- Create recommendations for revising standards and legislation
- Achieve an overall efficiency gain of 33% in long haul freight by 2025

SUCCESSSES

- ★ Utilisation of outputs and synergies from other EGVI projects to support more robust and impactful results
- ★ Generation of recommendations for standards and regulations for 2020+ to support overall efficiency gains in long haul freight
- ★ Demonstration and validation of impact and feasibility of new vehicle concepts delivering between 18-33% efficiency gains
- ★ Collaborations with multimodal transport operators to deliver cross-sector benefits e.g. CFL rail corridor through France

KEY TOPICS

Significant energy savings, private investment, demonstrator, EGVI synergies, recommendations for standards, cross-sector applications

QUANTIFIED ACHIEVEMENTS

- Integration of project technologies into two demonstrators
- Energy savings
- Separate platforms: 4-5%
 - Loading space: 4-6%
 - Flexible powertrain: 5-12%
 - Aerodynamics: 5-10%



ASSURED achieved objectives, developing and disseminating standard recommendations, and showcasing technology performance through vehicle and charger demonstrators

OBJECTIVES

- Developing next generation modular high-power charging solutions
- Providing high interoperability between buses, trucks & fast chargers
- Standardising conformance and interoperability test protocols
- Producing smart tool & fleet energy/charging management strategy
- Demonstrating solutions: 6 OEMs, 5 eBuses, 2 eTrucks, 1 eVan, 5 cities

SUCCESSSES

- ★ Produced and used demonstrator charger with eFleet – reducing charge time, lowering total cost of ownership and CO₂, and improving grid stability
- ★ Developed conformance and interoperability test protocol standards for vehicles and chargers e.g. pantograph or floor mount
- ★ Released a pre-normative technology roadmap and disseminated throughout the industry
- ★ Furthered the development activities of project ZEEUS from European Green Car Initiative to bring tested and interoperable urban transport solutions to market

KEY TOPICS

Development of standards, vehicle and technology demonstrators, follow on project, objectives achieved, pre-normative technology roadmap, EGVI synergies

QUANTIFIED ACHIEVEMENTS

- Produced technology demonstrators and proved out concepts
- Up to 45% energy saving in charging procedure
- Demonstrator for high power wireless charger >100kW and >94% efficiency
- Developed a fleet simulation and management tool



HIFI-ELEMENTS
High Fidelity Electric Modelling and Testing

HIFI-ELEMENTS successfully met objectives and developed recommendations for simulation standards, driving competitiveness and modelling fidelity in the European market

OBJECTIVES

- Development of a standard for electrical vehicle and component simulation from concept to model in the loop and hardware in the loop using a common simulation architecture and interface for signals and control
- Implementation of a workflow linking existing tools, e.g. data management, with automated test case generation methods

SUCCESSSES

- ★ Definition of a simulation architecture and interface standard for signals and control, published as recommendations for industry
- ★ Publication of 19 scientific and 18 non-scientific papers in recognised academic and other journals to support standardisation processes
- ★ Demonstrated the efficiency of developed standards and toolchain
- ★ Commercialised tool for improved e-vehicle and component competitiveness, and better safety and development test coverage
- ★ Recognised synergies with project OBELICS

KEY TOPICS

Recommendations for standards, publications, demonstrator, commercialisation, objectives achieved, EGVI synergies

QUANTIFIED ACHIEVEMENTS

- More than 50% reduction in development and test efforts
- Up to 10-fold increase in validation test coverage
- Model validation in hardware and on vehicle



THOMSON delivered objectives and demonstrated rapid transition technologies to help decarbonise ICE powertrains at competitive bill of material costs

OBJECTIVES

- Development of two different 48V architectures and powertrains: 1) diesel engine and 2) spark ignited direct injection compressed natural gas engine
- Development of cost-effective solutions for engine boosting and after treatment and new simulation models
- Production of two demonstrator vehicles integrating project solutions

SUCCESSSES

- ★ Illustration of rapid transition technologies applicable to current vehicle fleets and internal combustion engine applications
- ★ Diversification of the road transport decarbonisation to include broader coverage of powertrain technologies and solutions
- ★ Demonstration vehicles showcasing high levels of technology maturity highlighting commercial potential of solutions
- ★ Contribution to simplifying plug-in hybrid solutions based on a 48V board-net by using conventional power sockets and infrastructure

KEY TOPICS

Energy saving, private investment, rapid transition technology, diversified decarbonisation solutions, demonstrator, consensus building, cost reduction

QUANTIFIED ACHIEVEMENTS

- Up to 20% CO₂ reduction on Worldwide harmonised light vehicles test procedure for diesel engine compared with reference
- ~34% CO₂ reduction on real driving emissions for compressed natural gas engine compared with reference
- Vehicle BOM costs of the technologies either met or nearly met the 5% target



CEVOLVER achieved objectives, producing two demonstrators that incorporated synergies from other H2020 projects and a novel user-centric approach to deliver energy savings

OBJECTIVES

- Improve user confidence, functionalities and energy efficiency of electric vehicles
- Ensure the affordability of future electric vehicles via user centric development
- Validate systems, connected control strategy and functionalities
- Assess the impact of the technical advancements of CEVOLVER and their applicability in different EV types and vehicle classes

SUCCESSSES

- ★ Development of two demonstrator vehicles showcasing the CEVOLVER project technology outputs
- ★ More than €1 million private investment from project participants in addition to that provided by the Horizon 2020 funding mechanism
- ★ Publication of a peer reviewed scientific paper in Energies journal highlighting the benefits of thermal control on efficiency increases
- ★ Realisation of a cloud-based user-centric predictive optimisation algorithm and adoption of the OPTEMUS project heat pump system

KEY TOPICS

Private investment, demonstrator, peer reviewed publications, EGVI synergies, objectives achieved

QUANTIFIED ACHIEVEMENTS

- Two demonstrator vehicles highlighting TRL 6/7
- Energy savings
 - Eco-charging: 7.6%
 - Eco-driving: 11.6%
- Charging time savings of 13.7% (10°C) and 29.2% (0°C)



DOMUS achieved most objectives, delivering 15.4% WLTP range increases in simulation and 9.7% in a demonstrator; further commercial activities are planned from project outputs

OBJECTIVES

- 25% electric vehicle driving range increase compared to 2016 reference
- Minimisation of energy consumption from cabin systems
- Design guidelines for future electric vehicles: comfort vs. efficiency
- Deeply understanding users' comfort perception
- Develop an active system reacting to user characteristics and condition

SUCCESSSES

- ★ Development of new cabin components, systems, and control strategies for energy efficient, safe, and comfortable future electric vehicle up to TRL 5/6 – maturing technology for commercialisation
- ★ Partial achievement of objectives to improve upon state-of-the-art cabin conditioning systems and increase vehicle range by and 15.4% Worldwide harmonised light vehicles test procedure
- ★ Further commercial projects with participants and other partners and additional research proposals stem from this project

KEY TOPICS

Demonstrator, real driving range increase, commercialisation, further research projects, potential private investment

QUANTIFIED ACHIEVEMENTS

- Integrated virtual simulation range increase of 15.4% Worldwide harmonised light vehicles test procedure
- Development of a technology demonstrator vehicle for physical validation
- Demonstrator vehicle range increase of 9.7%



LISA met most objectives, delivering targeted cell cycle life outputs and progress on energy density; manufacturing pilots and patents also progress path to commercialisation

OBJECTIVES

- Targets: 10 Ah, 450Wh/kg, 700Wh/L, 700W/kg, 1.000 cycles maintaining 80% depth of discharge and 80% of beginning of life load and <€70 kWh-1 at cell level
- State of charge and ageing estimator development to support future battery management system development for electric vehicle pack integration and second life use assessment
- 50% (weight) recyclability and demonstrate economic viability at lab-scale

SUCCESSSES

- ★ Objectives exceeded for cell cycle life targets and partial success achieved for gravimetric and volumetric energy density
- ★ Development of two lithium anode, one hybrid solid state electrolyte and four Li-S cathode types and manufacturing techniques at a pilot scale – demonstrating progression to commercialisation
- ★ Recycling via an environmentally friendly and additive free water leaching process tested under different condition
- ★ Patents filed for Li-S manufacturing techniques

KEY TOPICS

Solid state batteries, second life assessment, recycling, patent development, improved manufacturing, commercialisation, demonstrator

QUANTIFIED ACHIEVEMENTS

- Pilot level technology demonstrator
- 18Ah pouch cell delivering 410Wh/kg and 450Wh/L
- Other 6Ah pouch cell have reached >1,200 cycles of the 80% beginning of life load and 50% depth of discharge

EGVIAFOR2ZERO

European Green Vehicles Initiative Association for the 2Zero partnership (EGVIAfor2Zero), non-profit organisation engaged with the European Commission in the "Towards zero emission road transport" (2Zero) partnership.

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