



EX-ANTE EVALUATION FOR A TECHNOLOGY TRANSFER PROGRAMME FOR LIGHTWEIGHTING

Study commissioned by the German Federal Ministry for Economic Affairs and Energy (BMWi)

Executive Summary

On behalf of the German Federal Ministry for Economic Affairs and Energy (BMWi), Project Management Jülich (PtJ) carried out an ex-ante evaluation for a planned technology transfer programme for lightweight construction between the 15th April and 15th October 2019. This Executive Summary provides an overview of the goals, methods employed and principal findings of the evaluation.

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1. OBJECTIVES AND PROCEDURE

The German Federal Ministry for Economic Affairs and Energy (*Bundesministerium für Wirtschaft und Energie*, BMWi) is planning funding activities within the framework of a technology transfer programme for lightweight construction (TT programme), in order to further develop lightweighting as a future technology and to promote its broad application and use. The overriding objective of the funding will be to initiate and promote the transfer of cross-sectorial and cross-material knowledge and technology of the various players active in lightweight construction in accordance with demand. Among other things, this will increase the value-creation potential of lightweighting, save resources and implement closed, sustainable cycles. Project Management Jülich (PtJ) was commissioned by the BMWi to carry out an ex-ante evaluation for the planned TT programme.

The evaluation concept is orientated towards three overarching objectives in order to meet the requirements of the administrative regulations of Article 7 (2) of the German Federal Budget Code (*Bundeshaushaltsordnung*, BHO): sharpening the objectives of the planned TT programme (target achievement control) and evaluating both its impact (impact control) and cost-effectiveness (economic efficiency control). This ex-ante evaluation thus includes:

- > an analysis of trends and developments as well as current research and funding activities in the area of lightweight construction,
- > the derivation of funding requirements and targets for the TT programme,
- > a description of the intended impacts in an impact model and the proposal of an associated set of indicators,
- > an investigation of the expected economic efficiency of the funding and
- > recommendations to the BMWi for the design of the TT programme.

2. ANALYSES: STATUS, TRENDS AND FUNDING LANDSCAPE

The starting point for the data analysis is an assessment of the current state of lightweighting in Germany and in international comparison, including trends and developments, economic significance and barriers to technology transfer. The evaluation was based on existing studies (60 international, European and German studies and reports) and published data on scientific publications, technology trends, resource efficiency effects, economic potential, patent applications and international developments. In addition, structured interviews were conducted with five national and three international experts from various lightweighting user sectors employing a guideline-based survey.

In order to assess the funding activities of the EU and of the Federal German Government and the Federal German States (*Bundesländer*), funding programmes related to lightweight construction were analysed. To this end, the relevant projects funded since 2010 (number of projects and volume of funding), technological maturity (technology readiness levels, TRL), participating players and user industries involved, lightweight materials and technology topics considered and cross-cutting topics addressed (education and training, networking, technology transfer, infrastructure) were identified.

At the national level there are relevant funding programmes and measures, in particular from the Federal Ministry of Education and Research (*Bundesministerium für Bildung und Forschung*, BMBF) and from the BMWi. These include measures with a thematic focus on lightweighting (e.g. WING - "Materials Innovations for Industry and Society", "From Material to Innovation", "Research for Tomorrow's Production", FONA³ - "Research for Sustainable Development"), interdisciplinary and technology-open programmes (e.g. the "*Spitzencluster*" competition, the "Entrepreneurial Regions" programme, "EXIST" - University-Based Business Start-Ups, WIPANO - "Knowledge and Technology Transfer through Patents and Standards"), in which individual projects relating to lightweight construction are funded, and also sector-specific technology programmes (the Civil Aviation Research Programme "LuFo" IV and V, the Maritime Research Programme, the technical programme "New Vehicle and System Technologies"), in which lightweight construction plays a role. In all, 16 relevant funding programmes were evaluated in depth.

The analysis of the national funding programmes identified a total of 295 collaborative projects with 1471 partners (individual projects) and a funding volume of about € 656 million which can be allocated to lightweighting. It can be assumed that there are further lightweight projects in other cross-cutting funding programmes which could not be covered within the framework of this study.

With the support of NMWP Management GmbH, the funding activities of the federal states in the lightweighting sector were also investigated. It soon became clear that the degree of lightweight project funding differs extensively in the individual states and that there are large regional differences. Here, a TT programme could help to close gaps, network regional activities and enable highly specialised lightweight construction manufacturing and research.

At EU level, the Horizon 2020 Framework Programme for Research and Innovation (H2020) has so far supported 86 projects related to lightweight construction with a total budget of around € 273 million. Germany is among the leaders in comparison with the other participating countries, both in terms of the numbers of successful applicants and the distribution of funding: 126 German project partners received € 65.5 million in funding for 45 projects.

As a result of the analyses of the studies and reports and of the expert interviews, it can be stated that lightweight construction with the aim of the optimal use of materials in terms of function and performance is particularly important wherever masses are to be moved or material is to be bound in products. In view of the growing scarcity of resources, mounting efforts for climate protection and the increasing pressure to innovate, the topic of lightweighting will continue to gain importance across all sectors. The speed of development and the penetration of lightweight construction differ in the various industrial sectors, with the aviation and automotive industries play a pioneering role.

The trend across industrial sectors is moving away from hybrid lightweight construction towards composite structures. Intelligent lightweighting solutions are needed, either by using an intelligent mix of materials or by developing function-integrated lightweighting approaches. Trends are also being seen in intelligent production processes, iterative engineering, the development of automated process chains, the networking of manufacturing machines and the development of resource-efficient materials. In this context, great importance is attached to digitisation as a key technology for lightweight construction. Obstacles to innovation result

from the lack of material characteristics and joining technology and high material costs. The development of new hybrid materials and their use requires players from different disciplines to work together and pool their specific knowledge.

An analysis of international publications and patent applications in the field of lightweighting shows that Germany plays a leading role in publications. But there is a lack of permeability from research to industry and both China and the USA are investing more money in technology transfer programmes. Indeed, Japanese and Chinese companies lead the way in terms of patent applications so there is considerable development potential for the German lightweight construction industry.

Key results of the analyses:

- > Cross-industry approaches have hardly been taken into account to date and key results are often determined exclusively for a particular company and are not transferred. Mechanical engineering and the construction industry have been given little consideration as user industries in support programmes for lightweighting up to now.
- > There is a need for development for all materials. In view of current climate protection targets, it is recommended to focus funding support on those lightweight materials and manufacturing processes which will particularly contribute to improving CO₂ balances and conserve resources.
- > The focus of funding to date has been on materials development, joining and bonding technology and manufacturing, while approaches to function integration, digitisation, automation and bionics are underrepresented. Holistic lightweighting approaches that take closed material cycles into account as well as approaches to improve energy and raw material efficiency have also received little attention up to now.
- > There are funding gaps in existing programmes for TRL 5-8 and in cross-industry approaches. This is where the TT programme should start.

3. OBJECTIVES AND IMPACT OF THE PLANNED PROGRAMME

The planned TT programme is embedded in the overarching political objectives of German industrial and innovation policy and contributes to strategies at national level (e.g. the government coalition agreement, the National Industrial Strategy 2030, the High-Tech Strategy 2025, the Raw Materials Strategy, the planned Lightweight Strategy, the German Sustainability Strategy, the German Resource Efficiency Programme, the Digital Strategy and the AI Strategy).

The core message of the planned TT programme is: "Lightweighting as an innovation driver for sustainable business". Five action-guiding goals are thus proposed to achieve this:

1. Bring lightweighting into broad industrial application
2. Raise the innovation and value-creation potential of lightweight construction
3. Promote knowledge and technology transfer across industry sectors and materials
4. Achieve climate and sustainability goals

5. Create end-to-end digitised, interconnected value-creation networks.

The following topics are proposed as definitive starting points for funding in the TT Lightweighting Programme:

- > Technology development (integration of new technology developments as drivers for sustainable lightweight solutions: a) digitisation and automation, b) sustainability and recycling, c) innovative design principles such as bionics);
- > Demonstration projects (pilot industrial implementations with lighthouse character; goal: TRL 6-8);
- > Internationalisation (targeted networking and cooperation with leading global lightweight nations);
- > Networking (expansion of networks for technology transfer: cross-industry networks, SMEs along the value-creation networks);
- > Qualification (further and advanced training for engineers, technicians and relevant training occupations in new lightweight construction technologies, exchange of specialists and development programmes for SMEs);
- > Standardisation (standardisation of materials and technologies, development of test methods, material databases, systematic collection of characteristic values, quality assurance).

In addition, accompanying activities to the TT programme can also be initiated within the framework of the planned lightweighting strategy. For selected thematic areas, impact models were developed which describe the relationship between the planned activities, the expected results and the impacts for the target group and beyond. In conjunction with the developed indicator sets, continuous success monitoring and strategic programme control are possible.

4. RECOMMENDATIONS FOR IMPLEMENTATION

The TT programme is initially planned to run for ten years. Due to the application level of the projects, the main target group consists of companies that can involve research institutions and universities as project partners. In order to increase the marketability of the lightweight construction materials, the funding of projects with high TRLs (5-8) in particular is to be implemented.

The implementation of the TT programme could take place in stages, with a first call for proposals setting out the framework and objectives of the programme (time horizon: 10 years) and the first priority topics for funding. Further updates and additions could then be made during the course of the programme through further calls for proposals or announcements of changes.

In addition to the funding activities within the planned TT programme, interfaces and synergies with existing funding programmes should be used. In particular, established technology-open funding programmes (e.g. ZIM, EXIST, WIPANO) offer great potential for supporting

technology development and transfer in lightweighting. Industry-specific programmes (e.g. the LuFo Programme or the Maritime Research Programme of the BMWi) also offer considerable potential for the further development of lightweight construction technologies for industry-specific applications. Funding opportunities for automation and digitisation are also relevant. On-going funding programmes should not be duplicated, but mobilised to accompany the planned TT programme. This will ensure a complementary orientation of these programmes and achieve a multiplier effect for lightweight construction through additional programme funding which would flow into lightweighting topics. It is thus recommended that incentives and interfaces be created and existing programmes be advertised in a targeted manner in the lightweighting scene in order that lightweighting players and topics achieve even greater participation in these complementary programmes. The TT programme, on the other hand, can offer good opportunities for connection to the above-mentioned programmes by supporting cross-industry projects and further development to high TRLs in order to support cross-sector transfer and the translation of research results into industrial practice.

It is also recommended that a communication strategy for the TT programme be developed in order to publicise the new funding programme and to ensure effective and efficient communication to its target groups. Close integration with existing structures (e.g. the German Lightweighting Initiative Coordination Office) and information channels (webpages about the Lightweighting Initiative, the German Lightweighting Atlas (LEICHTBAUATLAS), Lightweighting Forum) is a good way of achieving this.

5. CONCLUSION AND OUTLOOK

The ex-ante evaluation confirms the need for funding to expand knowledge and technology transfer in the field of lightweighting. Lightweight construction has great economic significance for key economic sectors such as automotive engineering and the aviation industry and offers potential for increasing competitiveness and resource efficiency in other sectors and new application areas. Germany is well positioned in key research, development and technology areas, but lags behind internationally in terms of both the number of patents applied for and its transfer activities in the field of lightweighting. The planned TT programme can address these needs and significant contributions can be expected for the central objectives of German industrial policy and the climate protection and sustainability goals of the Federal Government. A complementary orientation to existing funding programmes can be achieved in particular by focusing on cross-industry approaches along the lightweighting value chain and the realisation of high TRLs in the range 5-8.

During the implementation of the long-term TT programme, opportunities should be created for later updates of the topic areas, extensions of the funding objects or further funding phases. This will create a flexible programme framework that can be adapted as necessary in the light of future developments and new findings (e.g. from the ongoing lightweighting strategy process). In order to comprehensively address the possible funding approaches identified, additional funding over and above the € 4.25 million p.a. currently budgeted should be made available if possible. Otherwise, only part of the programme can be adequately addressed with the planned budget and the funding should be prioritised and, if necessary, spread over time.