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FASTEST

**Fast-track hybrid testing platform for the development of
battery systems**

Deliverable D7.4 – Update dissemination and communication plan 1

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Project Abstract

Current methods to evaluate Li-ion batteries safety, performance, reliability and lifetime represent a remarkable resource consumption for the overall battery R&D process. The time or number of tests required, the expensive equipment and a generalised trial-error approach are determining factors, together with a lack of understanding of the complex multiscale and multi-physics phenomena in the battery system. Besides, testing facilities are operated locally, meaning that data management is handled directly in the facility, and that experimentation is done on one test bench.

The FASTEST project aims to develop and validate a fast-track testing platform able to deliver a strategy based on Design of Experiments (DoE) and robust testing results, combining multi-scale and multi-physics virtual and physical testing. This will enable an accelerated battery system R&D and more reliable, safer and long-lasting battery system designs. The project's prototype of a fast-track hybrid testing platform aims for a new holistic and interconnected approach. From a global test facility perspective, additional services like smart DoE algorithms, virtualised benches, and DT data are incorporated into the daily facility operation to reach a new level of efficiency.

During the project, FASTEST consortium aims to develop up to TRL 6 the platform and its components: the optimal DoE strategies according to three different use cases (automotive, stationary, and off-road); two different cell chemistries, 3b and 4 solid-state (oxide polymer electrolyte); the development of a complete set of physic-based and datadriven models able to substitute physical characterisation experiments; and the overarching Digital Twin architecture managing the information flows, and the TRL6 proven and integrated prototype of the hybrid testing platform.

LIST OF ABBREVIATIONS, ACRONYMS AND DEFINITIONS

Acronym	Name
CBM	Cell and battery manufacturers
CBPST	Cell to battery pack system testers
CINEA	European Climate Infrastructure and Environment Executive Agency
DC	Dissemination and Communication
DoE	Design of Experiments
DT	Digital Twin
GP	General Public
HE	Horizon Europe
HIL	Hardware-in-the-Loop
KER	Key Exploitable Result
KPI	Key Performance Indicators
LIB	Lithium-ion battery
M	Month
OEM	Application & Integration
OS	Open science
PM	Policy Makers
R&A	Research and Academia
R&I	Research and Innovation
RSL	Recycling / Second Life
SC	Scientific community
SIE	Sustainable innovations
SO	Standardisation Organizations
STC	Standardisation Technical Committees
TM	Trade Media
WP	Work Package

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EXECUTIVE SUMMARY

This document describes the Dissemination and Communication Plan to be adopted by the FASTEST project, whose main objective is ensuring that the project's outcomes (concepts, scientific results, validated work, problem awareness) are disseminated to appropriate target communities. This will be done with a 360 approach, which includes online and offline strategies.

This deliverable is the first update of the Dissemination and Communication strategy, which describes (1) the overarching strategy of the project, and (2) the dissemination and communication activities undertaken so far until M18 of the project. Subsequent deliverables will continue reporting the activities and any changes in the strategy to increase the impact and outreach of the project.

1. OBJECTIVES

To enable the delivery of the results and main messages of the project to the targeted audiences, as well as contributing to the post-project achievement of the outcomes and the impacts, FASTEST has set a specific plan for the dissemination, usage, and valorisation of research and innovation results, and the communication efforts to inform the public about the utilisation of European funds for R&I projects, social issues, the results of a sustainable and cutting-edge cell manufacturing sector in the EU. Thus, improving the communication between science, business, and society. WP7, "Dissemination, exploitation, and communication," will take the lead on these efforts, liaising with the other partners to ensure the greatest impact is made, and delivering a comprehensive Dissemination and communication Plan by M18. Here is a brief explanation of the main components of this plan.

2. INTRODUCTION

This document updates the Dissemination and Communication Plan that is being adopted by the FASTEST project, whose main objective is to ensure that the project's outputs (concepts, scientific results, validated work, problem awareness) are consequently disseminated and/or communicated to appropriate target communities.

3.1. Context of WP7

The main aim of WP7 is to coordinate the project consortium in the performance of dissemination, communications, and exploitation activities, including IP management. Following the OS approach of the project, partners will maximise the openness of results and the interaction with sectoral stakeholders in a balanced way with IP protection measures established where necessary to ensure the proper exploitation of project KERs. The Consortium will contribute, upon invitation by the CINEA, to common information and dissemination activities to increase the visibility and synergies between HE/H2020 supported actions.

2.1 Objectives of T7.1

A detailed Dissemination and Communication Plan (D&C) will be produced by SIE at the beginning of the project (M6), based on the preliminary indications given in Section 2.2 and in collaboration with all the consortia. It will outline the project's audiences, key messages, and communication channels for dissemination, including roles and responsibilities. The different updates of the plan will offer the monitoring of the different dissemination and communications activities carried out by all partners, evaluated against its KPIs.

3. DESCRIPTION OF WORK

This document is the first update of the dissemination and communication plan of the FASTEST project. It serves to check if the basis set at the beginning is being followed and to describe the activities carried out in the period between M7 and M18 of the project. SIE has coordinated the overall strategy, drafting this and the previous deliverable, keeping constant communication with partners to both track their actions regarding communication and dissemination and show them the importance of good promotion of the project and working towards the achievement of the KPIs set in the Grant Agreement. After the ABEE's first delivery of the website, brand guidelines and communication materials, SIE has overseen new changes on those and other channels.

Disseminating a project like FASTEST is a central part of the project's strategy to maximise the uptake of its results by different audiences, especially in terms of entities delivering battery and battery cell testing and characterisation commercial services. Scientific advances need to be well-known by the entire society. Our main aims in terms of communication are to show that scientific collaboration makes a difference in social progress and to inspire, to give clues to the rest of the scientific community on our specific topic and to inspire the public to increase their interest in technical and scientific matters.

3.1 Target audiences

A sizable list of stakeholders for whom the dissemination and communication tools and materials will be intended has been initially established by FASTEST. Although the vehicle manufacturing sector is an established industry, the deployment of the cell manufacturing ecosystem in Europe is not, which justifies the value chain strategy used in the project, which is typical of fast-expanding industries. According to the European Battery Alliance, we list the key players in the value chain along with the key findings that will be shared with them throughout the project in Table 1 below.

Table 1: Targeted results and the stakeholders that they affect.

Targeted results/content	Target group / Stakeholder
The main result of the FASTEST project: "hybrid testing platform with reconfigurable XiL testing environment towards automatic BMS validation"	Cell to battery pack system testers (CBPST), Application & Integration (OEM), Cell and battery manufacturers (CBM), Research and academia (R&A),

	General Public (GP), Trade Media (TM)
A knowledge-based DoE methodology toolbox	CBPST, CBM, R&A
Physics-based modelling tools to fully understand the battery system	CBPST, CBM, R&A
Data-driven modelling tools to develop online aging estimation	CBPST, CBM, R&A
AI toolchain to simulate and monitor safety and reliability testing	CBPST, CBM, R&A
Digital Twin System to monitor in real time parameters of the battery system	CBPST, CBM, OEM, R&A
Knowledge, reproducibility, etc.	R&A
Standardisation, public roadmaps actualisation, etc.	Policy Makers (PM), Standardisation Organizations (SO)
EC funds, R&I efforts to enable affordable electric mobility.	GP

Table 1 summarises which stakeholder groups will benefit from each of the project results. The dissemination and communication strategy will conduct a thorough stakeholder analysis to better understand the influence and stakeholder interests, and to better adjust the key messages to deliver and how to do so, increasing the likelihood that the project's findings will be disseminated and used.

FASTEST consortium members have preliminary identified a list of key associations and organisations that will allow to enhance the project's results dissemination through mutual collaboration: [LiPLANET](#) (Network of battery cell Pilot Lines in Europe), [European Battery Alliance](#), [EMIRI](#), [ALISTORE](#), [EMMC](#) (European Materials Modelling Council), [BEPA](#) - BATT4EU Partnership, [BATTERY 2030+](#), [European Digital SME Alliance](#), and [ERMA](#) (European Raw Materials Alliance).

Consortium partners are a good reflection of the European battery value chain, including research centres, manufacturers, producers, and academia. Nevertheless, FASTEST intends to widen its collaboration with other relevant actors from the industry. Thus, a preliminary stakeholder list was prepared, including more than 300 organisations. This list will be regularly updated, and stakeholders will be informed of the project's regular outcomes.

Likewise, similar European and international projects have been identified to seek synergies: [LIBERTY](#), [SEABAT](#), [GIGAGREEN](#), [3beLiEVe](#), [SENSIBAT](#), [SPINMATE](#), [Arrowhead Tools](#), [COBRA](#), [COFBAT H2020](#), [BatWoman](#), [greenSPEED](#), [NoVOC](#), [NEXTCELL](#), [TEMPEST](#), [AccCellBaT](#), [NextBat](#), [IntelliGent](#), [Signe](#), [Digibatt](#) and [THOR](#). FASTEST has created [a dedicated section](#) on its website, so stakeholders can easily access all their information.

Finally, a set of trade media contacts was listed, including the most relevant magazines: [Autobuild](#), [Autofacil](#), [Automotive news](#), [Autopista](#), [Autovolt](#), [Batteries International](#), [Battery Power Magazine](#), [Car and driver](#), [Charged electrical vehicles magazine](#), [Clicacoches.com](#), [Electrek](#), [Electric cars report](#), [Electric Hybrid vehicles](#)

[magazine](#), [Electrical India](#), [Energy Magazine Australia](#), [Energy Storage News EV Magazine](#), [Inside EVS](#), [KM 77](#), [Motor 16](#), [Motor authority](#), [Motortrend](#). Also, project partners are expected to generate at least 9 peer-reviewed articles targeting Journals like [Journal of Materials Chemistry](#), or [Journal of Power Sources](#), as well as the Open Access journal from the EC [Open Research Europe](#).

3.2 Key Messages

Over the course of six technical work packages (WP), the FASTEST project will generate substantial volumes of data, fostering interest in the value chain of cell batteries and various other sectors. The outputs and messages from produced WPs, as well as the suitable instruments and channels for distribution, must be identified. The essential messages from each WP are displayed in Table 2 below. Additionally, the primary target group(s) and distribution channels are established. The consortium group will keep spreading information about its overall goals and partnership engagement in anticipated activities. This includes private business meetings, presentations to possible clients, and scientific materials, milestones, etc.

Table 2: Key messages and stakeholders of FASTEST's technical WPs

WP	Key message	Target group / Key channels
Specifications and use case definition	Use cases shape regulations, testing specs, and virtualization for digitalized test effort reduction, including battery testing and DT development.	CBPST, OEM, CBM, R&A
Design of Experiments, boundary conditions and methodologies	Improve battery testing via innovative and model-based DoE methods, minimize tests with low-quality information, smart combination of physical and virtual testing for further time and cost reduction.	CBPST, CBM, R&A
Advanced battery ageing and performance modelling	Minimize cell-to-battery test time/cost using diverse digitalization methods for efficient accuracy.	CBPST, CBM, R&A
Battery safety and reliability AI-powered toolchain	Create virtual toolchain for battery safety, covering degradation, failure scenarios, and scalable reliability assessment.	CBPST, CBM, R&A

Digital Twins for Hybrid Test in Battery Development	Establish DTs representing battery systems and components via standardized, adaptable structures, integrating physical testing and models.	CBPST, CBM, R&A
Development of hybrid testing platform	Integrate battery testing technologies from previous WPs, optimizing tests using data, models, and DoE in holistic approach.	CBPST, OEM, CBM, R&A

3.3 Tools and channels

The actions carried out by FASTEST and its results will be disseminated and communicated using a variety of methods and means. The Dissemination and Communication Plan will be more effective since each instrument and channel will be used effectively to speak to various target groups at various stages of the project execution. Table 3 shows the connections between the target audiences, the tools and channels, and the anticipated effects.

Table 3: links between the audiences, the tools, the channels, and the effects

Channels	Tools	Target group	Effects
Printed materials	Brochure	All target groups	Create awareness about the project goals, results and expected outcomes and impacts
	Leaflet		
	Poster		
	Rollup		
Online	Website	All target groups	Keep the audience engaged on the project activities, results, and related news, and making them publicly available.
	Newsletters		
	Social media		
Publications	Scientific papers	CBPST, OEM, CBM, R&A, PM	Guarantee knowledge transfer
	Articles	All target groups	Generate interest in the cell battery production and the state-of-the-art technologies developed by FASTEST
	Press releases	TM	Regularly inform trade media on

			the project outcomes and how this impact positively in European lives in terms of employment, technology development, improvement of environmental footprint, etc
Events organised by FASTEST	Workshops	All, except general public and TM	Disseminate specific results of the project to targeted audiences
	Webinars		
Events attended by FASTEST	Conferences	All	Keep the audience engaged on the project objectives and outcomes, as well as on achievements, and news.
	Tradeshows		

3.3.1 Project identity

To build a visual brand, a distinctive project identity has been created by ABEE (shown in Figure 1). It provides a set of templates that will make it easier to gain reputation as the project progresses. This involves developing the project's logo and the related style guide. Additional communication materials have been developed and made available on the project [website](#). This includes the project's logo, roll up, poster, factsheet, brochure, and presentation.

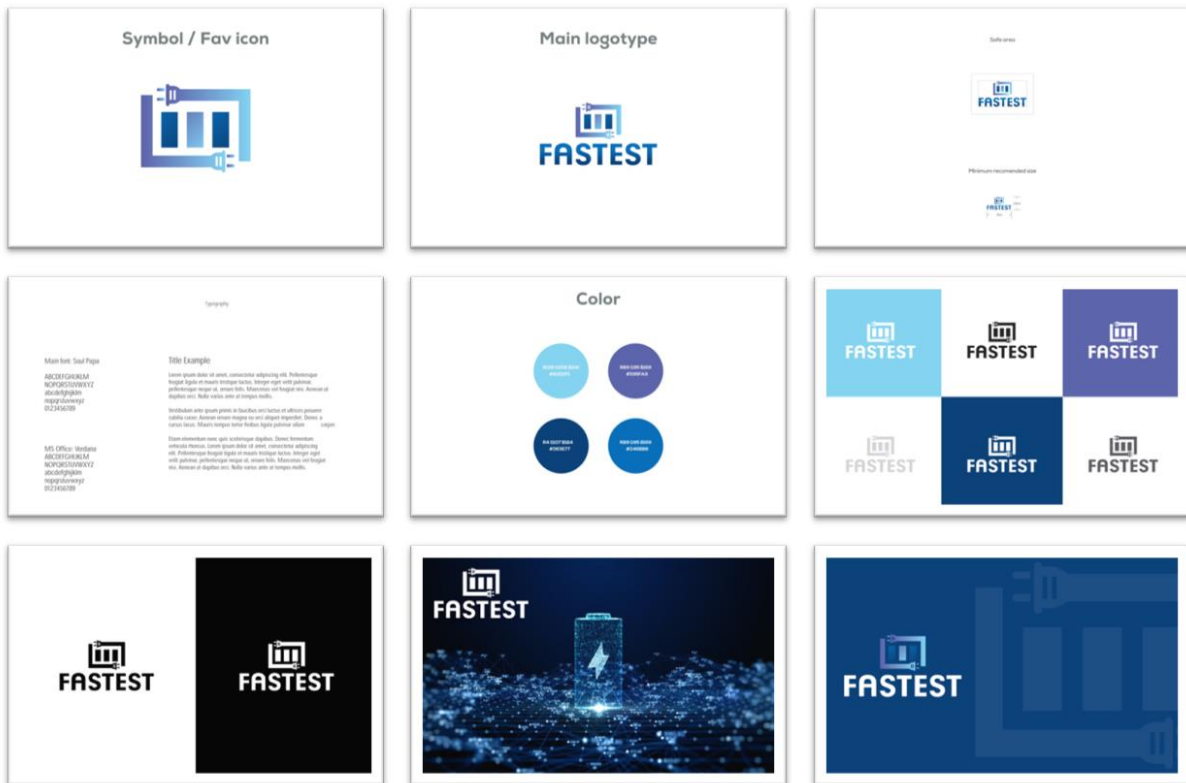


Figure 1: Visual guide pages

3.3.2 Project website

The FASTEST project [website](#) (which homepage is shown in Figure 2) has been created and continuously updated to be appealing for visitors. It was made available on M2 of the project life and serve as main repository of the project information and outcomes.

In this moment, it has three main sections (apart from the [homepage](#) and the [contact page](#)):

- About, with four subsections:
 - [Project](#)
 - [Work Packages](#)
 - [Partners](#)
 - [Related Initiatives](#)
- [News](#)
- [Downloads](#)



Fast-track hybrid testing platform for the development of battery systems

Efficient Li-Ion Battery Testing Solutions

Current methods to evaluate Li-ion batteries safety, performance, reliability and lifetime represent a remarkable resource consumption for the overall battery R&D process. The time or number of tests required, the expensive equipment and a generalized trial-error approach are determining factors, together with a lack of understanding of the complex multi-scale and multi-physics phenomena in the battery system. Besides, testing facilities are operated locally, meaning that data management is handled directly in the facility, and that experimentation is done on one test bench.



Figure 2: Website's homepage

3.3.3 Social media

To ensure greater diffusion to various age groups and target audiences, FASTEST has a social media presence on [LinkedIn](#) and [YouTube](#). LinkedIn is being used to promote project updates and, most significantly, to increase website traffic. YouTube, on the other hand, is being used to make available the project's communication efforts in webinars or workshops.

To broaden reach, FASTEST-related content has been posted often starting in M1 on LinkedIn. After the creation of the official project video, the YouTube channel was made available.

To create an audience for the project results, the social media accounts will distribute updates about the project scope and promote events where FASTEST will be showcased throughout the first phase of the project.

Online media platforms will be supervised to gather data on the metrics, sources, content kinds, and people or organisations who support or spread project messaging. This information will enable communication to be targeted and optimised for maximum reach of news or results. The final dissemination report and interim reports will both include these findings. SIE will be responsible for the social media profiles, assisted by partners.

Consortium members follow and participate in the project's social media platforms. The partners frequently share posts on their own corporate websites and social media platforms. SIE can advise them on the most effective ways to do so if they require support.

Milestone	WP	Lead partner	Date
Preliminary intelligent DoE for use cases is finished by FHG	WP2	Fraunhofer	M12

Advanced performance, ageing, safety and reliability model for generation 3b for the 3 use cases	WP3, WP4	ABEE	M18
Integration between the DT platform and the Virtual & physical validation platform	WP5, WP6	FEV/FEV.io	M28
Advanced performance, ageing, safety and reliability model for generation 4 for the 3 use cases	WP3, WP4	ABEE	M28
Successful integration of WP2 – 5 functionalities in the hybrid testing platform	WP2, WP3, WP4, WP5, WP6	FEV/FEV.io	M30

3.3.4 Printed material

To be distributed at conferences, exhibitions, and other events, as well as to partner networks, ABEE has developed a poster (Figure 3), a roll-up (Figure 4), a factsheet (Figure 5) and a brochure (Figure 6). General information regarding the research activities, participants, and anticipated outcomes is included in the initial project poster and brochure version. Later in the project life, other materials could be created to publicise findings.



Figure 3: FASTEST's poster



Figure 4: FASTEST's roll-up

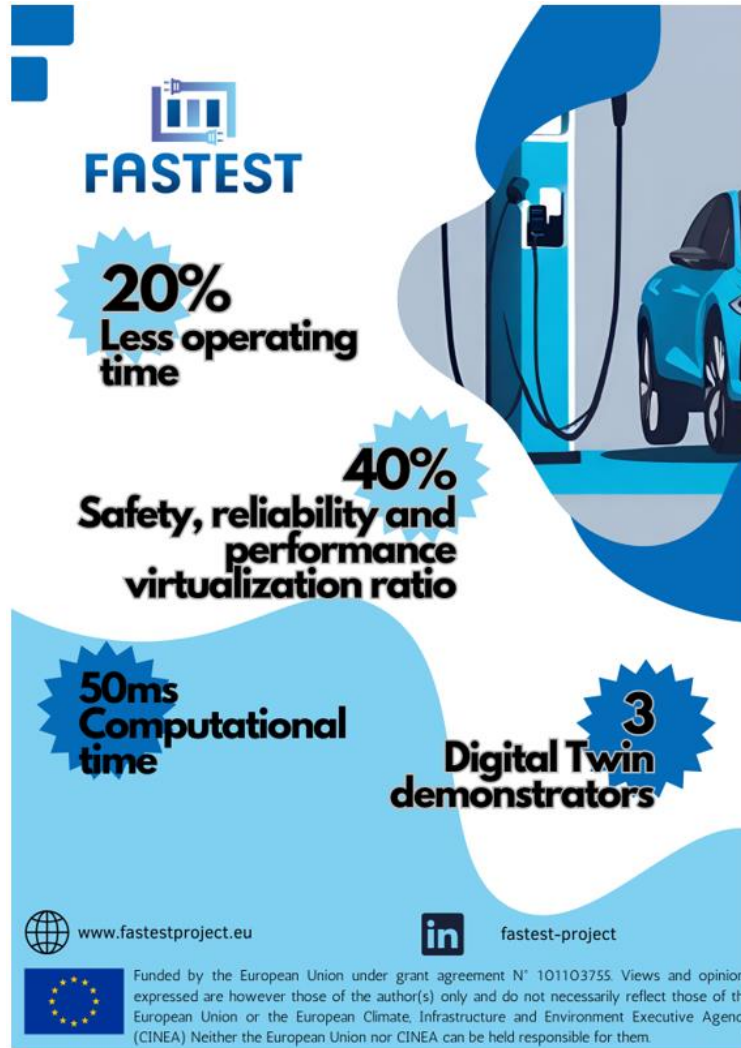


Figure 5: FASTEST's factsheet



Figure 6: FASTEST's brochure (both sides)

3.3.5 Newsletters and press releases

Every six months, electronic newsletters containing project updates, news, interviews, and other FASTEST-related information will be created, starting on M5. These newsletters will be sent to stakeholders and partner networks as well as uploaded on the project website. The first newsletter (which can be seen in Figure 7) was released on October the 4th.

1st Newsletter

[View this email in your browser](#)



A revolution in battery testing technology



FASTEST, a project financed by the European Union (EU) under the Research and Innovation Framework Programme Horizon Europe **kicked off with a meeting in Brussels (Belgium) on June, 6th-7th.**

Figure 7: First FASTEST newsletter

Additionally, project updates could be included in the partners' own newsletters, which are sent electronically to the contacts they have within the relevant industries.

Press releases will be released to announce noteworthy project advancements as they happen. With the support of the project partners, they will be written in English and distributed to the national media and the European press. A first newsletter was written to announce the project's kick off, and sent to 210 media in a first release. A second release was launched in October, sending the newsletter to 347 media.

3.3.6 Peer-reviewed articles

The technical and academic partners will create at least 9 scientific papers, bringing additional benefits like greater transparency in the research process, better opportunities for new scientific collaborations, and increased efficiency in research. It will be done following the Open Science principles (Open Access journals or paying Gold OA fees): making available all research data unless IP restrictions apply, early sharing of pre-prints in the project website, etc. The project's findings will be disseminated both internationally in international journals like [Journal of Materials Chemistry](#) or [Journal of Power Sources](#), as well as nationally, primarily in the member states where the partners are based. Open Research Europe is an open source, free of cost alternative as well for partners.

Likewise, the project website will compile all publications and make them available for free download.

3.3.7 Conferences and events

To meet target audiences, other stakeholders, public authorities, and the scientific community, project partners will attend sector-related events, conferences, and workshops. They will also spread the word about the project's goals and outcomes. Access to target audiences at the local, national, European, and worldwide levels will be made possible by these events.

The following conferences and trade shows have been pointed out as being of interest to the FASTEST project:

[Battery Experts Forum](#). November 2024

[Thermal management for EV/EHV](#). November 2024

[Future Battery Forum](#). November 2024

[Battery Innovation Days](#). November 2024

[Battery Tech Expo](#). January 2025

[Energy Storage Summit](#). February 2025

[E-World Energy & Water](#). February 2025

[Energy Storage Summit](#). February 2024

[All-Energy](#). May 2025

[eMobility Expo](#). March 2025

[E-Tech Europe](#). April 2025

[32nd CIRP Conference on Life Cycle Engineering](#). April 2025

[Advanced Battery Power](#). April 2025

[Automotive Testing Expo](#). June 2025

[Green Vehicle Expo](#). June 2025

[Electric & hybrid vehicle technology expo](#). June 2025

[The Battery Show Europe](#). June 2025

[Vehicle Electrification Expo](#). July 2025

To ensure that the project is present at events for dissemination, this list of events will be updated often in partnership with the consortia.

Along with attending conferences and trade shows, FASTEST will collaborate with other initiatives under the same call to host at least one workshop by the end of the project to address standardisation and policies, as well as six other webinars (of which two have already happened, as explained in 3.9.6) to raise awareness on the different project propositions.

3.4 Indicators and targets

The accomplishment of particular targets for various indicators will serve as a gauge for how well the Dissemination and Communication Plan is being implemented (Table 4).

Table 4: Targets & indicators

Tools / channel	Indicator	Target number	Information source
Brochure Poster Factsheet	Number of copies distributed	Material distribution: <300 poor; 300-500 good; >500 excellent	Consortium information, number of copies distributed to target groups / stakeholders
Website	Number of visits	Visits per year: <450 poor; 450 – 900 good; >900 excellent	Website statistics
Social media (LinkedIn)	Number of followers Engagement rate	LinkedIn; (a) Followers: <150 poor; 150 – 300 good; >300 excellent. (b) Engagement rate: <2% poor; 2- 3% good; >3% excellent	Social media analytics
Videos	Number of views Audience in conferences /trade shows	At least 2 in the project. Views: <200 poor; 200 – 300 good; >300 excellent	YouTube, website and social media analytics Attendance to booth /conference
Newsletters	Number of subscribers Number of opens Visits from website / social media	At least one each six months. Subscribers: <100 poor; 100 – 200 good; >300 excellent Opens: <15% poor; 15% – 17% good; >17% excellent	Mailchimp (newsletter service), Website and social media analytics
Press releases	Number of media stakeholders addressed Number of views on website and social media	At least 4. 70 media sources / journalists reached Number of views: < 40 = poor; 40-60 = good; >60 = excellent	Recording of e-mails sent, Website and social media analytics

Scientific publications	Number of views/downloads	9 publications	Link to site where posted or PDF version of article
Workshops	Number of attendees	1 standardisation / policymaking workshop. 6 scientific dissemination workshops Number of attendees each: <15 = poor; 15-25 = good; >25 = excellent	Registration list/webinar platform analytics (if online)
Conferences Trade fairs	Number of conferences and trade fairs attended Number of exhibitors and participants	Attend 25 conferences per year	Certificate of participation; Proof of registration; Event information

3.5 Levels of dissemination

The geographic levels at which the main target groups operate will affect the communication methods and media used.

3.5.1 European Level – European Commission

The results of the project are reported to the EC regularly (mid-term reviews, minutes of periodic meetings, updates to this document) so that they can make any necessary changes to the relevant regulations and suggest collaborating with other projects that are already in progress on dissemination efforts.

3.5.2 International level – Industry, Scientific community

The outcomes are communicated to the pertinent international organisations. Scientific knowledge can be converted into useful information, regulations, and guidelines. Electronic resources are normally distributed by direct mailing to specified organisations and stakeholders that are in the partners' networks, to increase public awareness.

For the transmission of knowledge at both the research and industrial levels, technical journals, conferences, and workshops at both the national and international levels, industry meetings, and participation in industrial forums are being and will be utilised (this will be intensified in the Exploitation-focused phase, explained below in section 3.7.3).

3.6 Methodology

To make sure that the FASTEST outcomes are effectively and efficiently conveyed to the project partners, stakeholders, and wider audiences, the following internal and external communication activities will be carried out throughout the project's duration and afterwards.

3.6.1 Internal Communication

To effectively share information and guarantee that the deliverables are met, effective internal communication is essential. Therefore, to exchange project information, update progress, and share outcomes, frequent meetings and conference calls are being held. Two times a year, consortium and technical meetings are done and WP collaboration is facilitated using Microsoft Teams and/or teleconferencing tools.

Apart from individual emails, taking advantage of the project monthly conference call, SIE collects information from partners on the upcoming dissemination and communication activities and events, to update the Communication & Dissemination Plan and expedite a content curating process. As a result, the partners are better able to communicate and report on the project while also adopting a more methodical and focused approach. Each FASTEST consortium partner sends a representative to this meeting.

SIE has also set up a Microsoft SharePoint space, which will host the project materials for internal use, including regular updates on the project development, meeting documents (agenda, minutes, and presentations), and project reports. This will help partners communicate effectively with one another. A login name and password will be required to access this exclusive area.

In this SharePoint, SIE has shared two documents that are key for the project's dissemination and communication follow-ups. The first one is the so-called "Action Plan for Events", an Excel sheet where SIE regularly adds upcoming events (also partners add events when they detect that they are not registered) and partners check a box if they are planning to go. The other document is another Excel file, the so-called "Dissemination Tables", where partners register any promotion action that they take (see Annexe 2).

3.6.2 External communication

The consortium is making efforts to spread the word about its activities through the media, journals, conference presentations, trade shows, workshops, the Commission, and industry associations. The project's findings will be published in reports, academic publications, and articles. To encourage scientific collaboration, all public communications and scientific publications are being made open-access.

The partners will send SIE the text whenever a translation is required, and SIE will take care of modifying the design.

3.7 Development phases

As the project has different development phases, the communication focus would be different across each of them.

3.7.1 Phase 1: awareness phase

In this phase, FASTEST will prioritise the generation of a community of interested stakeholders and of suitable channels. It comprised from months 1 to 12.

3.7.2 Phase 2: scientific cooperation phase

This second phase will consist of knowledge management for the cooperation of FASTEST with similar projects and initiatives and ensuring the availability of research outputs to a targeted audience. It started in M6 and will last for the project duration.

3.7.3 Phase 3: Exploitation-focused phase

This phase will cover the support to the actual exploitation of project results via marketing towards end users (commercial results) or workshops and roadmaps (non-commercial results) and will comprise the final stages of the project (M24-M36).

3.8 Activities M1-M6

3.8.1 Project identity and materials

During the initial stage of the project, FASTEST's visual identity (which can be seen in of the section 3.3.1) was developed by ABEE, with feedback from SIE. It contained the project's logo and the brand guidelines (typography, colours). A project presentation (Figure 8), a roll-up, a poster, and a variety of other communication tools were also created (all of them can be seen in the Figures in the section 3.3.1 above). The partners were provided with a template for the deliverables (Figure 9), and a PowerPoint template (Figure 10).



Figure 8: FASTEST's presentation



Figure 9: Deliverables template



Figure 10: PPT template

3.8.2 Press releases

A press release (Figure 11) was launched at the beginning of the project. It was sent to more than 200 local and trade media by SIE and several consortium partners. It was also [uploaded to the "Downloads" section](#) of the website and [as a post in the "News" section](#). A second sending was done in October, reaching more than 300 media.



The FASTEST project kicks off to deliver more reliable, safer and long-lasting battery system designs

- FASTEST is a project financed with almost 5 million euros by the European Union within the framework of the research and innovation programme Horizon Europe with the aim of developing a fast-track hybrid testing platform for the development of battery systems.
- The initiative is supported by a multidisciplinary consortium of 14 partners comprising research centres, universities, consultancy companies, material suppliers, and cell manufacturers from 8 European countries.

Brussels, June 13, 2023. FASTEST, an initiative funded by the European Union within the framework of the research and innovation programme Horizon Europe with the aim of **developing a fast-track hybrid testing platform for the development of battery systems** has just kicked off with a meeting held in Brussels (Belgium).

To develop and market Lithium-ion batteries, manufacturers need to evaluate their **safety, performance, reliability, and lifetime** according to standardised methods that consume a remarkable amount of time and economic resources. The time or number of tests required, the expensive equipment and a generalised trial-error approach are determining factors, together with a lack of understanding of the complex multiscale and multi-physics phenomena in the battery system. Besides, testing facilities are operated locally, meaning that data management is handled directly in the facility, and that experimentation is done on one test bench. When several technology developers are involved, the lack of centralised data management and harmonised design of experiments only hampers the process.

In this context, the FASTEST project, made up of fourteen partners from eight different European countries, will work for thirty-six months on a strategy based on the development of a fast-track hybrid testing platform that capitalizes on a **smart Design of Experiments methodology for the accurate and reliable evaluation of cell, module, and battery pack parameters by combining physical experimentation and multi-scale and multi-physics modelling tools**. This will enable an accelerated battery system research and development process for more **reliable, safer, and long-lasting battery system designs**. Hence, providing a key competitive advantage to European cell and battery manufacturers to provide quickly and efficiently the requested quality product for original equipment manufacturers in the international markets.

This innovative platform and its components will be demonstrated for three representative use cases: **automotive, stationary, and off-road vehicles**. The tool is aimed to be a flexible platform for any chemistry and application in the three previous scenarios mentioned since it will incorporate a complete set of physic-based and data-driven models able to replace most physical characterisation experiments.



Funded by the European Union under grant agreement N° 101103755. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [name of the granting authority]. Neither the European Union nor the granting authority can be held responsible for them.

Figure 11: FASTEST's first press release

The total impacts for this type of communications reached 547 outlets in total, including media, consortium partners and related projects portals, as shown in section 3.8.8.

3.8.3 Website

The website www.fastestproject.eu was launched on M5 with essential information of the project (as described in section 4.3.2) and will be updated constantly with progress and news from the project and partners.

Apart from the sections mentioned above, regarding the News section, 3 posts about the project scope and interviews to the partners have been uploaded by SIE:

- [The FASTEST project kicks off to deliver more reliable, safer and long-lasting battery system designs](#)
- [Interview with Álvaro Sánchez \(ABEE\)](#)
- [Interview with Foad Gandoman \(RSTER\)](#)

The figures of the website in this period can be seen in Figure 12 below.

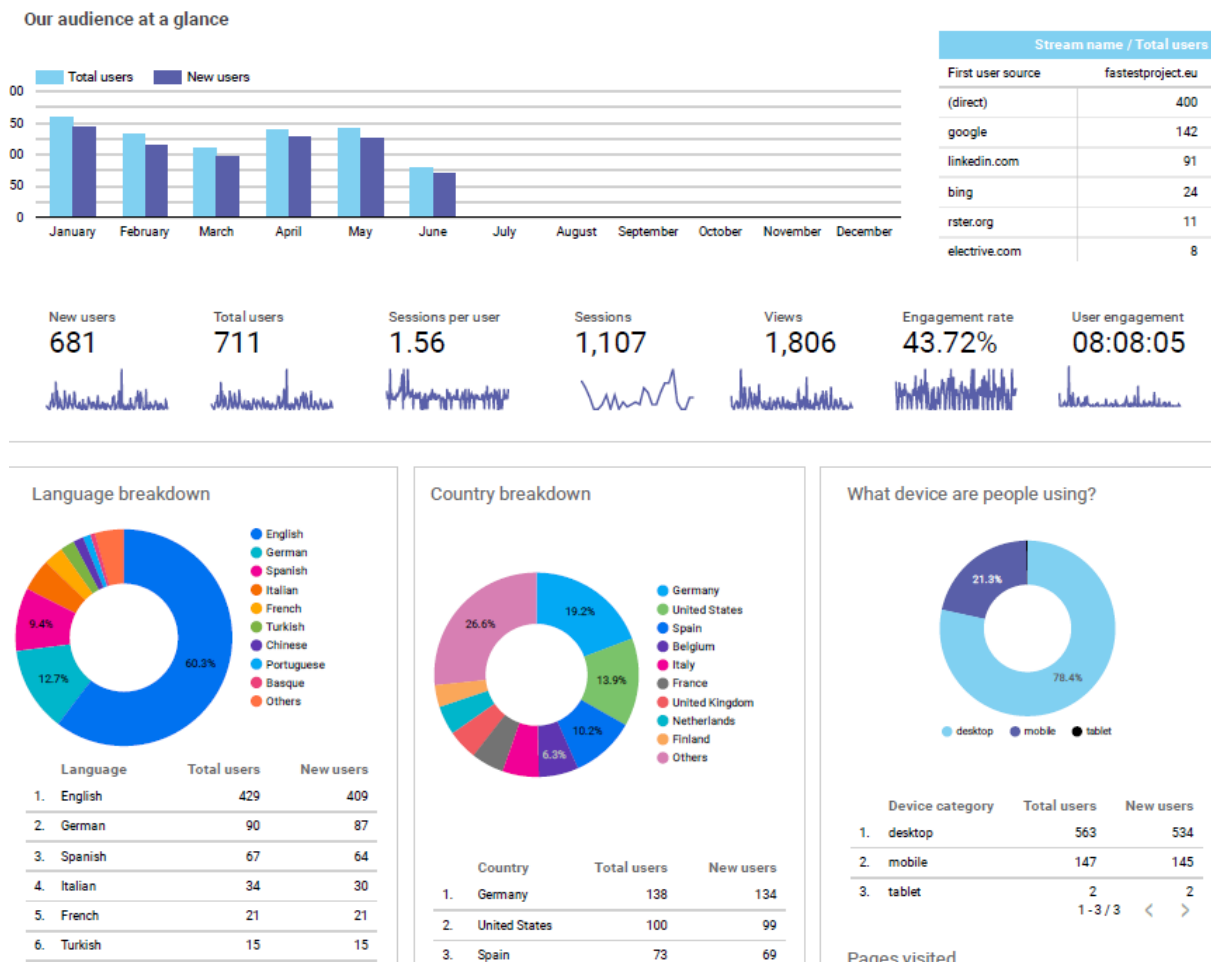


Figure 12: Website analytics M1-M6

3.8.4 Social media

The LinkedIn account (Figure 13): <https://www.linkedin.com/company/fastest-project> was created and updated with content on a regular basis since the project's kick off.

During this period, 16 social media posts were shared, reaching out up to 122 followers, and our publications had a total of 8 052 impressions and an average engagement rate of a 0.12 %, as of November 28th 2023.



Figure 13: FASTEST's LinkedIn account

3.8.5 Newsletter

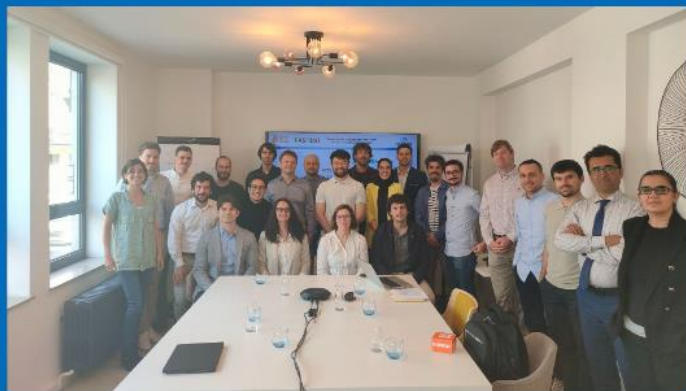
In M5, [the first Newsletter](#) was released, as can be seen in Figure 14. It was sent to 120 contacts, and was opened by 49 of them, which means a 40,83% open rate.

1st Newsletter

[View this email in your browser](#)



A revolution in battery testing technology



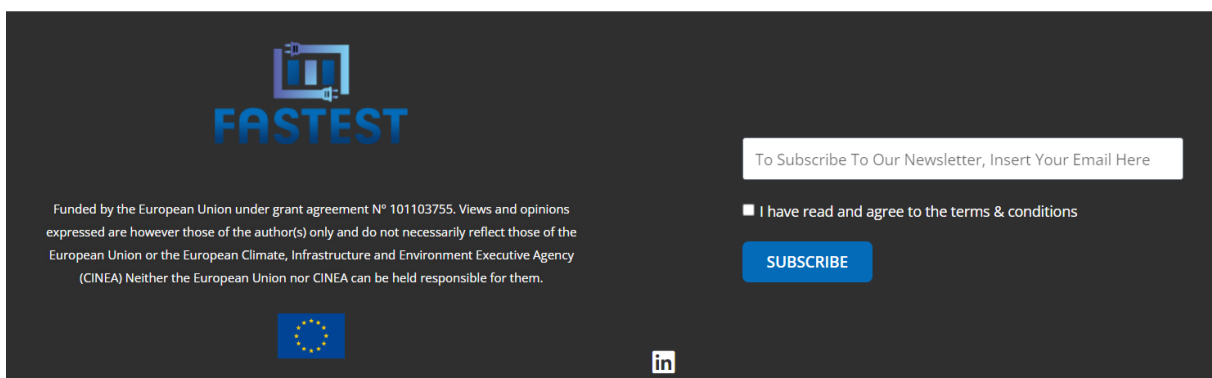
FASTEST, a project financed by the European Union (EU) under the Research and Innovation Framework Programme Horizon Europe **kicked off with a meeting in Brussels (Belgium) on June, 6th-7th.**

For 36 months, **15 partners from 9 different European countries will work together to bring to reality a new generation of test equipment for batteries.**

FASTEST will develop and validate a testing approach, which will be a symbiosis between physical and virtual testing, using Design of Experiments (DoE) principles.

Figure 14: FASTEST's newsletter

To grow the newsletter's subscribers, a subscription form has been added to the webpage footer, as shown in Figure 15.



FASTEST

Funded by the European Union under grant agreement N° 101103755. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA) Neither the European Union nor CINEA can be held responsible for them.

To Subscribe To Our Newsletter, Insert Your Email Here

I have read and agree to the terms & conditions

SUBSCRIBE



 

Figure 15: FASTEST's website footer

3.8.6 Events attended

During M1-M6 of the project, the different FASTEST members did not attend any event. However, SIE has been working to identify the relevant events where partners can disseminate the project, as described in section 3.3.7.

3.8.7 Interaction with other EU initiatives

The aim of the clustering is to ensure that the project undertakes cooperation and clustering activities at two levels:

1. Cooperation with specific projects and EC initiatives (especially under Batt4EU partnership and Battery2030+ initiative) with regards to exchange of information, coordination of methodologies, etc.
2. Develop joint communication and dissemination activities i.e., joint workshops to generate a multiplier effect.

In a first stage, SIE will map relevant EU projects and initiatives through desk research and feedback from partners. In a second stage, the project will screen the most interesting initiatives to establish direct communication channels with them, so joint technical, dissemination and communication activities can be agreed (ABEE as coordinator will lead this stage). The projects under the same topic were already detected and will be soon contacted to start clustering activities:

- <https://h2020thor.eu/>
- AccCellBaT (no website)

Apart from this, FASTEST has also a direct contact with some other projects where SIE is also involved and are also working on the battery field. Coordinated actions have been or will be done, such as supporting communication in social media, conjunct webinars or SIE serving as a point of connexion for technical partners. These projects' websites are:

- <https://nextcell.eu/>
- <https://tempestproject.eu/>
- <https://gigagreenproject.eu/>
- <https://defacto-project.eu/>

3.8.8 Impacts on media outlets and other relevant websites

UNIVERSITY OF LJUBLJANA:

<https://www.fs.uni-lj.si/en/project/fast-track-hybrid-testing-platform-for-the-development-of-battery-systems/>

RSTER:

<https://rster.org/projects/>

BE OPEN:

https://beopen.openaire.eu/search/project?projectId=corda_he::029998c7ec2d71bcd12329668550c7cb

UKRI:

<https://gtr.ukri.org/projects?ref=10078013>

SUSTAINABLE INNOVATIONS:

<https://sustainableinnovations.eu/fastest-hybrid-platform-test-electric-vehicle-battery/>

MONDRAGON UNIVERSITY:

<https://www.mondragon.edu/es/-/proyecto-ofrecer-plataforma-pruebas-hibridas-desarrollo-sistemas-bateria>

3.9 Activities M7-18

3.9.1 Project identity and materials

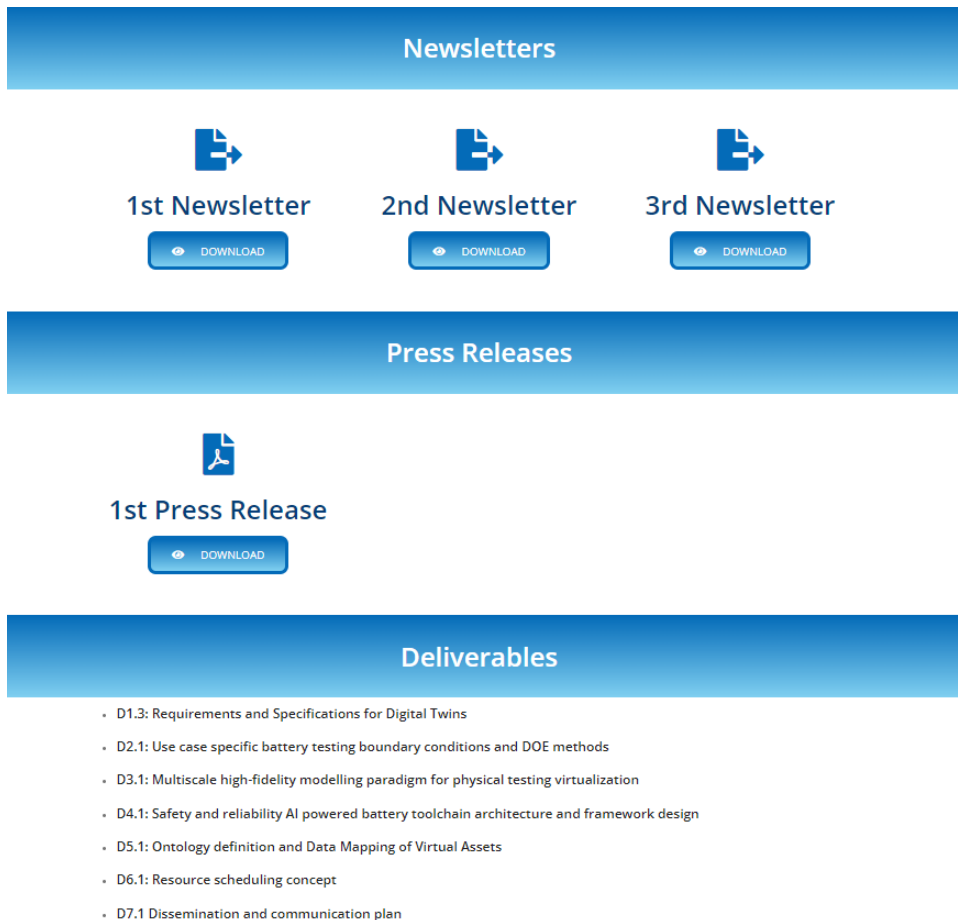
The project identity has been overall maintained, with small changes applied to most of the materials. The biggest change was to include the other funding entity, UKRI, in all the printed documents, templates, and the website. This also implied changing the EU logo and the disclaimer, which was updated to refer that the project is Co-Funded. Examples of these changes can be seen in Figure 16 and in Figure 17.



Figure 16: First page of the project presentation, updated with UKRI's logo

5. [Interview with Christian Ramones \(FEV\)](#)
6. [Interview with Naqeeb Tahasildar \(BMZ\)](#)
7. [Sustainable Innovations presents the FASTEST project at Genera](#)
8. [Interview with Daniel Matilla \(SIE\)](#)
9. [Interview with Antonio Silvio de Letteriis \(FLASHBATTERY\)](#)
10. [Mondragon University presents FASTEST on their 3rd Scientific Meeting of Battery-based Energy Storage Systems](#)
11. [Interview with COMAU](#)
12. [Flash Battery showcases FASTEST at the iVT Expo](#)
13. [Interview with VTT](#)
14. [FASTEST, at ISMA-USD2024](#)
15. [DigiBatt, AccellBat, Thor, and Fastest join forces in a first clustering meeting](#)
16. [FASTEST, at Signe's workshop at Ferrari facilities](#)
17. [Interview with IKERLAN](#)
18. [FASTEST, presented at the THOR Project's General Assembly](#)

The "Downloads" section has also been fed regularly. Concretely, the project's newsletters, press releases and public deliverables were uploaded (and subsections have been created) as soon as they were available, as can be seen in Figure 18.



The screenshot displays the 'Downloads' section of a website, organized into three main categories, each with a blue header bar:

- Newsletters:** This section contains three items, each represented by a document icon with a right-pointing arrow. The items are labeled '1st Newsletter', '2nd Newsletter', and '3rd Newsletter'. Below each label is a blue button with a white eye icon and the text 'DOWNLOAD'.
- Press Releases:** This section contains one item, represented by a document icon with a right-pointing arrow. It is labeled '1st Press Release' and has a blue 'DOWNLOAD' button below it.
- Deliverables:** This section contains a list of seven items, each preceded by a small blue dot. The items are:
 - D1.3: Requirements and Specifications for Digital Twins
 - D2.1: Use case specific battery testing boundary conditions and DOE methods
 - D3.1: Multiscale high-fidelity modelling paradigm for physical testing virtualization
 - D4.1: Safety and reliability AI powered battery toolchain architecture and framework design
 - D5.1: Ontology definition and Data Mapping of Virtual Assets
 - D6.1: Resource scheduling concept
 - D7.1 Dissemination and communication plan

Figure 18: "Downloads" section on the website

In this second period, the website received a total of 1,291 unique visits (an “excellent” target, following the project’s KPIs), and the average session duration of the visitors was 13:55 minutes, as shown in Figure 19.

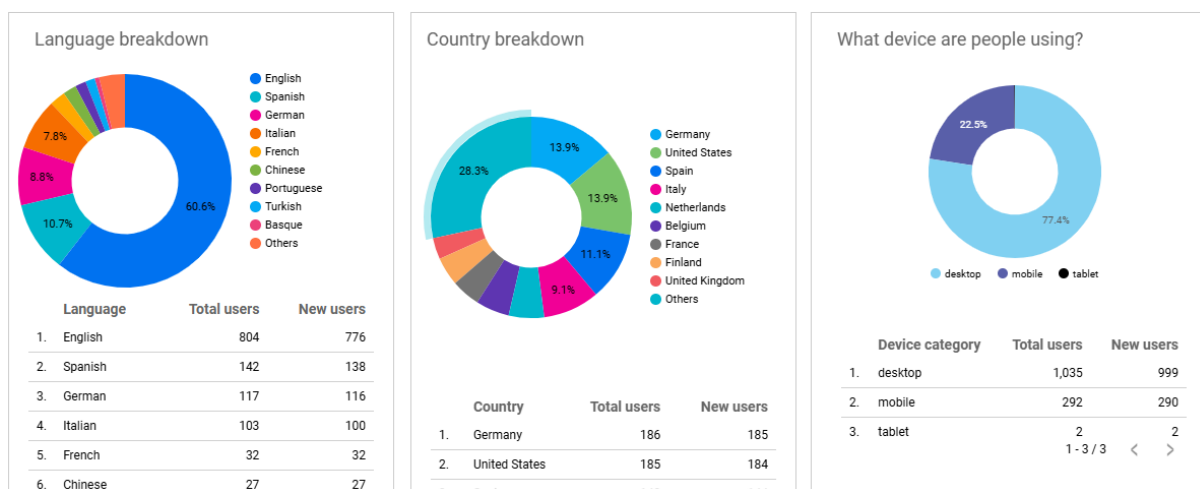
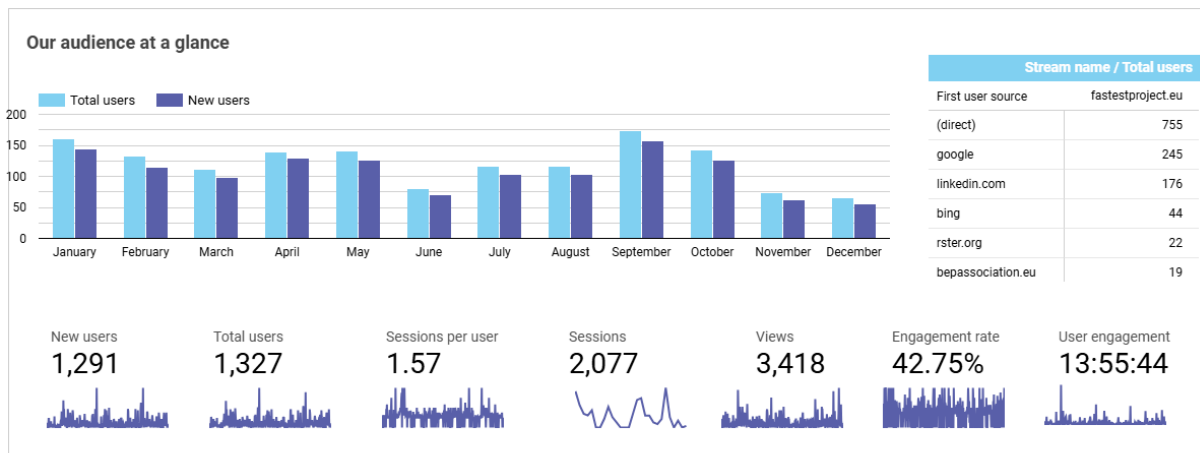


Figure 19: FASTEST’s website analytics (M7-M18)

A last action worth mentioning regarding the website was certifying that it is hosted in green hosting. This was done using [the app available on the Green Web Foundation’s website](#). This app generates a badge that states this fact, which was added to the FASTEST’s site footer, as seen in Figure 20.

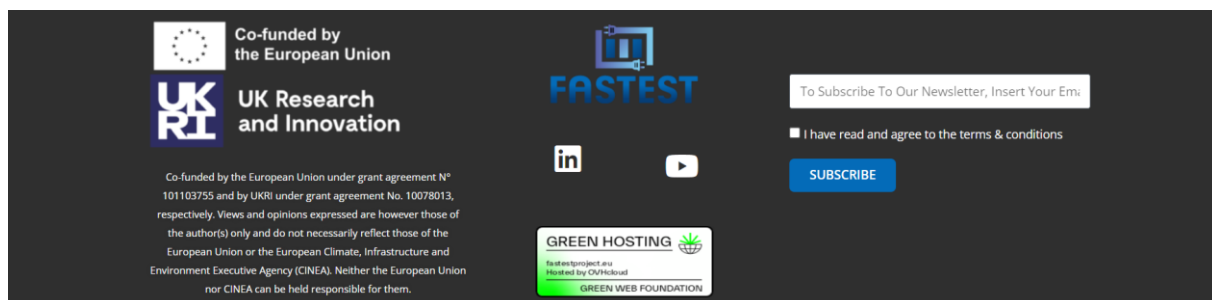


Figure 20: FASTEST footer with the green hosting badg

3.9.3 Social media

Social media networks have been updated or created responding to the project's communication and dissemination needs. Currently, FASTEST counts with two social media channels: LinkedIn and YouTube.

3.9.3.1 LinkedIn

Since its creation, the LinkedIn page has been updated weekly except during holiday periods (August and Christmas). Different styles of content have been shared, going from news from the project's website (Figure 21) to new documents coming from the project (Figure 22), events organised (Figure 23), or information that we considered relevant for the FASTEST audience (Figure 24).

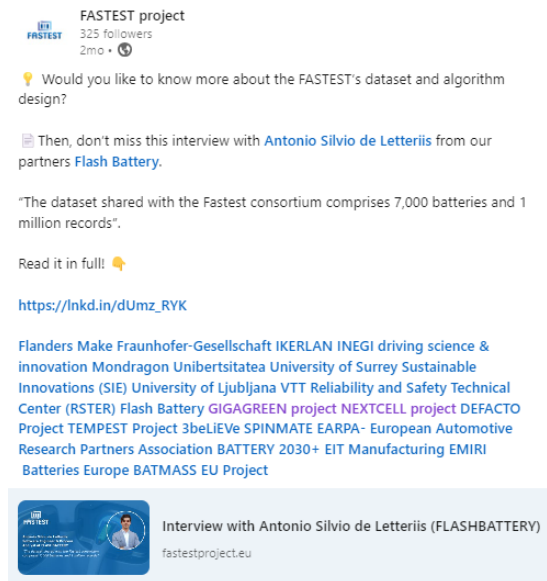


Figure 21: Post on LinkedIn with a news from the website

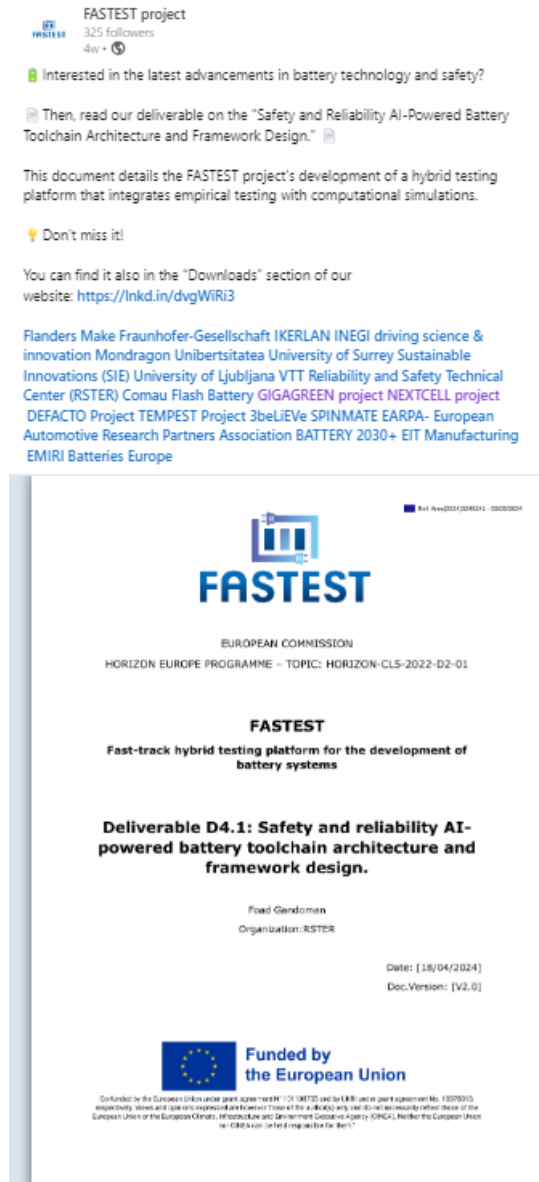


Figure 22: LinkedIn post promoting a deliverable

FASTEST project
325 followers
3w • Edited •

💡 Workshop: The future of EV batteries.

📌 Get to know more about the latest innovations in the battery field in Europe in this event organised by **SIGNE Project** at Ferrari, where our **FASTEST project** will be showcased.

Other projects like **Highspin**, **IntelliGent EU Project**, **TEMPEST Project**, **BIG LEAP Project**, **HAVEN EU Project** and **NEXTCELL project** will be there as well.

Don't miss it! 🗓️

📅 September, 24th, 9:30 - 16:00 CET

👉 Join online: <https://lnkd.in/dAxZ4U4>

Flanders Make Fraunhofer-Gesellschaft IKERLAN INEGI driving science & innovation Mondragon Unibertsitatea University of Surrey Sustainable Innovations (SIE) University of Ljubljana VTT Reliability and Safety Technical Center (RSTER) Flash Battery GIGAGREEN project NEXTCELL project DEFACTO Project TEMPEST Project 3beLiEVe SPINMATE EARPA- European Automotive Research Partners Association BATTERY 2030+ EIT Manufacturing EMIRI Batteries Europe



Figure 23: Post promoting the Signe project's workshop

FASTEST project
325 followers
2mo •

📌 **Batteries Europe** and **BEPA - Batteries European Partnership Association** have introduced five Position Papers, each addressing a vital area within the battery industry.

💡 These papers focus on Education and Skills, Sustainability, Safety, Social Sciences & Humanities, and Digitalisation.

Don't miss them to gain a wider perspective of the sector! 📌

<https://lnkd.in/dE6m2tXn>

Flanders Make Fraunhofer-Gesellschaft IKERLAN INEGI driving science & innovation Mondragon Unibertsitatea University of Surrey Sustainable Innovations (SIE) University of Ljubljana VTT Reliability and Safety Technical Center (RSTER) Flash Battery GIGAGREEN project NEXTCELL project DEFACTO Project TEMPEST Project 3beLiEVe SPINMATE EARPA- European Automotive Research Partners Association BATTERY 2030+ EIT Manufacturing EMIRI Batteries Europe BATMASS EU Project

Position Papers on Cross-cutting topics 2024
batterieseurope.eu

Figure 24: Post informing about BEPA papers

During this period, 44 social media posts were shared, reaching out to 342 followers, and our publications had a total of 32,294 impressions and an average engagement rate of a 12.6%, as of November, 18th.

3.9.3.2 YouTube

Once the project’s official video was done, [a YouTube channel](#) was created to give it more visibility. As can be seen in Figure 25, the video now has 53 views. After this, it was uploaded the recording of the “Empowering Europe” webinar (Figure 26), which is explained below in section 3.9.6.2, as well.



Figure 25: FASTEST project official video on YouTube



Figure 26: Empowering Europe webinar recording

3.9.4 Newsletters

To this date, 3 newsletters have been sent to the FASTEST audience, concretely 2 have been sent between M7 and M18. The 2nd newsletter (Figure 27) was sent in March 2024 to 124 subscribers and had a 41.94% open rate. The 3rd newsletter (Figure 28) was sent in September 2024 to 127 subscribers and had a 37.80% open rate.

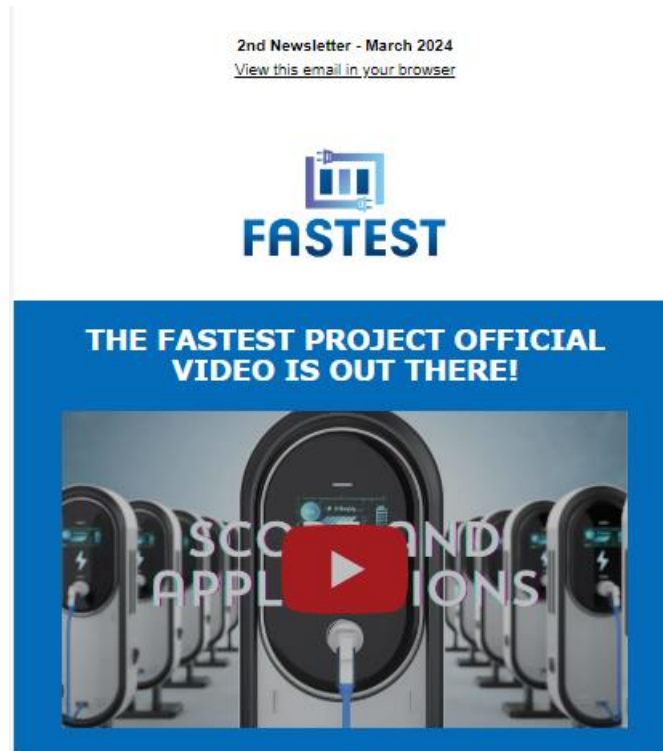


Figure 27: Second project's newsletter



Figure 28: Third project's newsletter

3.9.5 Events attended

Partners have attended 8 events in total in this period. Concretely, to the ones listed in Table 5 below.

Table 5: Events attended by partners

Event	Partner	Place and date
Battery Innovation Days	Comau	Bordeaux, December 2023
Battery Experts Forum	BMZ	Darmstadt, November 2023
Genera	SIE	Madrid, February 2024
360 Tech Industry event	INEGI	Porto, May 2024
3rd Scientific Meeting of Battery-based Energy Storage Systems	Mondragon	Mondragon, June 2024
iVT Expo	Flash Battery	Cologne, June 2024
ISMA-USD2024	IKERLAN	Leuven, June 2024
PhysML workshop 2024 ¹	Fraunhofer	Oslo, May 2024
Workshop on Advancing Scientific Machine Learning in Industry ¹	Fraunhofer	Garching, October 2024

3.9.6 Interaction with other EU initiatives

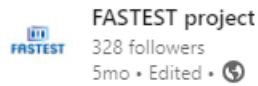
FASTEST has carried out an intense activity in terms of collaboration with related initiatives since the beginning of the project. Although the T7.2, which is the one related to this specific activity, was set to start in M12, some actions were taken before, intensifying gradually the degree of implication.

The actions taken in this period are a continuation of the ones described in section 3.8.7 of this document and are the following.

3.9.6.1 Empowering Europe webinar

FASTEST participated in a webinar organised by SIE to introduce seven EU-funded projects on battery innovation. The webinar, titled Empowering Europe, featured other participating projects such as [BATSS](#), [NEXTCELL](#), [TEMPEST](#), [VERSAPRINT](#), [EXTENDED](#), and [NEXTBAT](#). During the event, the project coordinators from each project provided a summary of their respective initiatives, followed by a Q&A session. The webinar attracted over 80 participants at its peak. FASTEST contributed to the dissemination by promoting the event through social media (an example can be seen in Figure 29), posting a pop-up on the project's website, and featuring it in the project newsletter. The event was recorded, uploaded to YouTube (as mentioned above), and shared via the project's social media platforms (Figure 30).

¹ We haven't written a post yet about these contributions because a scientific paper will be produced from it, and all the information will be published at once, as demanded by the partner in charge.



Last call to join our "Empowering Europe" Webinar!

7 EU-funded projects on battery innovation in just one event. Join us to know the future of European energy! 🚗 🔋

May 14th, from 14:00 to 15:15 (CET), online.

<https://lnkd.in/dsS-kyQC>

AVESTA BMZ Germany GmbH FEV.io Comau Flanders Make Fraunhofer-Gesellschaft IKERLAN INEGI driving science & innovation Mondragon Unibertsitatea University of Surrey Sustainable Innovations (SIE) University of Ljubljana VTT Reliability and Safety Technical Center (RSTER) Flash Battery GIGAGREEN project NEXTCELL project DEFACTO Project TEMPEST Project 3beLIEVe SPINMATE EARPA- European Automotive Research Partners Association BATTERY 2030+ EIT Manufacturing EMIRI Batteries Europe

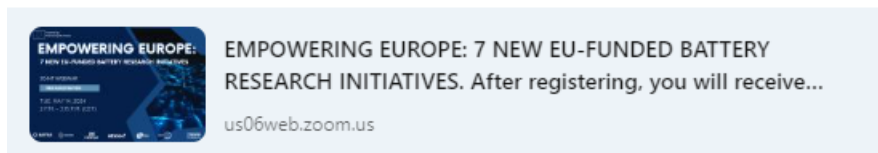


Figure 29: Last call for Empowering Europe webinar on LinkedIn



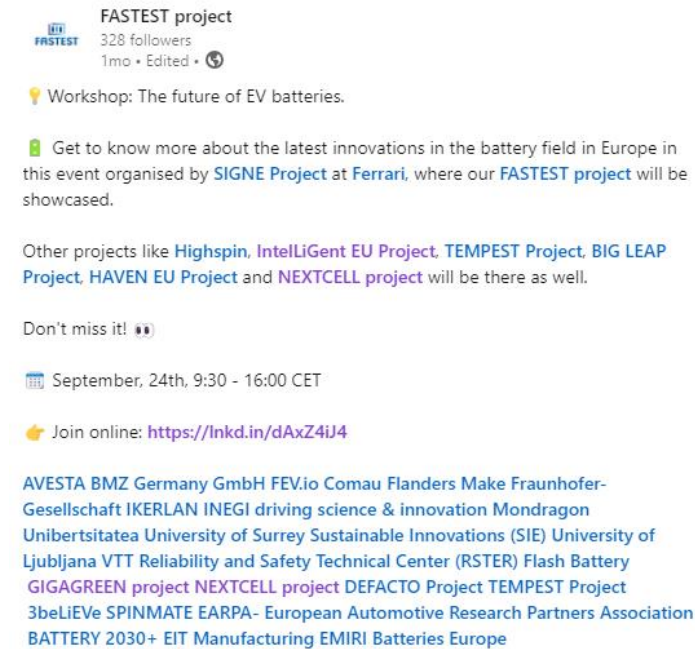
FASTEST AT EMPOWERING EUROPE: 7 NEW EU-FUNDED BATTERY RESEARCH INITIATIVES

Figure 30: Recording of the Empowering Europe webinar on YouTube

3.9.6.2 Signe workshop

On September 24th, the FASTEST project's coordinator, Bruno Rodrigues, presented the project at a workshop organised by a related project, Signe, on the Ferrari premises in Maranello. Our project coordinator participated online, as did other participants. Representatives from [NEXTCELL](#), [TEMPEST](#), [HAVEN](#), [BIG LEAP](#), [Signe](#) and [IntelLigent](#) also presented their projects. Before the event happened, it was promoted on the project's social media channels (Figure 31). Afterwards, Bruno's presentation was recorded and uploaded to FASTEST's YouTube channel

(Figure 32), and [a piece of news about the event](#) was published on the website and promoted on social media.



FASTEST project
328 followers
1mo • Edited •

Workshop: The future of EV batteries.

Get to know more about the latest innovations in the battery field in Europe in this event organised by **SIGNE Project** at Ferrari, where our **FASTEST project** will be showcased.

Other projects like **Highspin**, **IntelliGent EU Project**, **TEMPEST Project**, **BIG LEAP Project**, **HAVEN EU Project** and **NEXTCELL project** will be there as well.

Don't miss it!

September, 24th, 9:30 - 16:00 CET

Join online: <https://lnkd.in/dAxZ4IJ4>

AVESTA BMZ Germany GmbH FEV.io Comau Flanders Make Fraunhofer-Gesellschaft IKERLAN INEGI driving science & innovation Mondragon Unibertsitatea University of Surrey Sustainable Innovations (SIE) University of Ljubljana VTT Reliability and Safety Technical Center (RSTER) Flash Battery GIGAGREEN project NEXTCELL project DEFACTO Project TEMPEST Project 3beLiEVe SPINMATE EARPA- European Automotive Research Partners Association BATTERY 2030+ EIT Manufacturing EMIRI Batteries Europe



Figure 31: Promotion of the Signe workshop on LinkedIn



FASTEST at Signe's Workshop at Ferrari

Figure 32: FASTEST's participation at Signe workshop on YouTube

3.9.6.3 First meeting with projects under the same topic

On October 14th, SIE and ABEE worked together to organise and lead a meeting with the other three projects under the same topic: [DigiBatt](#), [AccCellBat](#), and [Thor](#). In the meeting, representatives of the four projects introduced themselves and their projects, and the following agreements were reached:

- Applying to the Horizon Results Booster.
- Creating a shared folder for internal communication purposes.
- Voting for a name for the cluster.
- Promoting the rest of the projects.
- Creating documents to propose topics:
 - Webinars (addressed to a wider audience, external).
 - Workshops (aimed at discussing common problems/challenges with specific topics among the consortia, internal).

From now on, meetings will be recurrent and will happen every two months.

3.9.6.4 Horizon Results Booster

ABEE, with SIE's support, applied to the Horizon Results Booster service representing FASTEST and the three projects mentioned above. They have been contacted for a first meeting that will happen on December, after the delivery of this document.

3.9.6.5 THOR General Assembly

Bruno Rodrigues, FASTEST project coordinator from ABEE, presented the project's progress at the THOR Project General Assembly, on November 19th, alongside contributions from DigiBatt and AccCellBaT. The session highlighted collaborative efforts among leading European battery initiatives (Figure 33).

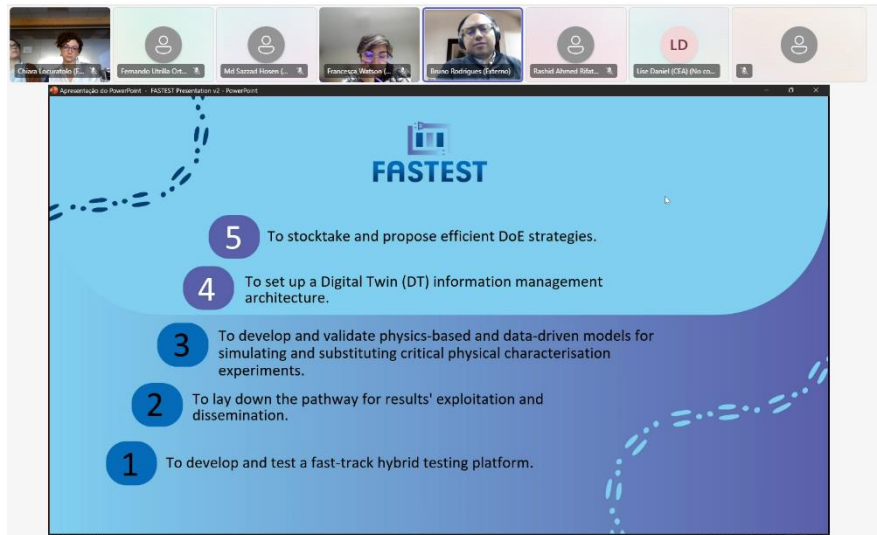
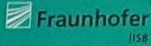


Figure 33: FASTEST presented at THOR's General Assembly

3.9.7 Scientific contributions

Although to this date no scientific contribution framed in the FASTEST project has been published, at least two contributions are being prepared and will be published soon:

- INEGI and RSTER drafted a paper and submitted it to the [16th International Conference in Knowledge Engineering](#), entitled "Towards Developing an Ontology for a Digital Twin in Battery Testing".
- Fraunhofer presented also a poster at the "Workshop on Advancing Scientific Machine Learning in Industry" (Figure 34), which will become a related paper.



Physics-Informed Deep Operator Networks as Surrogate Models of Lithium-Ion-Batteries

Philipp Brendel and Andreas Rosskopf
Fraunhofer Institute for Integrated Systems and Device Technology IISB, Erlangen, Germany

I. Introduction

Motivation:

- Difficulties in parameter identifiability for surrogate models of Lithium-Ion-Batteries (LIB) cause high expenses in time and cost during R&D.
- Design-of-Experiment (DoE) methods aim at an efficient model parametrization by maximizing the information provided by measurements, e.g., via Fisher-Information-Matrices (FIMs).

Goals:

- Evaluate the potential of Physics-Informed Deep Operator Networks (PI-DeepONets) [1] as fast surrogate models for varying boundary conditions and parameter setups.
- Employ trained networks for optimal DoE [2] by fast approximation of FIM-related quantities.

II. Methodology

Single-Particle-Model (SPM):

- Derivation from Fick's Law of diffusion to describe lithium concentrations in spherically symmetric particles for anode ($j=n$) and cathode ($j=p$) via
$$\frac{\partial c_j(r,t)}{\partial t} = \frac{D_j}{r^2} \frac{\partial}{\partial r} \left(r^2 \frac{\partial c_j(r,t)}{\partial r} \right)$$
- Initial and Boundary Conditions
$$c_j(r,0) = c_j^0, \quad \frac{\partial c_j(R_j,t)}{\partial r} = \pm \frac{I(t)}{A_l j F D_j a_j}$$
- State-of-charge and voltage profiles can be post-processed from $c_j(R_j,t)$.

Physics-Informed Deep Operator Network (PI-DeepONet):

- Purely physics-driven loss terms minimizing residuals of PDE and initial/boundary conditions.
- Branch network: Generalizing over discretized current profiles $I(t)$ sampled from different function spaces:




Figure 1: Single-Particle-Model.

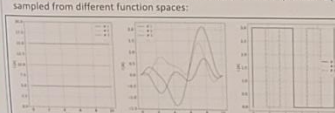


Figure 2: Example current profiles $I(t)$ for each considered function space.

- Parametrized trunk network: Generalizing over spatio-temporal domain and diffusivity parameter space (D_n, D_p)

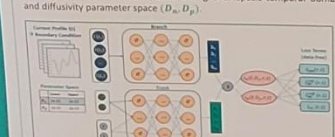


Figure 3: Parametrized PI-DeepONet for varying current profiles (branch) and diffusivities (trunk).

III. Results

Surrogate model accuracy:

- Normalized Mean Absolute Percentage Error at particle surfaces:
$$NMAPE^{surf} = 100 \frac{1}{N_t} \sum_{t=0}^{N_t} \frac{|c_j^{surf}(R_j,t) - c_j^{ref}(R_j,t)|}{\max(c_j^{surf}(R_j,t) - \min(c_j^{ref}(R_j,t))} \%$$

$I(t) \in \mathcal{B}_{[0,1],(0,1)}$	Average NMAPE ^{surf} [A vs. mins]	Evaluation for exemplary profile $I(t)$	
		$I(t)$	NMAPE ^{surf} (D_n, D_p)
CC	2.27%		
GRF	3.64%		
Pulses	6.30%		

Table 1. Evaluation of separately trained PI-DeepONets for each considered function space.

FIM analysis on CC function space:

- FIM quantifies the amount of information that an observable variable y carries about unknown parameters θ :
$$FIM(\theta) = \int_0^T S_y^T(t,\theta) Q(t)^{-1} S_y(t,\theta) dt, \quad S_y(t,\theta) = \nabla_{\theta} y(t,\theta)$$
- Analogously for SPM:
$$FIM(D_n, D_p) = \begin{bmatrix} \frac{\partial c}{\partial D_n} \tau + \left(\frac{\partial c}{\partial D_n} \right) \tau + \left(\frac{\partial c}{\partial D_p} \right) \tau \\ \left(\frac{\partial c}{\partial D_n} \right) \tau + \left(\frac{\partial c}{\partial D_n} \right) \tau + \left(\frac{\partial c}{\partial D_p} \right) \tau \end{bmatrix}$$

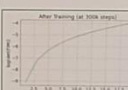


Figure 4: Evaluation of FIM-determinant via trained PI-DeepONet.

FIM-related gradients	PyBAMM	Parametrized PI-DeepONet
$\frac{\partial c}{\partial D_n}(R_n, t, I)$	-1.25 s	-0.5 s (AE)
$\frac{\partial c}{\partial D_p}(R_p, t, I)$	43 mins	-0.5 s (parallel AE)

Table 2. Inference times for FIM-related gradients (Intel Core i7-8650U).

IV. Conclusion / Outlook

Parametrized PI-DeepONets as versatile surrogate models for LIBs:

- Promising generalization capabilities for different current profiles and diffusivity setups within a single network / training setup.
- Potential for application in DoE methods due to fast approximation of FIM-related gradients after training.

Outlook:

- Investigation of advanced architectures for Operator-Learning and more complex parameter learning setups, e.g., with non-constant diffusivities.
- Application to advanced battery models, e.g., incorporating electrolyte dynamics and aging effects.

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[1] Brendel, P., Rosskopf, A., & Kowitz, G. (2022). Physics-informed deep neural operator networks. In *Machine Learning for Modeling and Simulation: Methods and Applications* (pp. 233-254).
[2] Park, S., Ross, C., Sank, J., Park, A., & Moore, S. (2018). Optimal experimental design for parameterization of electrochemical lithium-ion battery models. *Journal of The Electrochemical Society*, 165(7), A1396.

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Figure 34: Fraunhofer's poster

