

UNDER EMBARGO UNTIL TUESDAY 23<sup>RD</sup> MARCH, 12 NOON GMT / 1PM CET



**WILLIAMS** | ADVANCED  
ENGINEERING



## PROJECT TRIUMPH TE-1 CREATING UK ELECTRIC MOTORCYCLE CAPABILITY

### PHASE 2 – POWERTRAIN PROTOTYPE

With the exciting reveal of the innovative advanced electric powertrain and battery and the first styling sketches for the final Project TE-1 Prototype, Phase 2 of this landmark four phase collaboration in British design and engineering reaches a successful conclusion.

Delivering on the objectives announced at the start of the TE-1 project in May 2019, focused on developing specialist electric motorcycle technology and innovative integrated solutions, this unique collaboration between Triumph Motorcycles, Williams Advanced Engineering, Integral Powertrain Ltd, and WMG at the University of Warwick funded by the Office for Zero Emission Vehicles, has already achieved significant results.

Including innovation in battery and powertrain design, initial test performance results far exceed the current benchmarks and industry targets. Developments in performance, efficiency and range is enabling Project TE-1 to fully deliver the partnership's objectives to enhance the credibility and profile of British industry providing substantial input into future electric motorcycle strategy from Triumph.

- **Announcing the completion of Phase 2** - with the reveal of the battery and powertrain prototype, initial high level performance results, and the first design concept drawings for the Project TE-1 Prototype motorcycle that will be created at the end of the next phase.
- **Key project achievements to date** include test results that show significant innovation in mass, battery technology, and powertrain performance that exceeds the target set by the UK Automotive Council for 2025, meeting the project's ambitious objectives to deliver genuine innovation for a new standard in fully usable electric motorcycle performance.
- **Project TE-1 is a unique collaboration between four major UK industry and academic leaders** – Triumph Motorcycles, Williams Advanced Engineering, Integral Powertrain Ltd.'s e-Drive Division, and WMG, at the University of Warwick.
- **The objective of this two-year project is focused on developing electric motorcycle capabilities** – providing an input into Triumph's future electric motorcycle offer, driving innovation, capability and new intellectual property, enhancing the credibility and profile of British industry and design.
- **Project TE-1 is funded** by the UK Government's Office for Zero Emission Vehicles (OZEV), and delivered through Innovate UK.

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“The completion of Phase 2, and the promising results achieved to date, provide an exciting glimpse of the potential electric future and showcase the talent and innovation of this unique British collaboration. Without doubt the outcome of this project will play a significant part in our future efforts to meet our customer’s ambition and desire to reduce their environmental impact and for more sustainable transportation.” said **Nick Bloor, Triumph CEO**. “This important project will provide one of the foundations for our future electric motorcycle strategy, which is ultimately focussed on delivering what riders want from their Triumph; the perfect balance of performance, handling and real world usability, with genuine Triumph character.”

## **PROJECT TE-1 – PHASE 2 OUTCOMES**

### **Battery and powertrain prototype**

#### **WILLIAMS ADVANCED ENGINEERING (WAE)**

Based on the agreed specification, we identified appropriate cell technology and battery architecture to deliver the performance objectives. Using this as a framework, we then optimised the battery module layout to balance mass and positioning within the prototype chassis taking into consideration centre of gravity, space and relationship with the powertrain and charging approach.

In addition to the module layout, we have also developed a new and unique vehicle control unit which is integrated into the battery pack to minimise weight and packaging. In parallel, WAE has also created innovative battery management software to ensure power is delivered in relationship to battery performance.

The outcome of Phase 2 for WAE includes a fully bench-tested battery with performance results that exceeds anything else on the market in terms of Power and Energy Density.

“We are delighted to be working on this project, working to deliver next-generation battery technology and control systems. Within the current landscape, most electric motorcycle technology arguably delivers compromised performance at low levels of battery charge. By using a lightweight, compact solution we have been able to give the rider all of the performance all of the time (regardless of battery charge), and a class leading range. We have focussed on pushing the boundaries to reduce mass and optimise frame position to benefit handling. We have also pushed the limits of battery performance, balancing the design for acceleration and range, with simulations modelled on track-based riding. In other words, as aggressive as possible,” said **Dyrr Ardash, Senior Commercial Manager**, Williams Advanced Engineering. “The energy density of this new battery will be a significant step forward from existing technology giving the rider more power, for longer. WAE has also designed and developed an electronic control unit from the ground-up combining the battery management system with the bike control functions in one package. This is a first for this market, benefiting packaging and integration whilst optimising performance and range.”

#### **INTEGRAL POWERTRAIN LTD.’S E-DRIVE DIVISION**

Our experience in cutting edge motor and inverter design and manufacture has helped us to push this technology on to the next level for the TE-1 project. In Phase 1 we worked to integrate the normally separate motor and inverter into one single, compact, package. Integration reduces the mass and volume of the drivetrain by reducing additional boxes on the vehicle, mounting features, coolant pipework and heavy high voltage connections.

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The innovative integration concept is also a fully scalable one, whereby the number of power stages can increase for larger diameter, higher torque motors for example. Combined with our state-of-the-art motor technology, we have seen very exciting results already, with the motor achieving a power density twice that of the target set by the UK Automotive Council for 2025.

We have also implemented advanced silicon carbide switch technology in the inverter, this reduces losses in the inverter and results in greater drivetrain efficiency, power delivery and range. At the end of Phase 2, we are proud to have built a fully operational, new, prototype motor that has been bench tested and is delivering on all aspects of performance.

“One of the most influential factors in how well a motorcycle handles and performs is mass, so at Integral Powertrain we have focused heavily on making a step change in motor and inverter design, removing heavy high voltage cables for example. This delivers a product that is significantly more compact and lighter than anything currently available on the market. The motor produces 130kW or almost 180 horsepower, but weighs only 10 kilograms, much lighter than existing technology and clearly a small fraction of the mass of traditional internal combustion engines.” said **Andrew Cross, Chief Technical Officer at Integral Powertrain Ltd.** “The silicon carbide switch technology in our new scalable integrated inverter will help set new standards in terms of electric motorcycle efficiency; application of this technology means a lighter weight overall with significantly more performance and range. In parallel, we have a very strong focus on design for manufacture and assembly activity, so that all this high motor and inverter performance can be offered cost-effectively. Ultimately, this is really going to be an industry-leading powertrain that will help define the future of electric mobility. With the TE-1 project we are proud to be part of this landmark project for British industry.”

### **WMG, AT THE UNIVERSITY OF WARWICK**

At WMG we have been working closely with all the TE-1 partners during Phase 1 and 2 to develop representative models to simulate the systems of the bike including battery, motor and vehicle control. Initially this allowed us to validate the specification against the intended component selection by assessing performance criteria such as range and top speed with initial models. This has enabled Triumph to carry out software development at an early stage prior to hardware being built with thorough testing programmes to ensure that real-life testing can deliver on refinement. Most recently we have been conducting powertrain rig testing using the prototype IPT powertrain to ensure our simulations are accurate and to confirm that the motor functions within the system as intended. We have also been providing guidance to Triumph relating to future legislation, charging infrastructure and recycling strategies that will need to be implemented across future electric motorcycle platforms.

“Our creation of initial computer-based simulation models at the start of Phase 1 has been instrumental in ensuring that the component selection was appropriate to achieve the performance targets defined by the partners for the TE-1 Prototype. We have continued with this work across Phase 2 of the project, refining the models to a much more complex level to allow us and the partners to imitate further components on the bike such as braking, throttle, lighting and other systems and mimic real-world riding to provide development opportunities before components were fully designed. Additionally we have created a physical rig wired with all of the control units, in order to implement a design validation test programme to ensure the function of each section was within the allowable range.” said **Truong Quang Dinh, Assistant Professor of Energy Management and Control Systems at WMG, University of Warwick.**

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Throughout phase 2 Triumph have developed an all new advanced vehicle control software which incorporates all of the electrical systems to ensure intuitive throttle response, regen braking, traction control and all of the dimensions that a customer would expect from a high-performance Triumph motorcycle. Additionally, we have integrated leading functional safety strategies into this software, plus supported WMG in rig testing and have also fully developed the new prototype instrument display. Alongside this electrical and control system work, we have designed a brand-new prototype chassis including main frame and rear frame which have been optimised alongside the battery and motor packages which will be further evolved in Phase 3 into the TE-1 Prototype which will be used as a mule test platform in Phase 4. During this chassis development we have taken into account both the transmission design and the final styling of the TE-1 Prototype, the drawings of which we are pleased to reveal for the first time today.

**Steve Sargent, Triumph's Chief Product Officer** said "The starting point for us in the TE-1 project was to gather important customer feedback about what riders really want from their motorcycles and understand how an electric motorcycle can provide the experience that riders desire. This includes considering the type of riding, range, feel and nature of power and torque delivery together with the ergonomics and bike controls. Taking all of this feedback into consideration we began the chassis design, focusing on bringing everything together on the TE-1 Prototype in a way that provides a riding experience that is exciting and new but ultimately familiar. We have begun to define the powertrain and battery interaction through the use of software refinement to deliver an exhilarating power delivery and throttle response, which provides great control and feels intuitive to the rider. Overall with the styling we wanted to create something that is fresh and exciting but a natural evolution of the Triumph brand. Something desirable in its own right, with distinctive Triumph DNA and definitely not something that is different just for the sake of being different. Pulling all of this together with the partners we are thrilled to see the progress of such an exciting demonstration vehicle which incorporates the cutting-edge technology needed to guide the strategy for the future roadmap of electric motorcycles from Triumph. The team are proud to be leading such an innovative, strong and dynamic project with a fantastic group of partners which ultimately should set British engineering and design rightly at the forefront of future 2 wheel design."

## PROJECT TE-1 OVERVIEW

### Project TE-1 collaboration – Triumph Motorcycles, industry experts, academic leaders and UK Government

Project Triumph TE-1 is a ground-breaking collaboration between Triumph Motorcycles and the UK's electrification experts, each of whom is focussed on creating innovations in their own areas:

- **Triumph Motorcycles** is leading the project, providing advanced motorcycle chassis design and engineering expertise, manufacturing excellence and pioneering functional safety systems, as well as defining electric drivetrain power delivery characteristics.
- **Williams Advanced Engineering** is providing industry-leading lightweight battery design and integration capability, using its test and development facilities to deliver an innovative battery management system combined with vehicle control unit.
- **Integral Powertrain Ltd.'s e-Drive Division** is leading the development of bespoke power-dense electric motors and a silicon carbide inverter, integrating both into a singular motor housing.

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- **WMG, at the University of Warwick** is providing electrification expertise, and the critical vision to drive innovation from R&D to commercial impact, through modelling and simulation based on future market needs.
- **The Office for Zero Emission Vehicles (OZEV)** is a team working across government to support the transition to zero emission vehicles, as well as funding to support chargepoint infrastructure across the UK. This will contribute to economic growth and will help reduce greenhouse gas emissions and air pollution on UK roads. OZEV is part of the Department for Transport and the Department for Business, Energy and Industrial Strategy.
- **Innovate UK** is the government's research and innovation agency that supports business led R&D funding and UK business growth.

### **A two-year project focused on developing technical innovation and advanced electric motorcycle capabilities**

The project is organised into four main phases, with one of its key aims being increased systems integration. By developing individual components of automotive-based electric drivetrains and optimising them into innovative combined units, the project aims to deliver sophisticated electric motorcycle systems which reduce mass, complexity and package requirements.

Triumph Motorcycles is working alongside the partner organisations to accelerate joint expertise in the packaging and safety of batteries, optimum electric motor sizing and packaging, the integration of braking systems including regenerative braking, and advanced safety systems. The innovation and capabilities developed in these areas will input into Triumph's future electric motorcycle strategy.

The Project Triumph TE-1 partnership, with the support of the Office for Zero Emission Vehicles and Innovate UK, is focused on facilitating the creation of:

- Electric motorcycle capability that meets the needs of customers seeking lower environmental impact transportation, delivering against the UK's focus on reducing emissions
- Strong, commercially viable and sustainable partnerships with UK industry manufacturers and supply chains
- Expertise and capability within the UK workforce, creating jobs and a talent base that both ensures sustainable employment and drives the UK's reputation and influence on the world stage.

### **Dr Francesca Iudicello CEng MIMechE – Programme Manager – Automotive Zero Emission Vehicles – Innovate UK**

"Innovate UK has worked in close partnership with the Office of Zero Emission Office to deliver the integrated delivery programme since 2013. This provides funding to ground-breaking innovation in the automotive sectors for zero emission vehicle technologies from proof of concept to vehicle demonstration.

The TE-1 project is a part of this programme under the IDP15 competition and is aligned with the road to zero policy and marks an important milestone towards zero emission vehicles and the race to net zero.

We are proud to have delivered the funding for this project which is a pioneering project for the zero-emission vehicle motorcycle manufacturing in the UK as it has successfully developed, thanks to a very talented group of innovators, the very first Triumph electric motorcycle in a very quick development time and prepared the groundwork for the future of electric motorcycles."

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**Jon Bray – Research & Development (R&D) Lead - Office for Zero Emission Vehicles**

“Investment in Research and Development is key to our mission of putting the UK at the forefront of the design, manufacture and use of zero emission vehicles. By supporting these technologies, we are helping to deliver our road transport decarbonisation goals, while anchoring economic activity across the UK, which will support the green recovery in the wake of the pandemic.

This is why the Office for Zero Emission Vehicles continues to design and fund a series of R&D competitions, which support UK innovation in developing zero emission vehicle and charging infrastructure technologies.

Triumph’s TE-1 project is part of our diverse R&D portfolio of ambitious electrification projects, which are addressing challenges in line with our accelerated phase-out ambitions of petrol and diesel cars and vans and electric vehicle commitments in the Prime Minister’s Ten Point Plan.

We are excited to see that our funding is supporting Triumph Motorcycles in driving forward innovation and capability in the electric motorcycle space, while fostering collaboration between several pioneering UK companies”.

For further information contact Natalie Fern-Lyons on [natalie.fern-lyons@triumph.co.uk](mailto:natalie.fern-lyons@triumph.co.uk)

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## Notes to Editors

### About Triumph

- First established in 1902, Triumph Motorcycles celebrated 118 years of motorcycle manufacture in 2020. For more than three decades, Triumph Motorcycles has been based in Hinckley, Leicestershire, and has produced iconic bikes that perfectly blend authentic design, character, charisma and performance.
- Building around 60,000 bikes per year, Triumph is the largest British motorcycle manufacturer and has around 650 dealers across the world.
- This focus, innovation and engineering passion has today created a broad range of bikes suited to all motorcycle riders, including the stunning new Trident 660, epic new Tiger 900, world leading Rocket R and GT, new higher performance Street Triple 765RS, iconic Scrambler 1200, Speed Triple, transcontinental Tiger 1200, iconic Triumph Bonneville family including the sporty Speed Twin, Bonneville Bobber, legendary Thruxton RS, accessible Street Twin, Street Scrambler and iconic Bonneville T120 and T100, plus an exciting and accessible A2 range of Triumph motorcycles.
- Triumph currently employs around 1,800 personnel worldwide and has subsidiary operations in the UK, North America, France, Germany, Spain, Italy, Japan, Sweden (Scandinavia), Benelux, Brazil, India, China and Thailand as well as a network of independent distributors. Triumph has manufacturing facilities in Hinckley, Leicestershire, and Thailand plus CKD facilities in Brazil and India.
- The Triumph Bonneville, famously named to celebrate Triumph's 1956 land speed record on the Bonneville Salt Flats in Utah, USA, was the original British superbike and a race-winner straight out of the crate, chosen by famous motorcyclists of the past for its legendary handling, style, and character. Updated for 2021 with even more performance, capability and style, it's that handling, character and iconic looks, married to modern rider-focused technology that makes the new Bonneville family THE authentic modern classic choice today.
- Triumph has a glorious racing history, competing in and winning races in almost every class and field of motorcycle sporting achievement. From winning the second ever Isle of Man TT in 1908, through to 1960s road and track domination in Europe and America, right up to contemporary racing achievements with the 675cc Triumph triple powered 2014 Daytona 200 win, the 2014 Isle of Man Supersports TT win, the 2014 and 2015 British Supersports titles and World SuperSport racing, and again in 2019, with another victory at the Isle of Man Supersports TT, piloted by Peter Hickman.
- Triumph's racing legend continues as the exclusive engine supplier to the FIM Moto2™ World Championship since the start of the 2019 season. Triumph Motorcycles provides all of the teams with race-tuned 765cc triples, each of which is based on the class-leading Street Triple RS powerplant. Redefining the class and breaking record after record in the inaugural year, including the first ever +300km/h Moto2™ top speed, the 2020 season got even faster with another 11 all time lap records and seven different winners from 15 races.
- Triumph's racing activities are further bolstered by a return to the British Superbike paddock in 2021 with a factory-supported race team in the British Supersport Championship.

Website: [www.triumphmotorcycles.co.uk](http://www.triumphmotorcycles.co.uk)

Facebook: [www.facebook.com/TriumphMotorcyclesGlobal](https://www.facebook.com/TriumphMotorcyclesGlobal)

YouTube: [www.youtube.com/OfficialTriumph](https://www.youtube.com/OfficialTriumph)

For The Ride Blog: [www.fortherride.com](http://www.fortherride.com)

Instagram: [www.instagram.com/officialtriumph](https://www.instagram.com/officialtriumph)

Twitter: [www.twitter.com/OfficialTriumph](https://www.twitter.com/OfficialTriumph)

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## About Williams Advanced Engineering

Williams Advanced Engineering Limited is a world-leading technology and engineering business, born out of Williams F1 in 2010.

Based on the Williams technical campus in Grove, Oxfordshire, UK we successfully deliver projects for a global customer base. With over 300 employees, we pride ourselves in solving the most difficult applied engineering challenges for clients across a wide range of sectors, combining cutting edge technology and the industry's best engineers with precision and speed to market.

Our unique knowledge of high performance lightweight batteries has been honed in the highly-competitive and demanding motorsport arena and the company now provides battery systems for the majority of the global electric racing series including Formula E, Extreme E and ETCR.

WAE actively supports sustainability with innovative through transformational technologies and capabilities such as advanced simulation, digital and stress modelling, aerodynamic and thermodynamic optimisation, systems / full vehicle testing, integration, and low volume production.

EMK Capital acquired a majority equity stake in WAE in December 2019, unlocking the potential for further growth.

A multi-award-winning business, the company was accorded the RAC Simms Medal in 2015 and Queens Award for Enterprise, in 2018. For more information see [www.wae.com](http://www.wae.com), follow on [Twitter](#), [LinkedIn](#) and [Instagram](#).

## About Integral Powertrain Ltd

Integral Powertrain Limited (IP) is a global engineering & manufacturing business that, for more than 20 years has been continuously developing next generation electric powertrain technologies as part of the move towards a more sustainable way of powering vehicles. Working closely with prestigious manufacturers and Tier 1 suppliers globally, IP's engineers create some of the world's most innovative, high performance and market leading powertrain and power dense e-Drive solutions used for a wide range of applications in motorsport, passenger, and off-highway vehicles as well as aerospace, marine and industrial equipment.

The multiple award winning, record breaking company operates two divisions; Integral e-Drive and Integral Powertrain and employs over 150 people at its new Milton Keynes Technical Centre and Emissions Test Centre. The company was honoured with many awards in 2018, including the prestigious Royal Automobile Club's Dewar Trophy.

For further information see [integralp.com](http://integralp.com), follow us on [Twitter](#), [LinkedIn](#), [Facebook](#) and [Instagram](#) or email us at [contact@integralp.com](mailto:contact@integralp.com).

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### **About WMG, University of Warwick**

WMG is a world leading research and education group transforming organisations and driving innovation through a unique combination of collaborative research and development, and pioneering education programmes.

As an international role model for successful partnerships between academia and the private and public sectors, WMG develops advancements nationally and globally, in applied science, technology and engineering, to deliver real impact to economic growth, society and the environment.

WMG's education programmes focus on lifelong learning of the brightest talent, from the WMG Academies for Young Engineers, degree apprenticeships, undergraduate and postgraduate, through to professional programmes.

An academic department of the University of Warwick, and a centre for the HVM Catapult, WMG was founded by Professor Lord Kumar Bhattacharyya in 1980 to help reinvigorate UK manufacturing and improve competitiveness through innovation and skills development.

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