Press news for immediate release

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HIPERCAR

An all new Ariel

880kW · 1180 bhp
1800 Nm · 1330 ft lb

Ariel Motor Company, manufacturers of the Atom and Nomad cars and Ace motorcycle, release details of their all new, ultra-high performance, range extended, electric sports car project - HIPERCAR.

Standing for High Performance Carbon Reduction, the project is destined for full release in 2019 and Ariel production in 2020 alongside the Atom, Nomad and Ace. As with other Ariel vehicles the focus of HIPERCAR is on extreme performance, agility and usability, now coupled with zero and ultra-low emissions. To be available in four wheel drive and two wheel drive variants HIPERCAR will offer staggering performance utilising cutting edge, UK developed technology and will be built in Somerset, England by Ariel.

Phase 1 of the project, undertaken by Ariel with partners Equipmake and Delta Motorsport, will demonstrate both 2 wheel drive and 4 wheel drive prototypes and will be shown at the Low Carbon Vehicle (LCV) Show at Millbrook on 6 and 7 September 2017.

To be initially unveiled as a rolling chassis with all componentry visible, Simon Saunders, Director of Ariel, said, '*We're not unveiling final bodywork at this stage and it's unusual for a car manufacturer to do things this way round. What you usually get is an exterior concept with some vague promises about what is happening underneath and how wonderful it's going to be. But, as ever, we're different at Ariel and the core of HIPERCAR is the technology, the design and the engineering so that's what we are showing. This is an important part of Ariel's future so it has to be right*."

HIPERCAR, with a model name yet to be decided, is not just an Ariel production car, destined to be one of the highest performance and sought after vehicles in the world, but also a launchpad of UK developed technology into other niche, medium volume and ultimately high volume production. The vehicle showcases what the UK can achieve in the highly competitive and fast changing automotive sector with all key HIPERCAR components - motor, gearbox, battery, power electronics, range extender, chassis, driveline and mechanical components - developed by British companies. "*Developing another of the fastest cars in the world is important for Ariel," said Saunders, "but anchoring the technology in this country and building a British supply chain is vital for the economy*."

History

HIPERCAR began as a feasibility study in 2014 to investigate the direction for future Ariel growth and additional production cars to built alongside the Atom and Nomad. The study, drawing on Ariel's background, combined their drive to produce world beating performance cars with UK government policy to reduce automotive emissions. Investigating various hybrid architectures and analysing readiness of new automotive technologies, the study carried out exhaustive simulations to establish performance targets and overall requirements for the vehicle. It proved that not only was a range extended EV (Electric Vehicle) viable but that it had the ability to substantially outperform the equivalent pure internal combustion engine and mild hybrid cars in the Supercar sector, while maintaining zero and ultra-low emissions.

From this initial study HIPERCAR grew into a major R&D project, with Ariel being joined by partners Equipmake of Hethel and Delta Motorsport of Silverstone, winning over £2m in R&D funding from Innovate UK, the UK's innovation agency, to help develop the various technologies. Motors, power electronics, batteries, range extender and chassis have all been developed within HIPERCAR. Two battery packs have been developed for the car, one within the HIPERCAR project for the 4 wheel drive car and another within a separate £12m Innovate UK funded battery research project (AMPLiFII) for the 2 wheel drive version. The Ariel HIPERCAR platform takes the output of a number of UK R&D projects and turns them into production reality, beginning to build a UK automotive supply chain of the future.

"*The government assistance through Innovate UK to us and other contributing projects has been vital in developing the many technologies and components featured in the vehicle*," said Saunders, "*This is an extremely advanced cutting edge car that brings together UK developed technology in every aspect of its design. Not only is HIPERCAR going to be one of the fastest vehicles in the world but also one of the most technically advanced. The fact that it has been developed in the UK and supported by UK government agencies shows just how important the vehicle and the technology is to us and the UK economy*."

The R&D phase of HIPERCAR finishes in September 2017 with completion of the first prototypes. From October 2017 Ariel, Delta and Equipmake will be joined by large manufacturing partners GKN Hybrid Drive, Johnson Matthey and Semikron taking the vehicle and components forwards to further testing, development and production. The consortium, with steering group of JCB and Alexander Dennis, have been successful in securing a further £6m of grant support, to match the partners' investment, through the Advanced Propulsion Centre (APC), a £1bn initiative enabling the research & development of low-carbon propulsion technology.

Jon Beasley, Director – Technology and Projects at the Advanced Propulsion Centre, said: ***"****The HIPERCAR Project is a great example of how smaller companies and members of the UK's Niche Vehicle Network are creating opportunities to adopt, and bring to market, cutting edge low-carbon technology through their future vehicle programmes. This is one of a number of projects in the Advanced Propulsion Centre's portfolio that is significantly reducing CO2 and safeguarding or creating jobs, in addition to developing UK automotive capability. APC8, the next round of funding is now open."*

Vehicle Description

HIPERCAR is a Series Hybrid EV (Electric Vehicle) featuring a 750 Volt, 42 kWh or 56kWh, lithium-ion, cooled and heated battery pack which is charged, when required, by a 35kW micro-turbine range extender, negating any range anxiety issues and making the vehicle independent of any charging infrastructure.

HIPERCAR will be available as a 4 wheel drive or 2 wheel rear drive, full bodied car, the final exterior design of which is to be released at a later date. Based around an aluminium folded and bonded lightweight chassis with full rollover protection, the structure features aluminium front and rear subframes carrying aluminium wishbones and outboard adjustable suspension. Forged or carbon composite wheels carry 265/35/20 front and 325/30/21 rear tyres.

Powered wheels are driven by inboard motors via integral, single speed step-down gearboxes direct to driven wheels, with each individual motor developing 220kW (295bhp) and 450Nm (332 ft lb) of torque

In 4 wheel drive total power is therefore 880 kW (1,180bhp) and in 2 wheel drive form 440kW (590bhp).

Total torque is 1,800 Nm (1327 ft lb) at motor and 9,900 Nm (7301 ft lb) at the wheels in the 4 wheel drive HIPERCAR and 900Nm (664 ft lb) at motor and 4,950 Nm (3651 ft lb) at the wheels in the 2 wheel drive car.

A complete motor, gearbox and inverter assembly weighs only 57 kilos, contributing to the lightweighting throughout the vehicle.

The vehicle's electrical architecture consists of high and low voltage systems linked by multiple CAN networks enabling the Powertrain Controller, Vehicle Dynamic Control Interface and Battery Controller to communicate and interact with 12V and safety systems.

Pricing will not be finalised until later in the project. Simon Saunders said, "*Like other Ariels we want HIPERCAR to represent excellent value for money for the remarkable performance on offer. It will be an expensive car because of the technology involved but when compared to £1m+ supercars, which it will outperform, it's going to represent excellent value for money. This is the first true electric supercar that will cross continents, drive to town and lap a race track".*

Vehicle Performance

0 – 60 mph	**2.4 secs**
0 – 100 mph	**3.8 secs**
0 – 150 mph	**7.8 secs**
Top speed	**160 mph**

Vehicle Detail

Motor

The APM200 motor, developed by Equipmake in collaboration with partners Aim Co Japan, features a revolutionary rotor architecture in a lightweight aluminium housing. With a diameter of 318mm and weighing only 40 kilos each motor develops 220kW (295bhp) and 450Nm (332 lb ft) of torque. The rotor architecture features a “spoke” design, the magnets being arranged like the spokes of a wheel around the outside of the rotor, rather than the conventional solution where magnets are arranged in a V shape on the outside of the rotor laminations. This rotor design produces an increase in torque density of 25% compared with a conventional rotor, resulting in 25% less magnet material being required for the target torque. The unique design, patented within the HIPERCAR programme, incorporates direct cooling to the motor magnets by water glycol, allowing very high continuous power capability. The APM200, now being made ready for low volume production represents one of the lightest, highest power and torque density motors available in the automotive sector.

Gearbox

The HIPERCAR motor assembly incorporates an all new lightweight integrated epicyclic gearbox, weighing only 9 kilos. The single speed gearbox features a reduction ratio of 5.5:1, giving 2,475Nm (1825lb ft) per wheel. This fully integrated solution results in a compact package, saving weight and space on the vehicle while delivering phenomenal power. Gears are helical cut to reduce noise under load and, using advanced materials and heat treatment processes, have asymmetric tooth profiles and topological modifications to ensure increased durability and extended life. Efficiency and weight is further improved by the gearbox using a shared cooling system with the motor.

Motor Inverters and Power Electronics

A key part of the vehicle’s power electronics, the inverters have been developed by Equipmake specifically to meet the requirements of the HIPERCAR APM200 motor. Sitting above and connected to the motor the close coupling of the inverter reduces transmission losses in the interconnecting cabling, reduces weight, and improves EMC performance (Electromagnetic Compatibility). Efficiency is further increased and losses reduced by the use of the latest Silicon Carbide (SiC) Power Electronic Switch technology. Running at frequencies of up to 14kHz, to produce the waveforms required to drive the motor, the SiC components within the power electronic switches reduce the losses associated with this switching by up to 30%. The motor controller also updates the current demand at this rate, allowing the torque of the motor to be updated 14,000 times every second. The 4 motor/inverter systems are controlled by the central powertrain controller via CAN bus.

Vehicle Dynamic Control – Torque vectoring

With the power available at each wheel of HIPERCAR it is vital that power delivery is controlled from a performance as well as safety point of view, whether positive demands (acceleration) or negative (braking). Building on the research work carried out over the past 5 years on its own EV research vehicle, the E-4 Coupe, Delta Motorsport has developed sophisticated vehicle dynamics control capability to ensure the huge capability for cross-axle torque distribution in HIPERCAR is not mis-applied and performance is maximised. Scope for tuning HIPERCAR handling characteristics and power delivery, as well as providing stability control, is enormous whether focused on road or track applications.

Battery
Two battery systems have been developed for the HIPERCAR platform by Delta Motorsport. The 4 wheel drive battery pack, capable of delivering the staggering performance demands, has a nominal system voltage of 680V and peak of 750V, utilising a high power-density 26650 lithium-ion cell, to facilitate a peak current draw of 1200 Amps and maximum power capability of over 1,500kW.

The 2 wheel drive variant, with different drive cycle and performance targets, was developed within the AMPLiFII project headed by Warwick Manufacturing Group. Using a 18650 lithium-ion cell, the modular format pack is capable of delivering greater energy density while still providing a relatively high-power capability. The pack provides a nominal 648V and 56kWh capacity with peak current draw of 1050 Amps.

In order to overcome the challenges of thermal management in the packs, where average (RMS) power could be well in excess of 300kW, Delta have developed a unique and patented liquid-cooled system. Refrigerated water-glycol coolant is fed directly and evenly to every single cell in the pack, with the innovative solution being versatile enough to cope with the two differing pack architectures in 4 and 2 wheel drive vehicles. The effectiveness of this system is monitored by a large number of temperature sensors fitted throughout the pack and information is used to actively control the demand for heating or cooling as required.

Battery Control Systems
The complex task of battery management has been achieved in a tiered approach by Delta Motorsport supported by Potenza Technology. Each of the 67 battery modules, within the pack, has a local data capture board monitoring and managing the voltage of each parallel group of cells. This information is broadcast, along with the 360 measurements taken throughout the battery pack, into one of four sub-master units. These communicate with the battery master controller coordinating all information and making key decisions regarding parameters such as power limits, cooling requirements and current balancing. The master controller also has responsibility for contactor control, as well as interfacing with the powertrain controller and vehicle's 12v electrical systems.

Range Extender
Building on the output of the 'MiTRE' programme, a 17kW micro-turbine system released in 2016, Delta Motorsport have developed a 35kW version of its range extender to suit the HIPERCAR application. The unit features a gas turbine, running at a fixed 120,000 rpm to optimise efficiency, and operates at a nominal 750V generating power to maintain battery state of charge. The unit is automatically switched on and off as required via the battery management system, or by manual override. Weighing less than 50kg the range extender is significantly smaller and lighter than a piston engine alternative, allowing packaging flexibility and saving weight. The combustion system incorporates a recuperator and reduces emissions, particularly NOx, to a level well below legislative requirements.

Charging System
Provision has also been made on HIPERCAR to charge from the existing charging infrastructure and is compatible with CHAdeMO and Type 2 hardware. Ariel realise that it may be some years before the charging infrastructure is capable of supporting a 750V EV and have implemented an innovative approach to address the problem. The novel system allows a vehicle running an extremely high voltage battery to charge using existing industry standard (<500V) CHAdeMO equipment. The vehicles plug in capability is in addition to the onboard Range Extender which not only maintains state of charge during everyday journeys and high speed driving, but also allows off grid charging when no suitable CHAdeMO or Type 2 connection is available.

With approximately 1MW of power available between the four wheels the ability to recapture kinetic energy when off throttle is significant. Working within the capability of the battery system and vehicle stability, recharging of battery pack is carried out by the wheel motors .

Thermal Management
HIPERCAR features a multi-circuit heated and cooled water-glycol system for cabin HVAC, battery pack, power electronics and drivetrain. The complex architecture requires highly sophisticated control to ensure that all systems receive the specific attention demanded by their respective operating conditions across a wide range of drive cycles, from road to track. To maximise efficiency, optimise packaging and minimise vehicle weight some systems share essential hardware such as pumps, header tanks and their motorsport derived aluminium radiators. The thermal management system has been designed to operate in a temperature range of -20 degrees to 45 degrees ambient (Centigrade).

Chassis
The HIPERCAR chassis uses a laser cut and CNC folded, bonded aluminium monocoque with high strength safety roll over cage. Removable aluminium front and rear subframes are connected to the structure by precision machined aluminium interfaces, providing crush structure and mechanical mount points. With excellent torsional and beam stiffness, the all aluminium structure is designed to meet legislative requirements for front, offset and side impacts. The battery pack, integrated as low as possible under the floor and centre tunnel of the chassis to minimise centre of gravity, is mounted within the wheelbase to ensure security. Additional protection is achieved by the machined aluminium lower cover securing battery to chassis.

State of the art analysis of the chassis has been carried out in collaboration with ASDEC, an offshoot of Leicester University, investigating and refining the NVH (Noise, Vibration and Harshness) characteristics of the structure to ensure cabin comfort.

Aerodynamics
A comprehensive aerodynamic study was conducted with Brackley firm TotalSim using advanced CFD techniques normally applied to Formula One and top level motorsport to ensure that the HIPERCAR body is as efficient as possible. An important part of the work has been ensuring that drag is minimised and the complex requirements of the vehicle's multiple cooling systems are met, while delivering the downforce required for an ultra-high performance vehicle. The Atom AERO-P project, investigating the generation of downforce at zero speed, will feed into the next phase of the HIPERCAR programme.

Exterior
Exterior design will not be revealed until later in the programme but Ariel have released images to show the direction of the car and the results of initial testing. Various paths were investigated using the flexible architecture of the vehicle but, as with the Ariel Atom and Nomad, design is focused on light weight with functionality dictating design. The vehicle will feature a fully enclosed body, a first for Ariel, and will employ carbon fibre and lightweight materials with a concentration on aerodynamic requirements and performance. Large gullwing doors, allowing good structural stiffness and protection from high sills, have been tested on multiple rigs to allow ease of access for all levels of users.

Interior
Full interior design of the cabin is yet to be established however lightweighting with comfort and first class ergonomics will be a primary objective of Ariel in the detail design. Allowance has been made to accommodate 98 percentile driver and passenger with ease of ingress and egress an important part of the design.

Prototypes are shown with seats made specifically for the car by Seat Design Company in Derbyshire and a refinement of these will feature in the production car, together with other options. The reclining seats, with integral seat belt mounts, feature carbon fibre tube construction and pressure mapped design, weighing just 9kg each. Instrumentation is via two TFT displays supported by switchgear allowing a combination of manual and touchscreen operation.

Suspension, Steering, Brakes, Wheels and Tyres
HIPERCAR suspension features unequal length double wishbones all round, machined from aluminium billet for ultimate precision while maximising strength and minimising weight. Dampers, made by Bilstein UK, have independent adjustment of compression and rebound. Designed to maximise on road performance the dynamic driving experience reflects Ariel's reputation for engaging and entertaining the driver. With the addition of Vehicle Dynamic Control it will be possible to tune handling behaviour to suit driving conditions and driving style.

Steering is by a bespoke power assisted system, being developed specifically for HIPERCAR, with Ariel placing feel and feedback at the top of the priority list. A 330mm steering wheel, mounted on an adjustable reach and rake column, gives 2.25 turns lock to lock.

Foundation braking is taken care of by an AP Racing braking system comprising of six piston calipers on the front with 370x32mm ventilated and grooved discs, with four piston calipers and 328x30mm ventilated and grooved discs at the rear. Operated by a billet machined pedal with an adjustable ratio via an electric servo the assisted system has been tuned to provide feel and feedback, another essential element in creating the Ariel driving experience. Manual park brake is via individual lightweight Brembo calipers.

There is no regenerative braking on the vehicle, in order to maintain feel and consistency of brake pedal at all states of battery charge. As a true drivers' car performance and predictability is paramount to Ariel.

The huge power and torque of HIPERCAR is delivered to the road through Michelin Pilot Cup Sport 2 tyres in 265/35/20 size on the front and 325/30/21 on the rear. Further development through Michelin UK and Michelin France is planned during the ongoing test phases of the programme. Standard wheels are lightweight forgings, 9.5Jx20 at the front and 12.5Jx21 at the rear, with the option of a bespoke carbon composite wheel designed for HIPERCAR by British manufacturer Dymag for ultimate performance and weight saving.

Ariel HIPERCAR - a milestone in automotive history.

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