AUTOMOBILI LA'BERGITLA ENDURANCE SERIES

The Automobili La'Bergitla Endurance Series

Official Regulations & Technical Framework
All-Electric 24 Hours Racing

Establishing the Future of Endurance Motorsport
Innovation | Sustainability | Performance

Version:
2026 Official Rulebook

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Technical Division

The Automobili La'Bergitla Endurance Series

A Vision for the Future of Endurance Racing

Prepared By:

Automobili La'Bergitla Squadra di Motorsport Technical Division
2026 Official Submission

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Introduction

1.1 Overview of the Endurance Racing Series

The Automobili La'Bergitla Endurance Series is a revolutionary 24-hour endurance racing series that exclusively features all-electric prototypes. This championship represents the pinnacle of innovation in motorsport, blending the storied legacy of endurance racing with the latest advancements in electric propulsion, energy management, and battery technology. By pushing the limits of performance, efficiency, and sustainability, The Automobili La'Bergitla Endurance Series is set to redefine the future of endurance racing.

A Legacy of Innovation in Endurance Racing
For more than a century, the 24 Hours of Le Mans has stood as the ultimate proving ground for automotive innovation, engineering resilience, and technological ambition. Victory at Le Mans has never belonged solely to the fastest car — it has belonged to the most advanced, the most efficient, and the most intelligently engineered machine capable of surviving 24 relentless hours at the limit.

Throughout its history, Le Mans has consistently accelerated the evolution of road car technology. The race helped pioneer aerodynamic efficiency in the 1950s and 60s, turbocharging breakthroughs in the 1970s and 80s, and lightweight composite construction in the decades that followed. Since 2012, hybrid-electric prototypes have redefined performance expectations, proving that electrification and energy recovery can deliver both speed and efficiency at the highest level of motorsport. Many of today's production vehicle technologies — regenerative braking, advanced battery systems, and energy management software — trace their competitive origins back to endurance racing.

A defining strength of Le Mans has always been its willingness to evolve. The event has repeatedly embraced disruptive technologies, transforming motorsport rather than resisting change. The introduction of hybrid systems proved that efficiency could coexist with outright performance. Experimental Garage 56 entries have pushed boundaries even further, exploring hydrogen propulsion, alternative fuels, and electrified drivetrain concepts that challenge conventional racing norms.

The Automobili La'Bergitla Endurance Series continues this tradition of progress. Rather than abandoning the spirit of endurance racing, it extends it into the next technological era. Where Le Mans once proved the viability of turbocharging, diesel efficiency, and hybrid systems, this championship establishes the next frontier: **fully electric, high-performance, zero-emission endurance competition**.

This is not a departure from endurance racing's heritage — it is its natural evolution. Just as past eras redefined what performance meant, electric endurance racing redefines it once again: where energy management replaces fuel strategy, regenerative systems become as critical as aerodynamics, and engineering efficiency is as decisive as raw speed.

In doing so, The Automobili La'Bergitla Endurance Series does not merely follow the legacy of Le Mans — it carries it forward, ensuring that endurance racing remains the world's foremost laboratory for the future of automotive technology.

Pioneering the Next Era of Motorsport

This championship is more than just a new racing series—it is a technological showcase designed to accelerate the development of electric vehicle (EV) performance and infrastructure. By integrating state-of-the-art energy recovery systems, standardised swappable battery technology, and a network of sustainable charging solutions, The Automobili La'Bergitla Endurance Series proves that EV endurance racing can match—and even surpass—traditional internal combustion engine (ICE) formats in terms of performance, strategy, and excitement.

Core Objectives of the Series

The Automobili La'Bergitla Endurance Series is built on three key pillars that define its mission and impact:

1. **Technological Advancement:** The series provides a competitive environment for manufacturers and independent teams to develop and refine high-performance electric powertrains, advanced battery systems, and energy-efficient aerodynamics. These innovations will directly influence the next generation of EVs for both racing and consumer applications.
2. **Sustainability & Zero-Emissions Racing:** Unlike traditional endurance racing, which relies on fossil fuels, The Automobili La'Bergitla Endurance Series is a completely zero-emission series. Through renewable energy integration, battery swapping, and regenerative braking, the championship showcases sustainable solutions that can be adopted across the automotive industry.
3. **Strategic & Competitive Depth:** With unique challenges such as energy management, battery swap pit stops, and multi-class racing dynamics, this series introduces new strategic dimensions to endurance racing. Teams must optimize power deployment, maximize regenerative energy recovery, and carefully plan pit stop strategies, creating a fresh and engaging spectacle for fans and engineers alike.

Innovations That Define the Championship

To ensure The Automobili La'Bergitla Endurance Series remains at the forefront of technological and competitive excellence, several ground-breaking innovations set it apart from other racing series:

- **Swappable Battery Technology:** Unlike traditional endurance racing, where refuelling dictates pit stop strategy, The Automobili La'Bergitla Endurance Series introduces battery swapping stations. Teams will perform high-speed battery changes in the pit lane, mimicking the efficiency of refuelling stops while maintaining consistent power delivery throughout the race.
- **Advanced Regenerative Energy Systems:** All cars are equipped with cutting-edge regenerative braking and energy recovery technology, including shock absorber energy harvesting. These systems enable vehicles to recapture and reuse significant amounts of energy per lap, enhancing efficiency and extending range.
- **Homologated Electric Hypercar Platform:** The championship is built around a single class of homologated electric hypercars, ensuring close competition while controlling costs and maintaining technical direction. With standardised core systems—such as the swappable battery architecture and multi-speed electric transmission—teams compete through innovation in software, energy management, thermal efficiency, and vehicle integration rather than through escalating hardware spending.

- **Global Racing Calendar:** The championship is designed to be truly international, with races taking place across world-renowned endurance circuits, including the legendary Circuit de la Sarthe. Each venue presents unique challenges, from extreme weather conditions to varying track surfaces, testing the limits of electric endurance technology.

Revolutionizing the Motorsport Landscape
The Automobili La'Bergitla Endurance Series represents a bold step forward in motorsport, proving that electric racing is not just a niche segment but a viable and thrilling alternative to traditional endurance formats. By bridging the gap between sustainability and high-performance racing, this championship will attract the world's top manufacturers, engineers, and drivers, all competing to push the boundaries of what is possible with electric propulsion.

The future of endurance racing is here, and it is electric. The Automobili La'Bergitla Endurance Series is not just about adapting to change—it is about leading it. With a commitment to innovation, sustainability, and electrifying competition, this series is set to become the ultimate test of next-generation EV technology, shaping the future of motorsport and the automotive industry for decades to come.

1.2 Vision and Purpose

The vision for **The Automobili La'Bergitla Endurance Series** is to uphold the core principles of endurance racing - **reliability, efficiency, and teamwork over a gruelling 24-hour challenge** - while fully **revolutionizing** the motorsport landscape with **zero-emission electric power**. This series is designed not just as a race, but as a technological proving ground, where the next generation of **electric vehicle (EV) performance, energy recovery, and sustainable motorsport practices** will be defined.

At its core, **The Automobili La'Bergitla Endurance Series** is built upon three foundational pillars:

1. Honouring Motorsport Heritage While Driving Evolution
For over a century, Le Mans has been the pinnacle of endurance racing, where **innovation, strategy, and durability** take precedence over raw speed alone. The race has always been about **pushing boundaries**—from the dawn of aerodynamics in the 1920s to the **hybrid revolutions** of the modern era.

- **Continuing the Legacy:** The Automobili La'Bergitla Endurance Series preserves the legendary format of **24-hour endurance racing**, demanding the same high level of teamwork, mechanical reliability, and strategic execution that defines Le Mans.
- **A New Chapter in Motorsport:** The switch to fully electric power is a **natural evolution**, following the hybrid era that began in 2012. This championship will push **energy efficiency and powertrain durability** beyond anything seen before.
- **Balancing Tradition and Innovation:** The series is structured to remain **true to endurance racing principles** while allowing **cutting-edge developments** in electric propulsion, aerodynamics, and regenerative systems to shape the future.

2. Sustainability Without Compromising Performance
The Automobili La'Bergitla Endurance Series stands as definitive proof that sustainability and elite endurance motorsport are not mutually exclusive. The championship demonstrates that zero-emission

electric hypercars can deliver the speed, intensity, and spectacle expected of top-level endurance racing, while setting new standards in technological responsibility.

- **High-Speed, High-Stakes Racing:** The homologated electric hypercars in this championship are engineered for extreme performance, delivering instant torque, rapid acceleration, and sustained high-speed capability across long race distances. These vehicles are designed to meet the demands of the world's most challenging endurance circuits without sacrificing competitiveness or spectacle.
- **Endurance Meets Efficiency:** Unlike conventional electric racing formats constrained by static battery capacity or extended charging stops, this series pioneers high-speed swappable battery technology. Rapid battery exchanges enable continuous competitive running, ensuring that energy strategy, efficiency, and racecraft remain central to endurance racing.
- **Zero-Emission, Maximum Impact:** Fully electric propulsion eliminates on-track emissions while preserving the drama, strategy, and physical demands of endurance competition. The series proves that premier long-distance racing can evolve in step with global sustainability goals without diminishing performance or fan engagement.
- **Infrastructure for the Future:** From renewable-energy-powered paddocks to closed-loop battery lifecycle management and advanced charging and swapping infrastructure, The Automobili La'Bergitla Endurance Series establishes new benchmarks for sustainable event operations at the highest level of motorsport.

3. Accelerating the Next Generation of Electric Vehicle Technology

For decades, endurance racing has served as a proving ground for technologies that later redefine road cars. From braking systems to advanced powertrain control, the extreme demands of long-duration competition have consistently accelerated innovation and reliability in the automotive industry.

The Automobili La'Bergitla Endurance Series continues this tradition, operating as a real-world development platform for the next generation of high-performance electric vehicle technologies. By pushing electric systems to perform at maximum intensity over extended race distances, the championship directly contributes to advancements that will shape future production EVs.

- **High-Capacity, Quick-Swap Batteries:** The development of high-energy-density battery systems designed for rapid exchange during pit stops has the potential to transform electric mobility. Technologies proven in the championship could dramatically reduce downtime for road vehicles, offering future solutions that rival the convenience of traditional refuelling.
- **Advanced Regenerative Energy Systems:** The series drives innovation in regenerative braking and energy recovery technologies, including suspension-based energy harvesting. Improvements in efficiency, control, and energy recapture under extreme racing conditions will directly translate into longer range and smarter energy use in road-going EVs.
- **Thermal Management and System Reliability:** Sustaining peak performance over endurance race durations places extraordinary demands on batteries, inverters, motors, and transmissions. The resulting advancements in cooling systems, thermal modelling, and high-load durability will enhance the reliability, longevity, and performance consistency of next-generation consumer electric vehicles.

Through these innovations, The Automobili La'Bergitla Endurance Series reinforces endurance racing's role as a catalyst for real-world automotive progress — proving that the technologies of tomorrow are forged under the most demanding competitive conditions.

A Championship Aligned with the Future of Endurance Racing
This championship is a direct response to endurance racing's long-standing commitment to technological evolution and new energy solutions. As the sport looks toward sustainable propulsion, advanced energy systems, and reduced environmental impact, The Automobili La'Bergitla Endurance Series stands at the forefront of that transformation.

By launching a dedicated all-electric endurance racing platform, the series ensures that the pioneering spirit of long-distance competition remains firmly at the cutting edge of motorsport innovation. It establishes a new, future-proof performance benchmark for electric endurance racing while staying true to the core values that have defined the discipline for generations: **innovation, resilience, efficiency, and the relentless pursuit of performance over extended race distances.**

Rather than following tradition, The Automobili La'Bergitla Endurance Series builds upon endurance racing's legacy as a technology accelerator — proving that the future of high-performance motorsport can be both electrifying and sustainable.

A Championship Aligned with Le Mans' Vision for the Future
This championship is a **direct response** to the **Automobile Club de l'Ouest (ACO)'s commitment to new energy technologies**, including discussions around **battery-swapping electric race cars at Le Mans**.

By launching a dedicated all-electric endurance series, **The Automobili La'Bergitla Endurance Series** ensures that the **pioneering spirit of endurance racing remains at the cutting edge of motorsport**. It establishes a new, future-proof **performance benchmark** for electric endurance racing, while staying true to the **values that have defined Le Mans for a century** - innovation, resilience, and pushing the limits of what is possible.

1.3 Innovation in Electric Motorsport

The Automobili La'Bergitla Endurance Series does not merely introduce electric propulsion into endurance racing — it redefines how energy is **generated, stored, deployed, recovered, and optimised** over long-duration competition.

Unlike conventional racing formats where liquid fuel or hybrid systems dictate strategy, this championship is built around a fully integrated electric energy ecosystem. Every aspect of performance — from acceleration and top speed to stint length and pit strategy — is shaped by advanced energy management, pushing teams to extract maximum efficiency and performance from every joule of stored energy.

The series pioneers a holistic approach to electric endurance racing through the integration of:

- **High-speed swappable battery systems**, enabling sustained competitive running without extended charging downtime
- **Advanced regenerative energy technologies**, capturing energy from braking and vehicle dynamics to improve overall efficiency
- **High-power supercapacitor buffers**, supporting peak power demands, rapid energy transfer, and improved system responsiveness

Together, these innovations establish The Automobili La'Bergitla Endurance Series as a new benchmark for high-performance, long-distance electric competition — where endurance is measured not only in hours on track, but in the intelligent and efficient use of energy.

1.3.1 Standardised Swappable Battery System

To ensure competitive fairness, operational reliability, and the viability of high-speed electric endurance racing, all vehicles shall utilize a **championship-standardised, underside-mounted swappable battery pack** developed specifically for The Automobili La'Bergitla Endurance Series.

This system forms the foundation of the championship's energy architecture and defines a common performance baseline in energy storage while preserving innovation in vehicle design and control systems.

- **A Level Playing Field in Energy Storage:** While teams retain design freedom in areas such as powertrain configuration, aerodynamics, suspension, and chassis development, the standardised battery system equalizes usable energy capacity and establishes consistent mass and weight distribution parameters across all competitors. This ensures that race outcomes are determined by efficiency, strategy, and engineering execution rather than disparities in battery scale or cost.
- **Underside Battery Integration:** The battery pack is mounted low within the chassis structure, contributing to a reduced centre of gravity, improved stability, and predictable handling characteristics. This configuration also enables rapid and repeatable battery exchanges during pit stops, supporting the operational demands of endurance racing.
- **Universal Compatibility, Custom Performance:** Although the battery pack provides a uniform energy source, teams maintain full engineering control over how that energy is utilised. Competitive advantage is achieved through optimised motor efficiency, inverter control, cooling systems, regenerative strategies, and intelligent energy deployment over a race stint.

This system reflects the core spirit of endurance racing: success is determined not solely by outright speed, but by how effectively teams manage energy, plan pit interventions, and balance performance with long-term efficiency over extended race distances.

1.3.2 High-Efficiency Regenerative Energy Systems

A defining feature of The Automobili La'Bergitla Endurance Series is its comprehensive and multi-layered regenerative energy recovery architecture, enabling teams to continuously generate, capture, and redeploy energy throughout a race.

While conventional electric vehicles rely primarily on braking-based regeneration, this championship expands the scope of energy harvesting by integrating multiple recovery pathways across the vehicle. The result is an endurance racing platform where energy management is as critical to success as outright speed.

Key Innovations in Regenerative Energy Recovery

1. **Multi-Axle Regenerative Braking**

- Vehicles are permitted to implement regenerative braking across multiple driven axles, allowing energy recovery from both front and rear braking events where applicable.
- This multi-axle approach significantly increases total recoverable energy during high-speed deceleration phases, reducing net energy draw from the battery and improving overall stint efficiency.
- Regenerative braking strategies must remain balanced with vehicle stability, braking performance, and sporting energy limits defined elsewhere in the regulations.

2. Regenerative Suspension Systems

- The championship introduces energy-harvesting suspension technologies capable of converting vertical suspension movement into usable electrical energy.
- Energy is recovered from surface undulations, curb interactions, and continuous chassis motion, contributing incremental energy gains that become strategically significant over long race distances.
- These systems operate in parallel with traditional regenerative braking, forming an additional efficiency layer rather than a primary propulsion source.

3. Energy Management Software and Intelligent Deployment

- Teams may implement advanced control strategies to optimize regenerative recovery based on speed, braking zones, vehicle dynamics, and energy state.
- Drivers may be provided with adjustable regeneration modes, allowing them to balance energy recovery with braking feel, tire grip, and vehicle stability.
- All regeneration strategies must comply with the championship's energy accounting and power deployment regulations.

By integrating braking recovery, suspension-based energy harvesting, and intelligent control systems, The Automobili La'Bergitla Endurance Series ensures that competitive advantage comes from **how efficiently energy is harvested and managed**, not simply from the size of the energy store. Endurance success depends on strategic energy balance across an entire race distance, reinforcing the series' core philosophy of performance through efficiency.

1.3.3 Ultra-Fast Battery Swap Strategy

Unlike conventional electric racing formats that rely on fixed-duration charging stops, The Automobili La'Bergitla Endurance Series pioneers a **high-speed battery swap system**, introducing a new layer of strategy, operational precision, and competitive differentiation to electric endurance racing.

This approach mirrors the role refuelling once played in traditional endurance competition, while being purpose-built for a fully electric performance platform.

Key Features of the Battery Swap System

- **Pit-Stop Swappable Battery Architecture**
  - Rather than waiting for a depleted battery to recharge, teams may replace an exhausted pack with a fully charged unit during a pit stop.

  - Battery exchanges are designed to be completed in seconds to minutes, enabling race pace to remain consistently high and reducing downtime associated with static charging.
  - This system allows vehicles to operate at sustained competitive performance levels across extended race stints, shifting the emphasis from energy conservation to strategic deployment and timing.

- **Custom Swap Mechanisms for Teams**
  - While all competitors must use the standardised championship battery pack, teams are free to develop their own approved battery exchange mechanisms and procedures.
  - This encourages mechanical ingenuity, operational efficiency, and pit crew performance as areas of competitive advantage.

Two principal swap methods are permitted, subject to safety approval:

- **Manual Swap:** A trained pit crew may physically remove and install the battery pack using approved lifting and alignment systems, in a procedure comparable in complexity and choreography to traditional endurance pit operations.
- **Automated Swap:** Teams may implement robotic or semi-automated systems to perform battery exchanges, reducing pit stop time through high-speed, repeatable mechanical processes.
- **Timed Pit Stop Regulations for Safety and Fairness**
  - To ensure safe procedures and prevent excessive risk, the championship may impose a **minimum pit stop time** for battery swaps.
  - This ensures that the focus remains on precision, reliability, and strategic timing rather than unsafe attempts to gain marginal time advantages.
  - All swap operations must comply with high-voltage safety protocols and pit lane operational standards defined elsewhere in the regulations.

By removing the constraint of prolonged charging stops, the battery swap system eliminates traditional range limitations and allows teams to push their vehicles closer to peak performance. Success is determined not by who conserves energy the most, but by who best balances **stint performance, swap timing, energy strategy, and pit execution** over the full race distance — a true evolution of endurance racing strategy in the electric era.

1.3.4 Dual Supercapacitor Buffers

To further enhance energy efficiency, power stability, and operational reliability, The Automobili La'Bergitla Endurance Series incorporates a **dual-supercapacitor energy buffer system** as a core element of its electric power architecture.

Supercapacitors are capable of extremely rapid charge and discharge cycles, making them ideal for managing high transient power demands that occur repeatedly in endurance racing. Acting as instantaneous energy buffers, they complement the high-energy battery system by smoothing power flow, capturing short-duration energy spikes, and maintaining electrical stability during dynamic operating conditions.

These capacitors are strategically integrated to stabilize performance during high-energy transitions such as acceleration, regenerative braking, and battery swap operations.

The Dual Supercapacitor System

I. **Primary Capacitor (Battery-Integrated Buffer)**
   a. Integrated within the standardised battery system, this capacitor stabilizes voltage and current delivery during peak power demand.
   b. It mitigates voltage sag under heavy load, ensuring consistent motor and inverter performance during acceleration and sustained high-speed running.
   c. The capacitor also absorbs regenerative braking energy that may temporarily exceed the battery's charge acceptance rate, reducing energy loss and improving overall recovery efficiency.

II. **Secondary Capacitor (Chassis-Integrated Power Reserve)**
   a. Installed within the vehicle's electrical architecture outside the main battery pack, this capacitor functions as an independent energy buffer.
   b. It ensures continuity of power supply during battery swap procedures, preventing voltage interruptions when the primary battery pack is disconnected.
   c. This system maintains operation of critical vehicle systems — including control electronics, drive systems, safety circuits, and telemetry — allowing the vehicle to resume racing immediately after a swap without system reboot delays.

By incorporating supercapacitor technology, The Automobili La'Bergitla Endurance Series ensures:

- Instantaneous power availability during high-demand events
- Improved regenerative energy utilization
- Reduced electrical stress on the main battery system
- Stable performance during transitional race phases

This dual-buffer architecture supports both peak performance and long-term durability — key requirements in electric endurance racing.

A New Standard for Electric Motorsport Innovation

The Automobili La'Bergitla Endurance Series fundamentally reimagines endurance competition through an integrated approach to energy efficiency, battery management, and race strategy.

- The **standardised swappable battery system** ensures competitive fairness while allowing teams to innovate in vehicle design and energy deployment.
- **Advanced regenerative energy recovery technologies** create a self-sustaining performance model, maximizing efficiency across every lap.
- **High-speed battery swap strategies** replace conventional refuelling, enabling continuous racing without prolonged charging delays.
- **Dual supercapacitor buffers** stabilize power delivery, protect system integrity, and ensure seamless operation during critical race phases.

Through these pioneering advancements, The Automobili La'Bergitla Endurance Series is not simply an evolution of electric motorsport — it establishes a **new technological benchmark for the future of endurance racing**, where performance, efficiency, and sustainability operate in complete harmony.

1.4 Standardised Swappable Battery System

At the core of The Automobili La'Bergitla Endurance Series is a **standardised swappable battery system**, engineered to redefine the strategic and technical foundations of electric endurance racing.

In traditional endurance competition, fuel consumption and refuelling strategy play a central role in race dynamics. In this championship, that role is fulfilled by a high-performance, quickly exchangeable battery architecture that shifts the focus from fuel management to **energy efficiency, deployment strategy, and system optimization**.

By standardizing the battery platform, all competitors operate with a common energy storage architecture, ensuring:

- Equalised usable energy capacity
- Consistent mass and weight distribution parameters
- Controlled development costs and technical stability across the grid

This creates a level playing field in energy storage while preserving the championship's emphasis on innovation. Teams retain regulated technical freedom in areas including:

- Electric powertrain configuration and efficiency
- Aerodynamic design and vehicle integration
- Cooling systems and thermal optimization
- Energy deployment, regeneration, and control strategies

As a result, competitive advantage is derived not from larger or more expensive energy reserves, but from how intelligently and efficiently teams utilize the standardised energy available to them.

The swappable battery system is fundamental to enabling true long-distance electric racing. It provides a practical and operationally efficient alternative to extended charging stops, allowing vehicles to maintain competitive pace across prolonged race durations and ensuring that endurance racing remains defined by performance, reliability, and strategic execution.

1.4.1 Key Features of the Swappable Battery Unit

To meet the demands of sustained high-speed endurance racing, the standardised battery unit is engineered with advanced energy storage, cooling, structural, and safety technologies. The design balances maximum performance with operational reliability, rapid serviceability, and strict safety standards.

Modular Underside-Mounted Design

- The battery unit is mounted on the **underside of the vehicle chassis**, providing direct and repeatable access for rapid pit stop exchange procedures.
- A **quick-release structural attachment system** allows for secure installation during racing while enabling fast removal and replacement during battery swaps.
- Integration within the lower chassis structure contributes to optimised **weight distribution and a low centre of gravity**, enhancing vehicle stability, cornering performance, and overall aerodynamic efficiency.

- The battery housing forms a structural element of the vehicle architecture, contributing to stiffness while remaining compliant with crash and containment requirements.

Bidirectional Charging and Fast Energy Transfer

- The battery system supports **bidirectional power flow**, enabling both rapid charging and controlled energy discharge in coordination with the vehicle's power electronics.
- Compatibility with **high-power conductive charging systems** allows rapid turnaround charging between race stints, ensuring batteries can be returned to service quickly and efficiently.
- Provision for **inductive charging interfaces** allows teams to perform non-contact energy replenishment during testing and operational preparation, supporting flexible energy management strategies.

High-Density, Lightweight Construction

- The battery enclosure utilizes **advanced composite materials**, including carbon-fibre-reinforced structures, to achieve high structural integrity at minimal mass.
- The design prioritizes **impact resistance, torsional stiffness, and durability**, allowing the unit to withstand the mechanical loads and handling associated with endurance competition and repeated pit operations.
- The battery incorporates **high-energy-density cell technologies**, such as advanced lithium-ion or next-generation solid-state chemistries, maximizing usable energy within strict weight and volume constraints defined by the regulations.

Advanced Thermal Management System

- A multi-layered thermal management architecture combines **liquid cooling, controlled airflow, and thermal buffering materials** to maintain optimal cell operating temperatures.
- Real-time thermal monitoring systems adjust cooling performance dynamically in response to power demand, ambient conditions, and regenerative energy input, ensuring consistent performance across extended stints.
- Integrated heat exchangers and closed-loop cooling circuits actively dissipate heat build-up, protecting battery longevity and maintaining stable power output under extreme load conditions.

Enhanced Safety and Impact Protection

- The battery is housed within a **fire-resistant and electrically insulated enclosure**, designed to contain thermal events, and protect surrounding vehicle systems.
- An integrated **multi-layer safety architecture** includes over-current protection, voltage monitoring, and fault isolation managed by the Battery Management System (BMS).
- The casing is engineered to meet stringent **impact resistance standards**, ensuring structural integrity during collisions, debris strikes, or pit lane handling incidents.
- Automatic electrical isolation and safety interlocks activate during removal, installation, or in the event of an incident, protecting both drivers and pit crew personnel.

These advanced features ensure that the standardised battery system not only supports the extreme performance requirements of electric endurance racing but also establishes a new benchmark in safety, serviceability, and technological sophistication. Through this platform, The Automobili La'Bergitla Endurance Series reinforces its position at the forefront of sustainable, high-performance motorsport innovation.

1.4.2 Ensuring Fairness While Allowing Innovation

One of the central challenges in electric endurance racing is balancing competitive parity with meaningful technological innovation. The Automobili La'Bergitla Endurance Series battery framework is specifically structured to achieve this balance — creating a regulated environment that ensures fairness while still rewarding engineering excellence, operational precision, and strategic intelligence.

The standardised battery system forms a common performance foundation, while carefully defined development freedoms ensure that innovation remains a decisive factor in competition.

Standardised Energy Storage with Open Development Zones
To prevent cost escalation and ensure race outcomes are determined by skill, efficiency, and execution rather than financial advantage, the following principles apply:

- All teams must utilize the **same standardised battery architecture**, ensuring parity in energy storage capacity, mass distribution, structural integration, and safety performance.
- **Powertrain, drivetrain, and control system development remain open within defined technical parameters**, allowing teams to innovate in motor efficiency, torque delivery, regenerative systems, cooling strategies, and energy deployment software.
- Teams are permitted to design and optimize their own **battery swapping mechanisms and pit procedures**, creating competitive differentiation in pit stop efficiency, automation, and operational reliability.

This approach ensures that while energy capacity is equalised, **the intelligent use of that energy becomes a primary competitive differentiator**.

Mandatory Battery Swaps as a Core Endurance Strategy
Battery swaps are not merely a logistical necessity — they are a central strategic element of the championship.

- Battery exchanges form an integral part of race strategy, replacing traditional refuelling as the defining endurance pit stop operation.
- Teams must balance **stint performance, driver rotation, energy consumption, and traffic conditions** to determine optimal swap timing.
- The speed, precision, and reliability of a team's battery swap process can directly influence track position and overall race outcome.
- Unlike combustion-based endurance racing, where fuel load decreases during a stint, battery swaps maintain a relatively consistent vehicle mass profile, shifting the strategic emphasis toward **energy efficiency, power management, and sustained performance consistency**.

Innovation Focused on Efficiency, Not Scale
By combining standardised energy storage with open-ended development in vehicle systems and operations, The Automobili La'Bergitla Endurance Series ensures that teams compete through:

- Energy efficiency
- Thermal and electrical optimization
- Aerodynamic performance

- Strategic pit execution
- Driver consistency and racecraft

Rather than through increased battery capacity or escalating hardware expenditure.

A New Era in Electric Endurance Racing
The Automobili La'Bergitla Endurance Series represents a transformative step in the evolution of endurance motorsport. By integrating advanced battery-swapping architecture, multi-source regenerative energy recovery, and high-performance electric powertrain technologies, the championship establishes a new performance and sustainability benchmark.

Key Principles of the Standardised Battery System:

- Battery swapping serves as a practical and high-performance alternative to refuelling in long-distance racing.
- Electric endurance racing can deliver the same intensity, strategy, and spectacle expected at the highest levels of motorsport.
- Efficiency, energy management, and pit stop execution become defining factors in race success.

Through this integrated approach, The Automobili La'Bergitla Endurance Series demonstrates that endurance racing in the electric era can be technologically advanced, strategically complex, environmentally responsible, and uncompromising in performance.

This is not simply the adoption of electric propulsion — it is a redefinition of endurance racing for the next generation.

2. Mandatory Swappable Battery System

2.1 Overview of the Standardised Battery System

The Automobili La'Bergitla Endurance Series mandates the use of a **proprietary, standardised swappable battery system** for all competing vehicles. This system is designed to ensure uniform energy performance, operational safety, and competitive fairness across the championship, forming a central pillar of the technical and sporting framework.

The standardised battery architecture is fundamental to the series' objective of delivering a fully electric endurance racing platform that preserves the traditional values of long-distance competition — strategy, reliability, efficiency, and technical innovation — while redefining how energy is managed during a race.

By eliminating reliance on in-race charging and replacing it with high-speed battery exchanges, the system introduces a controlled and repeatable method of energy replenishment. This approach mirrors the strategic role historically played by refuelling in endurance racing, while being purpose-built for a modern electric performance platform.

The battery swap model offers several key operational advantages:

- It ensures that energy replenishment during pit stops is **swift, standardised, and equitably regulated**, minimizing variability between teams.
- It removes the dependence on high-power charging infrastructure during the race, allowing events to be staged at international endurance circuits without requiring extensive pit lane electrical upgrades.
- It guarantees that each vehicle begins a new stint with a fully charged, performance-ready energy source, maintaining consistency in competitive conditions.

In contrast to conventional electric racing formats that rely on rapid charging systems — which can introduce variability in charging time, thermal stress, and battery degradation — the swappable battery system provides a **predictable, controlled, and performance-focused energy model**. This ensures that competitive outcomes are determined by vehicle efficiency, energy management, pit strategy, and driver performance, rather than by disparities in charging capability or infrastructure.

Revolutionizing Endurance Racing Strategy with Battery Swaps

The introduction of a mandatory battery swap system fundamentally transforms endurance racing strategy, creating a dynamic layer comparable to the role refuelling has traditionally played in long-distance motorsport. Rather than managing fuel consumption, teams must now optimize **energy deployment, recovery, and efficiency** to determine stint length, pit timing, and overall race performance.

Battery swaps redefine the rhythm of endurance racing by shifting the focus from static charging intervals to high-speed, strategically timed energy replenishment.

Key Strategic Advantages of Battery Swaps Over Conventional Charging

- **Time Efficiency:** Rapid battery exchanges—completed in seconds to minutes—enable continuous competitive pace. Unlike high-power charging, which can require extended stationary periods, swapping minimizes downtime and preserves the intensity of endurance competition.
- **Consistent Performance:** Unlike liquid fuel, which reduces in mass as it is consumed, the swappable battery system maintains a relatively consistent vehicle mass profile between stints. This places greater emphasis on energy efficiency, power management, and vehicle balance rather than on adapting to changing weight distribution.
- **Elimination of Charging Constraints:** Battery swapping removes the limitations associated with high-rate charging, including thermal stress, variable charge acceptance, and dependency on trackside power infrastructure. This ensures a standardised and predictable energy replenishment process for all competitors.
- **Enhanced Strategic Complexity:** Teams must balance aggressive energy usage against stint longevity, selecting optimal moments to perform battery swaps based on track position, traffic conditions, safety car periods, and driver rotation. Pit execution becomes a decisive performance factor, mirroring the tactical depth of traditional endurance pit strategy.

By ensuring that all cars operate with identical energy storage architecture and replenishment procedures, The Automobili La'Bergitla Endurance Series guarantees that race outcomes are determined by **engineering efficiency, strategic decision-making, driver consistency, and operational excellence** — not by disparities in battery capacity or charging capability.

High-Performance Battery Design for Extreme Racing Conditions

The proprietary battery unit used in The Automobili La'Bergitla Endurance Series is a **high-performance, swappable energy storage system** engineered specifically for the extreme demands of long-duration endurance racing. The system delivers an optimised balance of energy density, structural integration, thermal stability, and operational safety, ensuring consistent performance across an entire race weekend.

This battery platform is not merely an energy container — it is a critical performance component designed to withstand repeated high-load cycles, rapid service procedures, and prolonged exposure to racing environments.

Key Technical Attributes of the Standardised Battery System

1. **High-Energy-Density Construction**
    - The battery incorporates **advanced high-energy-density cell technologies**, such as next-generation lithium-ion or solid-state chemistries, maximizing usable energy within tightly controlled weight and volume limits.
    - Cell and module design supports **rapid power discharge**, enabling strong acceleration, sustained high-speed performance, and consistent delivery of peak power under race conditions.
    - The system is optimised for **long-duration energy output**, maintaining efficiency and stability across multiple race stints without significant degradation in performance.
2. **Optimised Weight Distribution**

- The battery is **underside-mounted within the vehicle chassis**, contributing to a low centre of gravity and improved vehicle stability at high speed.
- A fixed battery specification across all teams ensures **uniform mass distribution**, supporting competitive fairness while preserving high-performance handling characteristics.
- Advanced cell packaging and lightweight composite enclosure materials reduce overall mass while maintaining structural integrity and containment performance.

3. **Rapid-Swap Modular System**
   - A **high-speed quick-release structural interface** enables battery swaps in a timeframe comparable to traditional endurance pit operations, minimizing time spent stationary.
   - The modular design supports repeatable, secure installation and removal, ensuring reliability under race conditions.
   - Teams may develop approved manual or automated swap systems, introducing competitive variation in pit stop execution while maintaining safety and standardization.
4. **Active Thermal Management**
   - An integrated **liquid cooling system**, supplemented by thermal buffering materials, maintains optimal cell operating temperatures during high-load operation.
   - Adaptive heat dissipation strategies respond dynamically to power demand, regenerative input, and ambient conditions, preventing overheating and thermal stress.
   - Real-time thermal telemetry enables teams to monitor and manage battery performance, supporting data-driven energy deployment decisions.
5. **Advanced Safety and Durability Features**
   - The battery enclosure is constructed with **fire-resistant and electrically insulated materials**, designed to contain thermal incidents, and protect surrounding systems.
   - A multi-layer structural protection system provides resistance to impact loads, including high-speed racing incidents and repeated pit handling.
   - An integrated Battery Management System (BMS) performs continuous monitoring of voltage, current, temperature, and system integrity, automatically isolating the battery in the event of a fault.

This battery system is engineered not only for peak race performance but also for **endurance reliability, operational safety, and performance consistency** throughout extended competition. It represents a purpose-built energy solution for electric endurance racing, where durability and control are as critical as outright power.

Ensuring Competitive Parity While Allowing Innovation

The adoption of a standardised energy storage system establishes a common technical foundation across all competitors, ensuring that no team can gain a disproportionate advantage through proprietary battery capacity, chemistry, or packaging. At the same time, the championship is structured to preserve meaningful areas of technical freedom, allowing innovation to flourish where it most enhances performance, efficiency, and strategy.

This balanced approach ensures that competition is driven by engineering excellence and race execution rather than financial escalation in energy storage technology.

Key Principles of Competitive Fairness

Fixed Battery Specifications
All teams must utilize the identical homologated battery unit, including defined limits for capacity, mass, energy density, and structural integration. This ensures:

- Equal energy availability across the grid
- Consistent weight distribution characteristics
- Uniform safety and reliability standards

By fixing the energy storage architecture, the championship removes battery scale as a variable in performance.

Open Powertrain and Efficiency Optimization
While the battery system is standardised, teams retain regulated freedom in key performance-defining areas, including:

- Electric motor architecture and efficiency
- Inverter control and torque delivery strategies
- Regenerative energy systems and energy recovery efficiency
- Cooling systems and thermal optimization
- Aerodynamic design and vehicle integration

This ensures that competitive advantage is achieved through **how efficiently energy is used**, rather than how much is stored.

Strategic Pit Stop Execution
Battery swaps introduce a core layer of endurance racing strategy. Teams must carefully determine optimal swap intervals by balancing:

- Stint performance and energy consumption
- Driver rotation and fatigue management
- Track position and race conditions
- Pit lane execution speed and reliability

Operational precision and strategic timing become decisive elements in overall race success.

By standardizing energy storage while maintaining engineering flexibility in performance systems, The Automobili La'Bergitla Endurance Series ensures that victory is determined by **efficiency, reliability, driver performance, and strategic execution** — not by superiority in battery scale or expenditure.

This framework preserves the spirit of endurance racing: innovation thrives, but always within a structure that guarantees fair and competitive racing for all entrants.

A New Era in Endurance Racing
The mandatory standardised swappable battery system forms the technological backbone of The Automobili La'Bergitla Endurance Series, redefining the foundations of electric endurance competition.

By combining rapid battery exchange, equalised energy storage, and strategic race management, the championship establishes a performance model where energy is managed with the same precision and tactical depth that has always defined long-distance racing.

This system ensures that electric endurance racing delivers the same intensity, unpredictability, and competitive drama expected at the highest levels of motorsport, while introducing a new dimension of efficiency-driven performance.

What This System Achieves

- **Rapid, controlled energy replenishment**, enabling sustained high-intensity race pace over long durations without the constraints of prolonged charging.
- **Competitive fairness** through standardised battery capacity and architecture, while preserving open development in powertrain efficiency, control systems, and vehicle performance.
- **Strategic race management**, where battery swap timing, stint execution, and energy deployment become decisive tactical elements.
- **Sustainable high-performance motorsport**, demonstrating that electric endurance racing can be both technologically ground-breaking and uncompromising in excitement.

By implementing battery-swapping technology as the cornerstone of its sporting and technical framework, The Automobili La'Bergitla Endurance Series does more than adopt electric propulsion — it establishes a new paradigm for endurance competition in the electric era.

2.2 Technical Innovations and Unique Features

The proprietary swappable battery system used in The Automobili La'Bergitla Endurance Series represents a significant advancement in electric endurance racing technology. Developed specifically for high-performance, long-duration competition, the system integrates a series of purpose-built innovations designed to deliver maximum efficiency, rapid energy replenishment, and exceptional durability under extreme race conditions.

Unlike conventional electric vehicle battery systems — which are typically optimised either for extended road range or short-duration high-power output — this championship's battery architecture is engineered expressly for endurance racing. It balances high energy density with sustained power delivery, rapid serviceability, thermal resilience, and structural robustness, ensuring consistent performance across repeated race stints.

This endurance-optimised energy system is defined by:

- A modular, underside-mounted architecture designed for rapid, repeatable pit stop exchange
- High-density cell technologies capable of supporting prolonged high-load operation
- Advanced thermal management solutions tailored for sustained race conditions
- Integrated safety and containment systems suitable for high-speed motorsport environments
- Compatibility with rapid recharging infrastructure between stints to maintain operational efficiency across an entire event

By aligning energy storage design with the unique demands of endurance competition, The Automobili La'Bergitla Endurance Series establishes a battery platform that is not only performance-focused, but also serviceable, safe, and strategically integral to race operations.

This approach ensures that the battery is not a limiting factor, but rather a central performance enabler — forming a key part of the championship's identity as a technologically advanced and strategically complex electric endurance racing platform.

2.2.1 Inductive and Conductive Charging Capabilities

The Automobili La'Bergitla Endurance Series standardised battery system is engineered with **dual-mode charging capability**, supporting both high-speed conductive charging and future-ready inductive charging integration. This ensures operational flexibility, efficient turnaround between stints, and compatibility with evolving energy infrastructure.

While battery swaps serve as the primary in-race energy replenishment method, controlled charging processes are essential for restoring packs to full capacity between sessions and race stints.

High-Speed Conductive Charging (Primary Charging Method)
Conductive charging is the principal method used to recharge battery units while they are removed from the vehicle.

- Enables **ultra-fast direct current (DC) charging** of battery packs outside the car, maximizing energy replenishment between stints.
- Utilizes **liquid-cooled high-power charging interfaces**, ensuring stable thermal conditions during rapid charge cycles.
- Charging occurs off-board, eliminating the thermal and electrical stress associated with high-power in-vehicle charging systems.
- Designed to meet race operational turnaround requirements, ensuring that fully charged battery units are consistently available for subsequent swaps.
- Incorporates a **standardised charging interface**, allowing integration with championship-approved multi-station charging infrastructure at race venues. This ensures uniformity, safety, and logistical efficiency across the paddock.

Inductive Charging Compatibility (Secondary and Developmental Use)
In addition to conductive charging, the battery system is designed with provision for **inductive (wireless) charging compatibility**, supporting future technological integration and operational flexibility.

- Allows non-contact energy transfer during testing, preparation sessions, or controlled operational scenarios.
- Reduces mechanical connector wear and supports automated energy management workflows in the paddock environment.
- Designed as a supplementary or developmental capability rather than a primary in-race energy replenishment method.

By combining high-speed conductive charging with inductive compatibility, the championship ensures that the battery system remains **operationally efficient, technologically adaptable, and aligned with future charging innovations**, while maintaining strict control over safety, consistency, and competitive fairness.

Wireless Inductive Charging (Future Expansion)
The standardised battery system incorporates provision for an **integrated inductive charging receiver**, enabling controlled use of wireless energy transfer technologies as part of the championship's long-term technical development roadmap.

While conductive charging remains the primary and mandatory method of energy replenishment, inductive capability is included to support research, operational flexibility, and future infrastructure evolution.

Potential applications include:

- **In-garage maintenance charging**, allowing battery units to be maintained at optimal charge levels between sessions and prior to installation for race stints.
- **Future dynamic charging research**, supporting controlled evaluation of in-motion energy transfer concepts as part of broader electric vehicle technology development initiatives.

Any implementation of inductive charging during official competition activities shall remain subject to championship approval and technical regulation, ensuring that competitive fairness, safety, and energy accounting integrity are preserved.

This integration ensures that The Automobili La'Bergitla Endurance Series remains technologically forward-looking, providing a platform for the exploration of next-generation electric vehicle energy systems within the demanding environment of endurance racing.

2.2.2 Dual Supercapacitor & Ultra-Capacitor Integration

Unlike conventional electric vehicle powertrains that rely solely on lithium-based energy storage, The Automobili La'Bergitla Endurance Series battery architecture incorporates a **dual supercapacitor (ultra-capacitor) system** designed to manage high transient power demands and ensure uninterrupted electrical performance under race conditions.

This multi-layer energy buffering approach enhances efficiency, protects the primary battery system from extreme load cycling, and provides operational stability during critical phases of competition, including battery swaps.

Key Functions of the Dual Supercapacitor System

1. **Primary Supercapacitor (Integrated Within the Battery Unit)**
    - Functions as a **high-power buffer**, absorbing and delivering short-duration energy surges without directly loading the core battery cells.
    - Stabilizes voltage and current output during peak discharge events, such as aggressive acceleration or sustained high-power operation.
    - Reduces instantaneous stress on lithium-based cells, contributing to improved thermal stability, reduced degradation, and enhanced battery longevity over repeated race stints.

- Captures short-duration regenerative energy spikes that exceed the battery's optimal charge acceptance rate, improving overall energy recovery efficiency.

6. **Secondary Supercapacitor (Vehicle-Integrated Buffer)**
    - installed within the vehicle's electrical architecture as an independent energy reserve separate from the main battery pack.
    - Ensures **continuity of electrical power** during battery swap operations, preventing interruptions to critical systems such as control electronics, drive systems, telemetry, and safety circuits.
    - Supports rapid deployment of recovered energy from regenerative braking, providing immediate power availability for acceleration and traction demands.
    - Enhances low-speed driveability and launch performance by delivering fast-response torque support in high-traction-demand zones.

By incorporating dual supercapacitor technology, The Automobili La'Bergitla Endurance Series establishes a layered energy management system that combines high energy density with high power responsiveness. This ensures that electric endurance prototypes can maintain peak performance, improve efficiency, and preserve core battery health over extended race durations — a critical advantage in long-distance electric competition.

2.2.3 Active Thermal Management System

Effective thermal regulation is one of the primary technical challenges in high-performance electric endurance racing. Excessive heat accumulation reduces efficiency, accelerates component degradation, and can compromise system safety. To address these demands, The Automobili La'Bergitla Endurance Series standardised battery system incorporates a **multi-stage active thermal management architecture** combining liquid cooling and phase-change thermal buffering technologies.

This system is engineered to maintain stable operating temperatures across repeated high-load cycles and prolonged race stints, ensuring consistent performance in a wide range of environmental and operational conditions.

Key Cooling Features

2. **Liquid-Cooled Thermal Management**
    - Integrated **closed-loop liquid cooling circuits** circulate coolant throughout the battery pack, extracting heat from high-load cells, busbars, and control electronics.
    - Actively controlled flow rates adjust in real time based on battery temperature, discharge rate, regenerative input, and ambient conditions.
    - Heat exchangers transfer thermal energy from the battery coolant loop to dedicated vehicle cooling systems, maintaining optimal operating temperatures during sustained high-power operation.
3. **Phase-Change Material (PCM) Integration**
    - Strategically placed **phase-change material layers** absorb excess thermal energy during peak discharge and regenerative events, buffering rapid temperature spikes.
    - PCM integration enhances temperature stability across long stints, reducing thermal cycling stress on battery cells.

- This passive thermal buffering layer supports system resilience and contributes to the prevention of thermal runaway under extreme operating scenarios.

4. **Pre-Cooled Battery Swap Protocol**
    - Battery units are maintained within controlled thermal windows prior to installation, ensuring that freshly installed packs begin each stint at an optimal operating temperature.
    - This approach maintains thermal consistency throughout the race, reducing performance variability between stints and protecting long-term battery integrity.
    - Coordinated cooling between on-board systems and off-board preparation infrastructure ensures that energy replenishment and thermal conditioning operate as an integrated process.

Through the combination of active liquid cooling, passive thermal buffering, and controlled pre-installation conditioning, The Automobili La'Bergitla Endurance Series battery system delivers **exceptional thermal stability, durability, and performance consistency**. This advanced thermal architecture enables sustained high-speed electric racing under extreme endurance conditions while upholding the highest standards of safety and reliability.

2.2.4 Modular Pack Design for Rapid & Safe Swaps

To enable fast, repeatable, and safe battery exchange operations, the standardised battery unit in The Automobili La'Bergitla Endurance Series is engineered as a **high-strength modular structural assembly**. The design supports rapid pit stop procedures while maintaining the mechanical integrity and safety standards required for high-speed endurance competition.

Key Design Innovations

1. **Quick-Release Battery Mounting System**
    - The battery assembly incorporates a **high-strength quick-release mounting interface** designed to support rapid pit stop swaps while maintaining secure structural integration during racing.
    - Precision alignment guides and locking mechanisms ensure repeatable installation and removal, reducing the risk of misalignment or improper seating.
    - The system is engineered to withstand race loads, vibration, and impact forces while enabling efficient detachment during controlled pit operations.
2. **Multi-Layered Impact Protection**
    - The battery enclosure utilizes **carbon-fibre-reinforced composite structures** to achieve high stiffness and strength with minimal weight penalty.
    - Integrated crush structures and energy-absorbing elements help dissipate impact loads in the event of a collision, protecting internal modules and electrical components.
    - Structural design prioritizes containment and isolation, reducing the risk of damage propagation to adjacent vehicle systems.
3. **Flexible Modular Cell Architecture**
    - The internal battery layout follows a **modular cell and sub-module configuration**, allowing controlled servicing and replacement of individual modules where permitted under championship regulations.

- This modular approach supports long-term durability and maintainability across a race season, minimizing performance degradation and reducing operational costs.
- The architecture is designed to maintain structural rigidity and electrical integrity even after repeated swap cycles and endurance race usage.

This modular battery design is central to the championship's endurance racing model. It ensures that pit stop execution remains a defining competitive element while maintaining the highest standards of structural safety, electrical reliability, and energy efficiency under extreme race conditions.

2.2.5 Proprietary Battery Chemistry for Endurance Racing

Unlike consumer electric vehicle batteries optimised for daily driving cycles, the battery system used in The Automobili La'Bergitla Endurance Series incorporates a **race-specific proprietary cell chemistry** developed for the extreme demands of long-duration, high-power motorsport operation.

This chemistry is engineered to balance ultra-fast charge acceptance, sustained high discharge capability, thermal resilience, and long-cycle durability — all critical for repeated race stints and rapid turnaround between sessions.

Key Chemistry Features

1. **Optimised for Rapid Charge–Discharge Cycles**
    - The cell chemistry is designed for **frequent high-power cycling**, maintaining stable performance across repeated deep discharge and rapid recharge events typical of endurance racing.
    - Ultra-low internal resistance reduces heat generation during both charge and discharge phases, improving efficiency and power delivery stability.
    - The chemistry supports consistent energy throughput over multiple race stints without significant loss of capacity or performance.
2. **High-Power Solid-State or Next-Generation Lithium Cells**
    - Incorporates **advanced high-power cell technologies**, such as solid-state or next-generation lithium-based chemistries, offering improved energy density and durability compared to conventional lithium-ion race battery designs.
    - Enhanced structural stability at the cell level contributes to improved safety, reduced degradation, and sustained power output over long-duration operation.
    - Designed to maintain consistent voltage characteristics across the discharge curve, ensuring predictable power delivery throughout each stint.
3. **Extreme Condition Resilience**
    - The chemistry is formulated for **high-temperature endurance**, maintaining functional stability and safety under prolonged high-load and elevated ambient conditions.
    - Cold-condition resilience ensures reliable performance in low-temperature environments, minimizing energy loss and maintaining stable output regardless of climate.
    - The cell design prioritizes resistance to thermal stress and mechanical vibration, supporting durability in the harsh environment of endurance racing.

This proprietary endurance-focused cell chemistry enables The Automobili La'Bergitla Endurance Series battery system to sustain high performance over extended race durations while maintaining efficiency, safety, and reliability. It represents a purpose-built energy solution that redefines the capabilities of electric propulsion in long-distance motorsport competition.

2.2.6 Advanced Crash Protection & Safety Mechanisms

To ensure driver safety, operational reliability, and compliance with international motorsport standards, the standardised battery system incorporates a **multi-layered crash protection and safety framework**. The design prioritizes containment, fault isolation, and controlled energy management in the event of an incident.

Key Safety and Protection Features

1. **CFRP-Reinforced Impact Casing**
    - The battery unit is housed within a **carbon-fibre-reinforced composite (CFRP) structural enclosure**, engineered to withstand high-speed impacts and race-induced structural loads.
    - The casing provides resistance to crash forces, debris strikes, and repeated handling stresses during pit operations.
    - Structural design ensures that internal modules remain protected and contained even under severe racing conditions.
2. **Integrated Fire Suppression and Thermal Containment**
    - The battery system incorporates **fire-resistant internal barriers** and thermal containment structures designed to limit the propagation of thermal events between modules.
    - Automatic fault detection can trigger **integrated fire suppression or thermal mitigation systems**, reducing the risk of escalation in the event of a cell failure.
    - Materials and layout are selected to slow heat transfer and provide additional response time for driver and marshal safety procedures.
3. **Motorsport-Grade Safety Compliance**
    - The battery system is engineered to meet or exceed recognised **international motorsport crash safety and high-voltage containment standards**.
    - Electrical isolation systems automatically disconnect high-voltage circuits in the event of a crash or fault condition.
    - Safety interlocks and monitoring systems protect drivers, pit crews, and track personnel during both racing and servicing operations.

Defining the Future of Electric Endurance Racing
By integrating advanced thermal management, rapid-swap modular construction, supercapacitor energy buffering, and motorsport-grade safety systems, The Automobili La'Bergitla Endurance Series battery platform establishes a new benchmark for electric endurance racing technology.

This system is not only a power source for competition vehicles — it is a foundational technology platform shaping the future direction of high-performance, long-distance electric motorsport.

2.3 Underside-Mounted Standardised Battery Design

The Automobili La'Bergitla Endurance Series mandates the use of a **uniform underside-mounted swappable battery system** for all competing vehicles. This standardised installation ensures competitive parity, optimised vehicle dynamics, and enhanced structural safety across the championship.

By fixing the battery's location and integration concept, the regulations establish a consistent energy storage architecture for all teams. This approach equalizes energy capacity, mass distribution, and safety performance, while preserving technical freedom in areas such as aerodynamics, powertrain efficiency, cooling strategies, and pit stop operations.

The underside-mounted configuration reflects core principles of high-performance motorsport engineering:

- **Optimised Weight Distribution:** Positioning the battery low within the chassis lowers the vehicle's centre of gravity, improving stability during high-speed cornering, braking, and directional changes.
- **Balanced Handling Characteristics:** Centralised mass distribution supports predictable vehicle behaviour over long stints, reducing setup variability linked to energy load placement.
- **Structural Integration:** The battery assembly contributes to the vehicle's lower structural architecture, enhancing torsional rigidity while remaining compliant with crash and containment requirements.
- **Serviceability for Endurance Racing:** The underside position enables direct and repeatable access for rapid pit stop battery exchanges, supporting the operational demands of long-distance competition.

Unlike battery placements commonly used in production electric vehicles, such as rear or upper-floor mounting, this motorsport-specific configuration is optimised for sustained high-speed performance and endurance reliability.

Through this standardised underside-mounted architecture, The Automobili La'Bergitla Endurance Series ensures that all competitors operate within a common performance and safety framework, while still allowing innovation in how energy is managed, deployed, and integrated into the overall vehicle design.

2.3.1 Key Benefits of the Underside-Mounted Battery System

The underside-mounted standardised battery system provides significant advantages in vehicle dynamics, competitive parity, operational efficiency, and safety — all of which are critical in high-performance endurance racing.

Low Centre of Gravity for Enhanced Handling and Stability

- **Optimised weight distribution:** Positioning the battery at the lowest point within the vehicle structure lowers the centre of gravity, improving cornering grip, high-speed stability, and overall vehicle balance.

- **Reduced body roll and pitch sensitivity:** A lower centre of mass minimizes lateral and longitudinal weight transfer, enhancing stability through high-speed direction changes, heavy braking zones, and varying aerodynamic load conditions.
- **Aerodynamic integration advantages:** With the battery housed within the chassis floor, teams can develop more efficient underbody airflow and aerodynamic packaging, avoiding the compromises associated with alternative battery placements.

Standardised Mounting Interface for Performance Consistency

- **Ensures competitive parity:** A universal mounting architecture prevents performance advantages arising from alternative battery placement or chassis balance manipulation.
- **Eliminates integration loopholes:** By mandating a defined installation location and interface, the system prevents teams from exploiting structural or packaging variations to gain unintended performance benefits.
- **Supports consistent vehicle behaviour:** Identical battery positioning across all competitors promotes predictable handling characteristics and simplifies performance balancing across the grid.

Rapid Access for Pit Stop Swaps

- **High-speed swap capability:** The underside mounting layout enables efficient battery removal and installation using approved manual, semi-automated, or automated pit equipment.
- **Standardised connection geometry:** Fixed interface points allow teams to refine pit stop procedures and hardware without altering the core battery integration, ensuring fairness while encouraging operational excellence.
- **Endurance racing relevance:** Swap times comparable to traditional endurance pit service maintain race intensity while adding a new strategic dimension centred on energy management and pit execution.

Structural Safety and Impact Resistance

- **Reinforced chassis integration:** The battery assembly is installed within structurally protected zones of the vehicle, designed to shield it from crash forces and debris intrusion.
- **Multi-layered impact absorption:** The enclosure utilizes carbon-fibre-reinforced composites, energy-absorbing structural cores, and protective internal layers to dissipate impact loads.
- **Fail-safe protection systems:**
    - Shock-resistant mounting structures help prevent displacement during severe impacts or rollovers.
    - Automatic electrical isolation systems disconnect high-voltage circuits in the event of a crash.
    - Fire-resistant materials and integrated suppression measures reduce the risk of thermal incidents in extreme scenarios.

Through this underside-mounted standardised architecture, The Automobili La'Bergitla Endurance Series achieves an optimal balance of **performance, fairness, serviceability, and safety**, reinforcing the battery system's role as both a structural and strategic foundation of electric endurance racing.

2.3.2 Engineering Considerations for Underside Battery Integration

To ensure consistent and safe integration of the standardised underside-mounted battery system, the championship defines strict engineering guidelines covering chassis structure, protective measures, and pit stop interface requirements. These provisions ensure that all vehicles can accommodate the battery safely while maintaining performance and aerodynamic efficiency.

Chassis Design & Battery Protection Measures

- **Chassis rigidity enhancements:**
  As the battery forms part of the vehicle's lower structural architecture, all cars must incorporate reinforced cross-members, floor structures, and load paths capable of withstanding the stresses associated with high-speed endurance racing, including sustained aerodynamic loading and curb impacts.
- **Protected undertray construction:**
  The battery compartment must be shielded by an aerodynamic and impact-resistant underbody structure. This undertray must protect against debris strikes, ground contact, and damage from track irregularities while maintaining controlled airflow beneath the vehicle.
- **Detachable structural mounting rails:**
  The battery interface must include high-strength mounting rails or equivalent structural supports that allow rapid removal and installation while maintaining rigidity under lateral, longitudinal, and vertical loads experienced during racing.

Pit Stop Compatibility & Swapping Mechanisms
To support safe and efficient battery exchange procedures, all vehicles must be compatible with approved battery swap systems and operational protocols.

- **Mechanical and Automated Swap Options:**
  Teams may implement one of the following approved swap approaches, subject to safety compliance:
  - **Manual systems:** Precision pit crew operations using mechanical lifting and alignment equipment, emphasizing reliability and procedural discipline.
  - **Semi-automated systems:** Mechanically assisted alignment and release systems that guide battery extraction and installation while retaining human oversight.
  - **Fully automated systems:** Robotic or machine-assisted platforms designed to perform rapid, repeatable battery exchanges within regulated safety parameters.

Standardised docking connectors:
All battery units must interface with the vehicle using championship-standardised electrical, data, and thermal connection points. These connectors ensure consistent high-voltage engagement, communication with vehicle control systems, and integration with cooling circuits during both operation and swap procedures.

These engineering requirements ensure that the underside battery integration supports **structural integrity, aerodynamic performance, and safe, repeatable pit operations**, while maintaining strict standardization and fairness across all competitors.

2.3.3 Comparative Advantages Over Alternative Battery Placements

Compared to traditional electric vehicle battery layouts, the standardised underside-mounted configuration offers clear advantages in race performance, serviceability, and crash safety. The table below summarizes the relative characteristics of alternative placements.

Battery Placement	Advantages	Limitations in Endurance Racing
Underside-Mounted (Standardised Championship Approach)	- Low centre of gravity improves cornering stability and high-speed balance - Enables rapid, repeatable pit stop battery swaps - Structural integration enhances crash protection and chassis rigidity - Supports efficient underbody aerodynamic packaging	- Requires chassis designs to incorporate standardised mounting and structural interfaces
Rear-Mounted Battery (Typical Road EV Layout)	- Simplifies packaging for road-car-derived architectures	- Rearward weight bias can compromise handling stability at racing speeds - Higher centre of gravity reduces cornering performance - Limited accessibility for rapid pit stop swaps - Greater exposure to rear-impact damage
Mid-Chassis Battery (Some Performance EVs)	- Centralised mass can improve traction balance	- Restricted access complicates fast pit lane swap procedures - Cooling and serviceability challenges due to confined installation space - Less effective structural integration for high-energy crash management

The underside-mounted architecture uniquely satisfies the combined requirements of **high-speed stability, rapid pit serviceability, aerodynamic efficiency, and impact protection**. It is the only configuration that fully supports the operational and performance demands of electric endurance racing.

A Future-Ready Battery Architecture for Electric Endurance Racing

By mandating a standardised underside-mounted battery system, The Automobili La'Bergitla Endurance Series establishes a platform that prioritizes fairness, safety, and high-performance vehicle dynamics while adding a new layer of strategic complexity through energy swap operations.

This architecture sets a benchmark for electric endurance racing, reinforcing the championship's commitment to:

- Technological advancement
- Competitive integrity
- Operational efficiency
- Long-term sustainability in high-performance motorsport

With its combination of dynamic handling benefits, seamless swap integration, and advanced structural protection, the standardised battery system is more than an energy source — it is a defining element of the championship's technical identity and a foundation for the future of electric endurance competition.

2.4 Ensuring Fairness and Competitive Balance

To preserve competitive integrity, technical parity, and strategic fairness, The Automobili La'Bergitla Endurance Series enforces strict regulations governing the standardised battery system. These measures eliminate disparities in energy storage, power delivery potential, and weight distribution, ensuring that race outcomes are determined by **driver performance, engineering efficiency, and strategic execution** rather than by differences in battery scale or proprietary energy technology.

The standardised swappable battery architecture forms the cornerstone of this competitive framework. All teams must utilize identical battery specifications, including defined limits for capacity, mass, and structural integration. This ensures:

- Equal baseline energy availability for all competitors
- Consistent vehicle balance and mass characteristics across the grid
- Uniform safety and reliability standards

While energy storage itself is standardised, the regulations deliberately preserve innovation in other performance-defining areas. Teams remain free, within the technical framework, to develop and optimize:

- Powertrain efficiency and motor control strategies
- Aerodynamic performance and chassis integration
- Thermal management systems
- Regenerative energy recovery and deployment tactics
- Pit stop procedures and battery swap execution

This balance between standardization and technical freedom ensures that competition is driven by **how effectively energy is used**, not by how much can be stored. Strategic decision-making, operational precision, and engineering ingenuity therefore remain central to success in the championship.

Through this approach, The Automobili La'Bergitla Endurance Series establishes a stable, transparent, and equitable technical platform that supports close racing, cost control, and meaningful innovation in electric endurance motorsport.

2.4.1 Standardised Battery Regulations for Competitive Parity

1. Mandatory Use of the Proprietary Swappable Battery System

- **All teams must use the proprietary, homologated battery pack** designed specifically for The Automobili La'Bergitla Endurance Series.
- **No modifications** to **capacity, chemistry, or structural design** are permitted, ensuring uniform performance across the grid.
- Each **battery unit undergoes pre-race scrutineering** to verify compliance with **technical specifications and FIA-mandated safety standards**.

2. Maximum Battery Capacity Regulations

- **Energy Storage Limit**:
    - The maximum allowable battery capacity is **100 kWh (±5%)**, ensuring no team can gain an advantage by increasing total stored energy.
    - The 100-kWh limit aligns with the **energy throughput required for competitive endurance racing**, ensuring stints remain strategically challenging.
- **Voltage Architecture**:
    - The battery operates on an **800V nominal electrical system**, allowing for **high-power efficiency, rapid discharge rates, and improved thermal stability**.

3. Uniform Energy Allocation Per Race

- Each team is allocated **three battery packs for race use**, ensuring **parity in available energy**.
- **Teams must manage energy consumption across all stints**, balancing **aggressive race pace with efficient deployment strategies**.
- **Energy strategy plays a pivotal role**, as improper usage could lead to premature swaps, affecting pit stop frequency and race positioning.

4. Maximum Power Output Cap

- **Regulated Output:**
    - Power delivery is capped at **500 kW (~670 hp)** to **align with current endurance racing performance levels**, ensuring that EV prototypes compete **on par with existing LMH and LMDh regulations**.
    - The **power cap prevents excessive battery drain**, allowing for **sustainable, long duration stints** without overheating concerns.
- **Adaptive Power Mapping:**
- Teams may configure **torque vectoring and power distribution** strategies within the **500-kW ceiling**, providing **performance flexibility without breaching the regulated threshold**.

5. Standardised Battery Weight Bracket

- **Fixed Battery Mass**:
    - All battery units must fall within a **standardised weight bracket of 400–500 kg**, preventing teams from exploiting **ultra-lightweight or oversized battery variants**.

    - **Weight consistency ensures equalised handling characteristics**, keeping vehicle dynamics comparable across all competitors.
- **Impact on Vehicle Performance:**
- The fixed weight bracket ensures that all cars experience **similar centre-of-gravity effects**, maintaining fairness in **cornering stability, acceleration, and braking performance**.

6. High-Voltage Safety Compliance and Protection

- **Automated High-Voltage Isolation**:
    - Each battery unit features **an automatic high-voltage disconnect system**, ensuring that **pit crews and drivers remain protected** during battery swaps.
    - **Instantaneous cut-off mechanisms prevent electrical hazards**, reducing risks associated with **high-voltage live connections**.
- **Fire and Thermal Safety Standards**:
    - Integrated **fire-resistant casings and thermal monitoring systems** ensure compliance with **FIA safety regulations**.
    - Each **battery undergoes extreme-condition testing**, including **impact resilience, overcharge protection, and emergency shutdown protocols**.

2.4.2 Enforcing Technical Regulations and Compliance

To uphold **fair competition and technological integrity**, The Automobili La'Bergitla Endurance Series enforces **stringent regulatory oversight** on all battery systems.

1. Pre-Race Technical Scrutineering

- **Battery packs are rigorously tested** for compliance with weight, capacity, and power output limits.
- **Seals are applied** to prevent unauthorised modifications or tampering.
- **Performance metrics are cross-checked** against baseline parameters to ensure parity.

2. Real-Time Monitoring & Telemetry

- All **battery units transmit real-time performance data** to race control, ensuring **no unauthorised performance tuning**.
- **Live telemetry feeds track power usage, thermal efficiency, and energy deployment**, allowing officials to verify adherence to race regulations.
- **Anomalies or unauthorised modifications trigger automatic investigation**, leading to potential **penalties or disqualification**.

3. Post-Race Battery Audits

- At the conclusion of each race, **selected battery packs undergo forensic analysis** to confirm **compliance with regulations**.
- Any **violations, tampering, or unauthorised adjustments** result in **severe penalties, including disqualification or point deductions**.

2.4.3 Competitive Balance and Strategic Depth

While the **standardised battery ensures equal energy availability**, The Automobili La'Bergitla Endurance Series maintains a **high degree of strategic freedom** in **how teams optimize their power usage, energy recovery, and pit stop planning**.

How Standardization Enhances Competition

- **Focus on Efficiency & Strategy:**
  - With fixed battery capacity, **teams must maximize efficiency** rather than relying on **excessive power output**.
  - **Carefully planned battery swaps** play a critical role in **race positioning**.
- **Emphasis on Energy Management:**
  - Teams that develop superior **regenerative braking strategies and power delivery optimizations** gain a competitive edge.
- **Open Innovation in Vehicle Design:**
  - While **batteries remain identical**, teams are **free to innovate in powertrain development, aerodynamics, and software-based optimizations**.

A Fair, Regulated, and Performance-Focused Energy System
By implementing a **strict but balanced regulatory framework**, The Automobili La'Bergitla Endurance Series ensures that **energy availability, performance output, and vehicle dynamics remain uniform across all competitors**.

This **standardised yet strategically flexible system** guarantees that race outcomes are dictated by **engineering ingenuity, driving excellence, and tactical execution**—upholding the **spirit of endurance racing** in a fully electric era.

2.5 Flexible Swap Mechanisms for Teams

The Automobili La'Bergitla Endurance Series introduces a **flexible battery swap framework**, allowing teams to **develop and optimize their own swapping methodologies** while adhering to strict **safety, performance, and fairness regulations**. This **strategic element** ensures that teams can refine their pit stop efficiency while maintaining the integrity of competition.

Unlike traditional endurance racing, where **refuelling times vary based on fuel flow rates and tank sizes**, **battery swaps introduce a standardised yet flexible approach**—where swap speed, automation levels, and pit logistics become **a critical component of race strategy**.

2.5.1 Battery Swap Timing & Parity Regulations

To ensure **consistent competition**, battery swaps must conform to the following regulations:

- **Target Swap Time:**
  - Battery swaps must be **completed within 60 seconds** to maintain **parity across all competitors**.
  - If a team **fails to meet this benchmark**, they risk losing track position or incurring time penalties.

    - Teams must optimize **crew efficiency, swap techniques, and logistics** to ensure minimal downtime.
- **Restricted Pit Stop Operations During Swaps:**
    - **No concurrent mechanical work** is permitted while the battery is being swapped.
    - **Driver changes** are **the only permitted simultaneous operation**, ensuring that **pit stops remain structured and streamlined**.
    - This rule prevents teams from **gaining unfair advantages by conducting additional servicing** while swapping the battery.

2.5.2 Approved Swap Methodologies

Each team may **choose its own battery swapping method**, if it complies with **safety, timing, and regulatory requirements**.

1. Manual Crew-Operated Swaps

- **Teams deploy a dedicated pit crew** to remove and replace the underside-mounted battery pack.
- The process requires **highly skilled operators** to ensure rapid, **secure attachment and detachment**.
- Manual swaps are **cost-effective and reliable**, making them a **viable choice for teams with smaller budgets**.
- Pit crews must follow **strict safety protocols** to prevent high-voltage exposure or connection errors.

2. Semi-Automated or Robotic Swap Systems

- **Semi-automated swap rigs** integrate robotic arms or hydraulic lifts to remove and install the battery.
- These systems are **faster and more precise**, reducing the risk of **misalignment, damage, or human error**.
- **Robotic-assisted swaps improve efficiency** but require significant **technical investment and calibration**.
- Systems must remain within the **60-second swap window** to avoid gaining an unfair advantage.

3. Hybrid Crew & Automated Swap Integration

- Teams can **combine human and robotic elements** for an **optimised hybrid swap process**.
- **Example strategy:**
    - **Crew detaches locking mechanisms manually.**
    - **Automated lift removes the spent battery and installs a fully charged unit.**
    - **Crew finalizes connections and completes the swap.**
- This hybrid model provides a **balance between cost efficiency and speed**.

All **swap methodologies must be submitted for approval** before the race season begins to ensure compliance with **league safety standards**.

2.5.3 High-Voltage Safety Compliance

Battery swaps involve **high-voltage disconnections and reconnections**, requiring stringent **safety measures** to protect pit crews, drivers, and race personnel.

- **Automated High-Voltage Isolation Protocols**
  - The vehicle's electrical system must **automatically shut off power** before battery disconnection.
  - This prevents **accidental electrical discharge** and ensures a **zero-energy state** before handling.
- **Standardised Quick-Release Connectors**
  - **Each battery pack must use a standardised, high-speed quick-release interface**.
  - This ensures **consistent fitment and eliminates compatibility issues between teams**.
  - Connectors must be **impact-resistant, dust-proof, and water-sealed** for **maximum durability and safety**.
- **Safety Lockout Procedures**
  - **No live current may flow** while the battery is detached or being handled.
    - Pit crews must wear **insulated gloves and protective gear** to guard against residual static discharge.

2.5.4 Cooling & Charging Management During Swaps

To **maintain battery longevity and performance consistency**, all swapped batteries must **undergo regulated cooling and charging procedures** before being reinstalled.

- **Active Cooling During Charging**
  - Each battery must be **actively cooled while charging** to **prevent overheating**.
  - This includes **liquid-cooled heat exchangers, phase-change materials (PCMs), and regulated airflow systems**.
  - Teams **must not modify the cooling setup** to enhance charge rates.
- **Standardised Charging Power Limits**
  - Battery packs must be charged at a **regulated rate of ~600–800 kW**.
  - This prevents teams from **gaining an advantage through excessive rapid charging**.
  - Charging speeds **must not exceed pre-approved FIA standards**.
- **Charging & Swap Logistics**
  - Swapped-out batteries must be immediately **placed in designated charging bays**.
  - Race control **monitors all charging telemetry in real time** to ensure compliance.
  - **Cooling system violations or unauthorised modifications** result in **time penalties or disqualification**.

2.5.5 Ensuring Parity & Strategic Depth

By **allowing teams flexibility in swap methodology** while **regulating performance timing and safety standards**, The Automobili La'Bergitla Endurance Series **preserves the competitive integrity of endurance racing**.

Impact on Race Strategy

- **Pit Stop Variations:**
  - **Faster swaps** can result in **track position gains**, while **slower swaps** may require more **aggressive energy management on track**.
- **Battery Usage vs. Swap Timing:**
  - Teams must decide whether to **push for performance and swap more often**, or **conserve energy for fewer stops**.

Technology Investment:
  - Teams must **balance development costs**—whether to **invest in semi-automated systems** or **perfect manual swap efficiency**.

A Dynamic & Fair Energy Swap System
The **flexible battery swap framework** ensures that:

- **All teams compete under equal energy conditions**, preventing disparities in charge speed or stored capacity.
- **Safety remains the highest priority**, with robust **high-voltage protection and pit crew safeguards**.
- **Strategic flexibility is preserved**, allowing teams to optimize **swap speed, crew performance, and energy deployment tactics**.

By integrating **cutting-edge battery technology with adaptable pit strategies**, The Automobili La'Bergitla Endurance Series **cements itself as the gold standard for EV endurance racing**, merging **high-performance competition with sustainable energy solutions**.

2.6 Dual Super/Ultra-Capacitor Integration

A defining innovation of **The Automobili La'Bergitla Endurance Series battery system** is the **dual super/ultra-capacitor integration**, designed to enhance **energy efficiency, performance stability, and high-power handling**. By incorporating two layers of **advanced capacitor technology**, the system optimizes energy flow, mitigates battery stress, and ensures **seamless vehicle operation** during critical race moments.

2.6.1 Primary Supercapacitor System (Battery-Integrated)

The **primary supercapacitor system** is built directly into the **swappable battery unit** and functions as an **energy buffer** between the **battery cells and powertrain**.

Key Functions:

- **Power Smoothing & Cell Protection**
    - **Supercapacitors stabilize energy output**, preventing **sudden surges or drops** that could degrade lithium-ion or solid-state battery cells.
    - This **reduces cell stress**, **improving battery longevity** and maintaining **consistent power delivery** throughout stints.
- **Enhanced Battery Lifespan & Thermal Management**
    - **By absorbing peak loads**, the primary capacitor reduces the need for **excessive cooling**, **minimizing thermal degradation**.
    - This ensures **optimal operating temperatures** over long endurance stints.
- **Rapid Energy Delivery for Acceleration**
    - Unlike chemical batteries, **supercapacitors charge and discharge instantly**.
    - This allows for **faster throttle response**, particularly when deploying **maximum power out of slow corners or during overtakes**.

2.6.2 Secondary Supercapacitor System (Vehicle-Integrated)

The **secondary supercapacitor system** is embedded **within the vehicle itself**, separate from the swappable battery. This system is primarily responsible for **energy recapture and rapid redistribution**.

Key Functions:

- **Regenerative Braking & Energy Storage**
    - Captures energy from **braking zones and suspension movements**, **storing it for immediate reuse**.
    - Acts as a high-speed buffer, allowing the car to **deploy stored energy instantly without drawing from the battery**.
- **Instant Power for Acceleration Bursts**
    - Provides a **temporary boost of stored power** for quick acceleration out of corners or during **high-speed overtakes**.
    - This function mimics **"push-to-pass" hybrid boost modes** seen in previous endurance racing prototypes.
- **Continuous Power During Battery Swaps**
    - Maintains essential systems (e.g., **telemetry, cooling, electronics, and hybrid braking functions**) **while the battery is being swapped**.
    - Prevents system resets, ensuring **seamless vehicle operation** during pit stops.

2.6.3 Advantages of Dual Super/Ultra-Capacitor Integration

1. Improved Peak Power Handling

- Supercapacitors can handle **high-power surges** without straining the battery, ensuring **maximum efficiency**.
- This prevents **voltage drops** during **high-load situations**, maintaining **steady and predictable performance**.

2. Reduction in Battery Stress

- The system **reduces wear on battery cells**, **extending their usable lifespan** over multiple race stints
- Less reliance on battery output **lowers heat generation**, minimizing **thermal management challenges**.

3. Enhanced Regenerative Energy Utilization

- Allows for **greater recapture efficiency** from regenerative braking and **chassis-based energy harvesting systems**.
- Ensures that **more recovered energy** is available for **performance-enhancing deployment**.

4. Optimised Endurance Racing Strategy

- **Strategic energy management** becomes a critical factor, as teams can determine **how and when to deploy stored capacitor energy**.
- Ensures that **battery energy is reserved for sustained output**, while **supercapacitors handle immediate power needs**.

2.6.4 Standardization & Competitive Integrity

To maintain **fairness and parity**, The Automobili La'Bergitla Endurance Series enforces the following **regulatory standards** regarding super/ultra-capacitor integration:

- **Fixed Energy Capacity Limits**
  - The secondary capacitor system is capped at **a predefined maximum storage limit**, ensuring **no team gains an unfair advantage**.
- **Uniform Integration Requirements**
  - Both **battery-integrated** and **vehicle-mounted capacitor units** must conform to **FIA approved designs**.
- **Restricted Direct Charging**
  - Capacitors **must be charged exclusively through energy recovery systems** and **cannot be manually recharged during pit stops**.
- **Technical Scrutiny & Compliance Testing**
  - All energy storage and deployment mechanisms are **monitored in real-time**, with teams required to **submit system specifications for pre-season homologation**.

2.6.5 A High-Performance, Efficient Energy Solution

The **dual super/ultra-capacitor system** represents a **breakthrough in endurance EV racing technology**, ensuring that:

- **Power delivery remains smooth and consistent**, optimizing **vehicle dynamics**.
- **Energy efficiency is maximised**, extending **battery life, and reducing thermal loads**.

- **Critical systems remain powered during battery swaps**, preventing **performance interruptions**.
- **Racing strategies are enhanced**, with teams balancing **battery conservation, energy recovery, and capacitor deployment**.

By combining **advanced capacitor technology with swappable high-energy-density batteries**, The Automobili La'Bergitla Endurance Series **redefines endurance racing**, proving that electric propulsion can **match and exceed** traditional internal combustion performance in the world's most demanding motorsport environment.

3. Technical Breakdown of the Battery System

The Automobili La'Bergitla Endurance Series battery system represents a **technological milestone in electric endurance racing**, engineered to deliver **high performance, safety, and efficiency** across an intense **24-hour race format**. This proprietary system is meticulously designed to handle the **rigors of sustained high-speed racing**, ensuring that energy delivery remains **consistent, predictable, and strategically manageable** throughout the event.

A key **differentiating factor** in this championship is the **exclusive reliance on battery-swapping technology**, eliminating the **charging downtime** traditionally associated with electric racing. While the **battery system is compatible with both inductive and conductive charging**, these methods are **only used when necessary to discharge a battery or for pre-race energy management**. Instead, **fully charged battery packs will be placed on high-speed chargers** in the paddock, ensuring a **seamless and efficient swap-based energy replenishment system**. This strategy **aligns with traditional endurance racing principles**, where pit stops focus on rapid refuelling—or in this case, battery replacement—rather than lengthy recharge times.

The **battery system's design is centred around four primary objectives**:

1. **Energy Density Optimization** – Maximizing the power-to-weight ratio while maintaining endurance and longevity.
2. **Safety and Thermal Stability** – Incorporating **advanced cooling and fire suppression mechanisms** to ensure safety under extreme racing conditions.
3. **Performance Consistency** – Enabling **stable power output across stints**, preventing performance degradation over time.
4. **Standardization with Competitive Innovation** – Providing a **level playing field** with uniform energy storage, while allowing teams to innovate in **powertrain efficiency and deployment strategies**.

This section will delve into the **technical composition, energy architecture, and operational protocols** that define **The Automobili La'Bergitla Endurance Series battery system**, highlighting how this technology is **not only redefining endurance racing but also paving the way for future advancements in electric propulsion**.

3.1 Structural Design and Materials

The Automobili La'Bergitla Endurance Series battery system is engineered with **advanced structural materials and design principles** to meet the **high-performance, safety, and endurance requirements** of a **24-hour electric race**. The battery **must withstand extreme conditions**, including high speeds, aggressive cornering forces, crash impacts, and continuous thermal cycling, while remaining **lightweight and durable** for optimal performance.

3.1.1 Carbon Fibre-Reinforced Polymer (CFRP) Housing

The **primary structural material** used in the battery casing is **carbon fibre-reinforced polymer (CFRP)**, which offers:

- **Exceptional Strength-to-Weight Ratio** – CFRP is significantly **lighter than steel or aluminium**, reducing unnecessary mass while maintaining structural rigidity.
- **High Impact Resistance** – The material is designed to **absorb and distribute energy** in the event of an accident, minimizing the risk of battery damage.
- **Thermal Stability** – Carbon fibre naturally resists **thermal expansion**, helping maintain **structural integrity** under varying temperatures and extreme racing conditions.

3.1.2 High-Strength Aluminium Framework

To complement the CFRP shell, **high-strength aluminium alloys** are used in key structural components:

- **Reinforced Battery Mounting** – Ensuring that the **underside-mounted battery** is securely attached to the chassis without flexing under high-G forces.
- **Lightweight Durability** – Aluminium provides an **optimal balance of weight reduction and mechanical strength**.
- **Crash-Optimised Bracing** – Strategic **reinforcements prevent intrusion** into the battery pack during high-speed collisions.

3.1.3 Underside-Mounted Design

All race cars in the championship must **adhere to a standardised underside-mounted battery configuration**, ensuring:

- **Uniform Weight Distribution** – The low placement of the battery **optimizes the centre of gravity**, improving vehicle stability and handling.
- **Fast and Efficient Swaps** – The mounting system allows for **quick-release and secure reattachment** during pit stops, enabling **battery swaps in under 60 seconds**.
- **Consistent Chassis Integration** – Preventing **aero or structural design advantages** while ensuring **compatibility across manufacturers**.

3.1.4 Protective Casing and Environmental Shielding

The battery casing is engineered to provide **multiple layers of protection** from **physical impacts, environmental hazards, and racing conditions**, featuring:

- **Multi-Layer Composite Armor** – A hybrid **CFRP and Kevlar weave** adds an extra layer of **puncture resistance**.
- **Water and Dust Resistance** – The housing is **sealed to prevent debris, water, and contaminants** from affecting internal components.

- **Mechanical Stress Resistance** – The **casing prevents damage** from repeated load-bearing impacts, vibrations, and extreme forces encountered during endurance racing.

3.1.5 FIA-Compliant Crash Safety & Fire Suppression

The **Automobili La'Bergitla battery system** is fully **FIA-homologated**, complying with **rigorous crash safety standards**, including:

- **Impact-Resistant Housing** – Battery units must **withstand extreme frontal, lateral, and rear collision forces** without compromising integrity.
- **Integrated Fire Suppression System** – Each battery pack contains **self-activating fire-retardant materials** that deploy in case of a thermal event.
- **Automatic High-Voltage Isolation** – In the event of an accident, the **battery system automatically disconnects from the vehicle** to prevent electrical hazards.

By utilizing **next-generation materials and structural safety enhancements**, The Automobili La'Bergitla Endurance Series ensures that the **battery system meets the highest standards of endurance racing safety, performance, and reliability**. This meticulous **engineering approach guarantees** that teams **compete in an electrified endurance format without compromising speed, agility, or safety**.

3.2 Inductive and Conductive Charging Options

The Automobili La'Bergitla Endurance Series battery system incorporates both **inductive and conductive charging technologies**, ensuring **maximum flexibility for energy management** while maintaining a **fast, standardised battery-swapping format during races**. While charging methods are not used during competition, they are **critical for off-track operations**, including **battery conditioning, discharge management, and practice sessions**.

3.2.1 Purpose and Implementation of Charging Technologies

Although the primary **energy replenishment strategy** for this endurance series revolves around **battery swaps**, both inductive and conductive charging technologies are built into the **standardised battery architecture** for supplementary use in specific circumstances:

- **Battery Pre-Race Preparation** – Ensuring that all teams start with **fully charged, optimised battery packs** before race sessions.
- **Post-Race Battery Conditioning** – Managing **controlled discharge cycles** to prevent degradation and maintain long-term battery efficiency.
- **Testing and Development Use** – Providing teams with options for **charging batteries outside race scenarios**, such as private testing and promotional events.

3.2.2 Inductive Charging System

The **Automobili La'Bergitla battery pack** is equipped with **wireless inductive charging capability**, allowing **contactless energy transfer** through an advanced **flat-coil antenna system**. This technology provides:

- **Zero Mechanical Wear** – **No physical connectors** are required, reducing wear on **charging ports** and **mechanical failures** over time.
- **High-Efficiency Power Transfer** – **Resonant inductive coupling** ensures that **energy is transmitted with minimal loss**, optimizing overall charging efficiency.
- **Enhanced Safety** – By eliminating **physical connections**, inductive charging **reduces risks of electrical faults**, making it an ideal solution for **wet or contaminated environments**.

Inductive Charging Limitations in Racing

- **Inductive charging is not used during races** due to its slower energy transfer rate compared to battery swaps.
- **Its primary use** is for **battery conditioning, vehicle testing, and controlled energy discharge cycles** outside competitive sessions.
- **Future applications** may explore integrating **inductive track-side charging** for endurance simulations or slow-speed pit-lane energy top-ups.

3.2.3 Conductive Charging System

The battery system also includes **high-speed conductive charging ports**, designed for **maximum energy transfer efficiency** in a **controlled off-track environment**. Key features include:

- **Silver-Plated Copper Contact Terminals** – Offering **exceptional conductivity** and **low resistance**, ensuring **rapid and efficient energy transfer**.
- **Ultra-Fast DC Charging Support** – The system is designed to handle **high-power direct current (DC) fast charging**, with power levels reaching **600–800 kW**, allowing for **quick battery turnaround**.
- **Secure Connection and Safety Monitoring** – Integrated **temperature sensors, voltage regulators, and current limiters** prevent overcharging and overheating during energy transfer.

Race Policy on Conductive Charging

- **Conductive charging is not permitted during active race sessions**—all energy replenishment is handled through **battery swaps**.
- **All charging is conducted off-track** in designated **high-speed charging stations**, ensuring **equitable energy availability for all teams**.
- **Teams may use conductive charging between practice and race sessions** to **balance energy levels** before battery installation.

3.2.4 Competitive and Safety Regulations

To maintain **fair competition and ensure safety**, strict regulations govern the use of **inductive and conductive charging**:

- **All charging infrastructure is standardised** across teams, preventing unfair technological advantages.
- **Inductive and conductive charging are prohibited in pit stops** to ensure **equal energy replenishment through swapping**.
- **Automated monitoring systems** enforce safe charging rates, preventing overloading or exceeding thermal thresholds.

By **integrating both inductive and conductive charging technologies**, the **Automobili La'Bergitla battery system** offers **future-proof flexibility**, ensuring that **battery conditioning, maintenance, and non-race charging needs** are met with **cutting-edge efficiency**. While **battery swaps remain the core race strategy**, the presence of **wireless and direct charging options** reinforces the **championship's commitment to pioneering EV endurance racing solutions**.

3.3 Adaptive Bidirectional Power Converter

The Automobili La'Bergitla Endurance Series battery system incorporates an **Adaptive Bidirectional Power Converter (ABPC)** to optimize energy flow, enhance **charging and discharging flexibility**, and support **advanced power management strategies**. This cutting-edge component ensures that energy transfer is **precisely controlled, highly efficient, and adaptable to multiple operational scenarios**.

3.3.1 Purpose and Functionality

The **ABPC** serves as a **critical interface** between the **battery, vehicle systems, and external power sources**, ensuring optimal energy distribution and utilization. Its primary functions include:

- **DC-to-AC Conversion for Inductive Charging** – Converts **direct current (DC) from the battery** into **high-frequency alternating current (AC)** for **wireless inductive power transfer**.
- **Bidirectional Power Flow Management** – Enables controlled **vehicle-to-grid (V2G)** energy discharge and dynamic power balancing.
- **Voltage and Current Optimization** – Adjusts energy flow in **real time** to ensure **maximum efficiency** in both **charging and energy deployment**.

3.3.2 High-Frequency DC-to-AC Conversion for Inductive Coupling

To facilitate **inductive energy transfer**, the **ABPC** utilizes **high-frequency power electronics** to efficiently convert **DC power into high-frequency AC**. This feature:

- **Enhances Wireless Charging Efficiency** – Optimised **power waveforms** improve **inductive charging speeds** and minimize energy loss.

- **Reduces Energy Conversion Waste** – Fine-tuned **power conversion algorithms** maximize **energy transfer rates** between charging pads and vehicle-mounted receivers.
- **Ensures Seamless Integration** – Works in conjunction with the **inductive charging system**, allowing for **safe and rapid energy transmission** without physical contact.

3.3.3 Bidirectional Power Flow & Vehicle-to-Grid (V2G) Capabilities

A core innovation of the **ABPC** is its **ability to manage power flow in both directions**, allowing:

- **Energy Discharge Before Battery Swaps** – Controlled **discharging of excess power** before swaps ensures a **safe and stable transition** between battery changes.
- **Vehicle-to-Grid (V2G) Integration** – Enables teams to **transfer excess stored energy back into the race paddock's energy network**, contributing to **smart grid efficiency**.
- **Load Balancing During Charging** – The system dynamically **regulates energy flow** to prevent sudden spikes or drops in power, ensuring **uniform charging conditions** across all race batteries.

3.3.4 Intelligent Power Optimization Software

To maximize efficiency and **prevent power fluctuations**, the **ABPC** features an **integrated optimization algorithm** that continuously fine-tunes:

- **Voltage and Current Levels** – **Real-time adjustments** ensure that **energy transfer remains within optimal efficiency thresholds**.
- **Thermal and Load Management** – Actively monitors **battery temperature and electrical load**, redistributing power as needed to **prevent overheating and inefficiencies**.
- **Dynamic Power Allocation** – During high-load scenarios (such as rapid acceleration or heavy braking regeneration), the system reallocates **energy delivery priorities** to balance performance needs.

3.3.5 Competitive and Safety Regulations

To ensure **fair competition and reliability**, all **Adaptive Bidirectional Power Converters** must adhere to **strict regulatory standards**:

- **Standardised Power Transfer Protocols** – Prevents teams from gaining an **unfair charging advantage** through custom modifications.
- **Safety-Certified Power Control Algorithms** – All voltage and current adjustments must comply with **FIA-approved safety regulations** to **prevent electrical faults**.
- **Bidirectional Power Use Restrictions** – While **V2G integration** is allowed for sustainability initiatives, **in-race energy exports are strictly prohibited** to ensure **consistent energy availability for all teams**.

An Intelligent Energy Management System

The **Adaptive Bidirectional Power Converter** is a key component of **The Automobili La'Bergitla Endurance Series battery system**, providing **intelligent energy flow management, high-frequency DC-to-AC conversion for inductive charging, and bidirectional power capabilities**. By ensuring **optimal energy transfer, load balancing, and safe battery swaps**, the **ABPC** enables endurance EV racing to **operate at peak efficiency without compromising performance, safety, or fairness**.

3.4 Advanced Battery Management System (BMS)

The **Advanced Battery Management System (BMS)** is a crucial component of **The Automobili La'Bergitla Endurance Series battery system**, designed to **optimize performance, enhance safety, and extend battery lifespan**. By utilizing **real-time monitoring, predictive analytics, and automated balancing mechanisms**, the **BMS** ensures that each race battery operates at peak efficiency under the extreme demands of endurance racing.

3.4.1 Real-Time Monitoring and Performance Optimization

To ensure **consistent and reliable power delivery**, the **BMS continuously monitors** the following parameters in real time:

- **Voltage Regulation:** Tracks the voltage of each individual cell to prevent **overcharging or deep discharging**, maximizing **battery life and efficiency**.
- **Current Flow Management:** Regulates current draw under varying loads, ensuring that **power is delivered efficiently without causing thermal stress**.
- **Thermal Control & Heat Dissipation:** Monitors **battery pack temperature** and actively adjusts **cooling mechanisms** (e.g., liquid cooling, phase-change materials) to prevent overheating during high-load scenarios such as full-power acceleration and regenerative braking.

The **real-time monitoring** capabilities of the **BMS** provide teams with **actionable telemetry data**, allowing them to make strategic energy deployment decisions based on live battery conditions.

3.4.2 Predictive Analytics for Maintenance and Early Failure Detection

The **BMS** utilizes **machine learning algorithms and predictive analytics** to anticipate **potential battery degradation or component failures** before they occur. Key predictive functions include:

- **State of Health (SOH) Estimation:** Continuously assesses battery **aging, wear patterns, and capacity fade**, ensuring teams can plan swaps and replacements before performance loss occurs.
- **Fault Prediction & Anomaly Detection:** Uses AI-driven diagnostics to **identify irregularities in voltage fluctuations, heat build-up, or current imbalances**, preventing unexpected battery failures mid-race.

- **Pre-emptive Maintenance Scheduling:** Provides **automated alerts** for necessary maintenance or cooling system adjustments to **prolong battery lifespan and ensure reliability over multiple race stints**.

By leveraging **advanced predictive analytics**, teams can **optimize battery performance, prevent catastrophic failures, and fine-tune their energy management strategies** throughout the 24-hour race.

3.4.3 Automatic Cell Balancing Mechanism

To maintain **uniform charge distribution** across the entire battery pack, the **BMS features an integrated active/passive balancing system**, ensuring:

- **Equalised Charge Across All Cells:** Prevents individual cells from **overcharging or undercharging**, which could lead to uneven power output and long-term battery degradation.
- **Dynamic Load Redistribution:** Actively **shifts energy between cells** to maximize overall pack efficiency, especially during **high-power demand scenarios** such as rapid acceleration or regenerative braking.
- **Improved Longevity & Efficiency:** Maintains a **consistent voltage profile across the battery pack**, enhancing **performance stability** over long endurance race cycles.

The **automatic balancing mechanism** plays a crucial role in **ensuring every battery pack operates at maximum potential**, preventing **cell degradation and power inconsistencies** that could impact race performance.

3.4.4 Compliance with FIA Safety and Endurance Racing Standards

To meet the stringent **safety regulations** of **The Automobili La'Bergitla Endurance Series and FIA endurance racing**, the **BMS** integrates a comprehensive set of **fail-safe mechanisms**, including:

- **High-Voltage Isolation & Overcurrent Protection:** Ensures safe handling during battery swaps by automatically **disconnecting high-voltage circuits** before removal.
- **Thermal Runaway Prevention:** In case of **overheating**, the **BMS** activates **cooling redundancy systems** or initiates **emergency power cut-off** to prevent potential thermal incidents.
- **Crash Detection & Emergency Shutdown:** Monitors impact forces and, in the event of a severe collision, **automatically isolates** the battery system from the car's powertrain for **driver and crew safety**.

By adhering to **strict FIA safety protocols**, the **BMS guarantees that all competing vehicles maintain the highest level of electrical safety while optimizing power deployment for endurance racing conditions**.

The Role of the BMS in High-Performance Endurance Racing
The **Advanced Battery Management System (BMS)** is an essential innovation in **The Automobili La'Bergitla Endurance Series**, enabling:

- **Real-time monitoring of voltage, current, and temperature** to optimize performance.
- **Predictive analytics for failure prevention and pre-emptive maintenance scheduling**.
- **Automated balancing of individual cells** to ensure longevity and consistent power output.
- **Compliance with FIA safety standards**, ensuring maximum reliability and crash protection.

By integrating **state-of-the-art battery intelligence**, the **BMS not only enhances race efficiency and safety but also sets a new benchmark for endurance EV performance**, reinforcing The Automobili La'Bergitla Endurance Series as a leader in cutting-edge electric motorsport technology.

3.5 Integrated Supercapacitors for Peak Power Demands

Introduction to Supercapacitor Technology in Endurance Racing

In high-performance endurance racing, **energy efficiency, rapid power delivery, and system stability** are critical factors that influence both **performance and reliability**. To address these demands, **The Automobili La'Bergitla Endurance Series** integrates a **dual-supercapacitor system** within its standardised battery technology, **enhancing energy management, power buffering, and vehicle efficiency**.

Supercapacitors, also known as **ultracapacitors**, differ from traditional lithium-ion battery cells in that they **store and release energy almost instantaneously**, making them ideal for handling short bursts of **high-power demand** and **regenerative braking energy capture**. By incorporating **dual supercapacitor buffers**, **The Automobili La'Bergitla Endurance Series** system enhances overall energy utilization while simultaneously **reducing strain on the battery pack**, extending its operational lifespan, and ensuring **peak performance in demanding race conditions**.

3.5.1 Dual Supercapacitor Buffer System: A Two-Tiered Approach

To maximize **power efficiency, responsiveness, and energy retention**, the **dual-supercapacitor system** is divided into two key components:

1. Battery-Integrated Supercapacitor Buffer (Primary Buffer System)

- Located **within the battery housing**, this capacitor buffer **absorbs and smooths out power surges** that occur due to sudden acceleration or braking events.
- Acts as a **shock absorber** for energy fluctuations, preventing **voltage drops or spikes** that could negatively impact performance.
- Enables **stable and consistent power delivery**, ensuring that energy output remains smooth even during high-load scenarios.
- Works in tandem with the **Battery Management System (BMS)** to optimize battery health, minimizing thermal stress and enhancing energy deployment strategies.

2. Vehicle-Integrated Supercapacitor Buffer (Secondary Buffer System)

- This secondary capacitor system is **installed within the vehicle itself**, independent of the battery pack.
- Designed to **store and supply power independently of the battery**, ensuring that critical vehicle systems remain operational even during a battery swap.
- Helps sustain **active vehicle electronics, telemetry, cooling systems, and drive functions**, preventing any interruptions in performance while the primary battery is being replaced.
- Provides an **additional power reserve for sudden energy bursts**, such as **rapid acceleration out of corners or instant deployment of energy in overtaking manoeuvres**.

3.5.2 Enhancing Vehicle Efficiency and Performance

The integration of **supercapacitors** significantly improves the efficiency and durability of **The Automobili La'Bergitla Endurance Series battery system** by mitigating high-energy stress points. Key benefits include:

1. Instantaneous Power Delivery for Acceleration

- Unlike lithium-ion batteries, **supercapacitors can discharge power almost instantly**, providing an **immediate boost of energy** when needed.
- This capability is particularly advantageous in **corner exits, overtakes, and high-speed acceleration zones**, where instant torque and power output are essential for maintaining race competitiveness.

2. Stress Reduction on Battery Cells

- Batteries experience degradation over time due to repeated **charge-discharge cycles and exposure to extreme loads**.
- By **handling short-duration, high-power events**, **supercapacitors reduce the workload on the main battery pack**, extending its lifespan and **maintaining optimal energy efficiency throughout long endurance stints**.
- The system **prevents excessive current draw from the battery**, leading to **lower thermal build-up and improved energy retention**.

3. Improved Regenerative Braking Efficiency

- In electric racing, **regenerative braking plays a crucial role in energy recovery**, converting kinetic energy back into stored electrical energy.
- Supercapacitors can **capture and release regenerative energy much faster than traditional lithium-ion batteries**, improving **energy efficiency and on-track recovery rates**.
- This feature allows teams to **maximize energy capture from braking zones**, providing a **strategic advantage in energy deployment over a race stint**.

4. Energy Buffering for Stable Performance

- In **high-performance racing**, **energy fluctuations can impact drivability, traction, and responsiveness**.

- Supercapacitors act as **buffers**, stabilizing the electrical system and **ensuring a constant flow of power to the motors**.
- This **smooth energy deployment** enhances vehicle control and reduces the risk of **power inconsistencies during critical race moments**.

3.5.3 Role in Battery Swapping Strategy

Battery swaps are a fundamental part of **The Automobili La'Bergitla Endurance Series**, mimicking traditional endurance racing pit stops for refuelling. However, unlike fuel stops, battery swaps introduce a **potential gap in power availability** during the transition phase. The **dual-supercapacitor system eliminates this issue** by:

- **Maintaining essential vehicle functions** (electronics, telemetry, cooling systems) during battery swaps.
- **Providing an immediate power reserve** for a seamless return to racing after a swap.
- **Ensuring no loss of telemetry or vehicle systems**, allowing teams to remain in full control without interruptions in power flow.

By integrating supercapacitor technology, **The Automobili La'Bergitla Endurance Series ensures that battery swaps are as efficient and performance-oriented as traditional refuelling stops in endurance racing**.

3.5.4 Compliance with Safety and Regulatory Standards

To maintain the highest safety and **FIA compliance**, the **dual-supercapacitor system** is subject to **strict performance and safety regulations**:

- **Thermal Stability and Overcharge Protection:** The system is **equipped with fail-safes to prevent overheating, overcharging, or accidental discharge**.
- **Crash Impact Resistance:** The supercapacitors are **housed in reinforced enclosures**, ensuring **structural integrity in high-speed collisions**.
- **Automated Isolation in Emergency Situations:** If a vehicle sustains heavy damage, the **Battery Management System (BMS)** can **automatically disconnect** the supercapacitors to **prevent electrical hazards**.

Revolutionizing Energy Deployment in Endurance EV Racing

The **dual-supercapacitor integration** in **The Automobili La'Bergitla Endurance Series** represents a **breakthrough in electric motorsport technology**, delivering:

- **Instantaneous power bursts for acceleration and overtakes**.
- **Efficient energy capture and release for regenerative braking**.
- **Enhanced battery longevity by reducing stress on lithium-ion cells**.
- **Uninterrupted vehicle operation during battery swaps**.
- **Smoother energy deployment, improving overall vehicle stability and performance**.

By combining **cutting-edge energy buffering technology with endurance race strategy**, **The Automobili La'Bergitla Endurance Series** ensures that its electric prototypes remain **as competitive, thrilling, and technologically advanced as their combustion-powered predecessors**. This **marks a new era in endurance racing**, where **efficiency, strategy, and high-performance electrification** define the future of motorsport.

3.6 Continuous Power Supply During Battery Swaps

Ensuring Uninterrupted Vehicle Functionality in the Pit Lane

A key challenge in **battery-swapping endurance racing** is maintaining vehicle functionality during pit stops. Unlike conventional refuelling, where fuel tanks remain intact, battery swaps temporarily disconnect the vehicle's **primary power source**, potentially causing **telemetry blackouts, cooling disruptions, and loss of key electronic controls**.

To mitigate these risks, **The Automobili La'Bergitla Endurance Series** mandates the use of an **integrated supercapacitor buffer** to provide **continuous power supply** throughout the battery swap process. This system ensures that teams can execute **fast, efficient, and risk-free battery exchanges** without **disrupting race-critical operations**.

3.6.1 Supercapacitor Buffer: The Key to Continuous Power

The **secondary supercapacitor buffer**, embedded within the vehicle's electrical system, ensures that all **critical onboard systems remain active** while the main battery is removed. This guarantees **seamless pit stops**, eliminating any potential performance loss due to power interruptions.

How It Works:

- The **moment the primary battery is disconnected**, the **supercapacitor buffer automatically supplies power** to essential vehicle systems.
- The **energy stored within the supercapacitor** is used to sustain **critical electronic controls, cooling mechanisms, and telemetry systems**.
- Once a **new battery pack is installed**, the supercapacitor system smoothly transitions power delivery back to the main battery, **preventing electrical surges or abrupt voltage changes**.

3.6.2 Maintaining Essential Race Systems During Swaps

During a battery swap, the following vehicle systems must remain operational to **avoid delays, system resets, or driver complications**:

1. Telemetry & Communication Systems

- Real-time telemetry remains active, ensuring that teams can **continue to monitor vehicle diagnostics, energy levels, and race data** during a swap.

- **No data loss or system reboot delays** occur, allowing the team to **seamlessly integrate race strategy adjustments** as soon as the new battery is installed.

2. Electronic Control Systems (ECUs & Drive Electronics)

- Electronic **braking, traction control, and differential systems remain powered**, preventing **software resets that could require recalibration**.
- Ensures the **driver retains full control** of auxiliary race systems, improving safety and pit lane efficiency.

3. Thermal Management & Cooling Systems

- The **battery cooling infrastructure remains operational** during the swap, **preventing overheating or thermal spikes** when the new battery is installed.
- The cooling loop is **powered independently from the main battery**, ensuring that optimal operating temperatures are **maintained during transitions**.

4. Driver Control Interface & Steering Systems

- The supercapacitor buffer keeps **steering assist, cockpit displays, and other driver interfaces powered**, allowing **seamless re-entry onto the track** once the new battery is fitted.
- This prevents situations where drivers must perform additional reset procedures before resuming the race.

3.6.3 Efficiency Gains: Eliminating Reboot & Reset Delays

One of the major advantages of a **continuous power supply** during battery swaps is the elimination of **reboot delays**. Traditional EV systems can take **several seconds to fully restart** after a complete power cycle, which in endurance racing is **time lost on track**.

By integrating **supercapacitor-based energy buffering**, **The Automobili La'Bergitla Endurance Series** ensures that:

- **No additional time is wasted waiting for system restarts**.
- **Vehicles can exit pit lane the moment the swap is completed**.
- **All race-critical functions remain operational** throughout the process.

This **seamless transition of power** allows for **lightning-fast swaps** that maintain the **rhythm and strategy of endurance racing**, aligning with traditional pit stops in **fuel-based competitions**.

3.6.4 Automatic Power Transition: Supercapacitor to Main Battery

To ensure a **smooth energy transition** back to the primary power source, the vehicle's electrical system follows this automated sequence:

- **Battery Disconnection** – As the existing battery is removed, the **supercapacitor buffer seamlessly takes over**, providing energy to essential systems.

- **Continuous System Operation** – While the new battery is fitted, all telemetry, cooling, and ECU functions remain active, preventing downtime.
- **Battery Reconnection** – Once the new battery is secured, the system **gradually transfers power demand from the supercapacitor back to the main pack**.
- **Supercapacitor Recharge** – The supercapacitor **replenishes its charge from regenerative braking and battery energy**, preparing for the next pit stop cycle.

This process ensures **zero interruption in vehicle performance** and provides **a competitive advantage by allowing teams to execute swaps with minimal time loss**.

3.6.5 FIA Safety & High-Voltage Compliance

To comply with **FIA safety regulations** and ensure pit crew protection, the **continuous power supply system** integrates the following safety mechanisms:

- **Automatic High-Voltage Isolation** – Ensures that only **low-voltage circuits** remain active during the swap, reducing **electrical risk to crew members**.
- **Surge Protection & Circuit Monitoring** – Prevents **overcurrent or sudden power fluctuations** that could disrupt vehicle operations.
- **Fail-Safe Manual Override** – Allows teams to **manually disconnect power if needed**, ensuring safety in emergency scenarios.

These safeguards ensure that battery swaps are not only **efficient but also safe for both drivers and pit crews**.

A Competitive Edge in Endurance EV Racing

The **continuous power supply system** in **The Automobili La'Bergitla Endurance Series** represents a **game-changing innovation** in electric endurance racing. By leveraging **supercapacitor buffering**, this system provides:

- **Uninterrupted vehicle operation during pit stops**.
- **Elimination of system reboot delays, improving efficiency**.
- **Seamless power transitions between supercapacitor and battery pack**.
- **Enhanced race strategy flexibility through rapid and reliable swaps**.

This **technological breakthrough** ensures that **The Automobili La'Bergitla Endurance Series** maintains the **intensity, precision, and strategy** of traditional endurance racing, while simultaneously **pushing the boundaries of electric motorsport innovation**.

3.7 High-Energy Density Cells and Charging Speed

Revolutionizing Energy Storage for Endurance Racing

The Automobili La'Bergitla Endurance Series battery system is engineered to push the boundaries of **electric endurance racing**, integrating **next-generation solid-state battery technology** to maximize energy density, **ultra-fast charging**, and high-performance discharge capabilities. Unlike conventional lithium-ion packs, these advanced cells ensure **sustained peak power output** without compromising safety, efficiency, or longevity.

This section provides an in-depth breakdown of the **energy storage innovations** that make this battery system a **cornerstone of all-electric endurance racing**.

3.7.1 Next-Generation Solid-State Battery Technology

The championship's battery pack utilizes **solid-state battery (SSB) technology**, which offers several advantages over traditional lithium-ion cells:

Key Benefits of Solid-State Batteries in Endurance Racing

- **Higher Energy Density** – Solid-state chemistry allows for a more compact, lightweight battery while **storing significantly more energy per unit volume**.
- **Faster Charging Capability** – The lower internal resistance of solid-state cells **enables rapid energy absorption**, reducing charge times.
- **Greater Safety & Thermal Stability** – Unlike conventional lithium-ion batteries that use liquid electrolytes, solid-state batteries **eliminate flammability risks** and drastically improve safety in high-stress racing conditions.
- **Extended Cycle Life** – The absence of liquid electrolytes minimizes **degradation over multiple charge cycles**, making the battery **more durable for endurance racing**.
- **Lower Operating Temperatures** – Solid-state cells produce **less heat** during charge and discharge cycles, reducing reliance on active cooling systems.

By leveraging **solid-state battery technology**, The Automobili La'Bergitla Endurance Series ensures that teams benefit from **maximum energy storage capacity, higher efficiency, and improved longevity**, setting a new benchmark in electric endurance racing.

3.7.2 Ultra-Fast Charging Capabilities

Unlike conventional electric vehicles that require **long recharge cycles**, **The Automobili La'Bergitla Endurance Series** battery pack is optimised for **extremely high-speed charging**, ensuring that teams can **rapidly replenish energy between stints**.

Charging Specifications

- **Ultra-Fast Charge Rate** – The battery system is designed to handle **10–15-minute charging cycles for a full 100 kWh recharge**.
- **800V+ Architecture** – High-voltage architecture enables **faster energy transfer**, reducing charge times while maintaining efficiency.
- **Race-Approved DC Fast Chargers** – Specialised charging stations supply power at **600–800 kW**, ensuring minimal downtime between stints.
- **Thermal Stability During Charging** – Advanced cooling mechanisms prevent **excessive heat build-up**, ensuring that rapid charging does not compromise battery performance.

Advantages of Ultra-Fast Charging in Endurance Racing

- **Minimizes Pit Lane Downtime** – Shorter charging times mean **faster turnaround between battery swaps**, allowing teams to optimize their strategy.
- **Eliminates "Battery Bottleneck" Issues** – With high-speed charging, teams are not limited by **slow energy replenishment**, ensuring that **swapped batteries are ready for immediate reuse**.
- **Maintains Race Intensity** – Unlike traditional EV racing, where charge time dictates pace, **The Automobili La'Bergitla Endurance Series ensures continuous high-speed competition without waiting for slow recharges**.

By combining **solid-state battery technology with ultra-fast charging**, this system delivers **high energy throughput**, ensuring that **electric endurance racing remains both competitive and efficient**.

3.7.3 High-Performance Discharge Capabilities

In endurance racing, batteries must not only **store large amounts of energy**, but also **deliver power efficiently under extreme conditions**. **The Automobili La'Bergitla Endurance Series battery pack** is designed to **sustain high-discharge rates**, ensuring peak performance without overheating or degradation.

Discharge Performance Specifications

- **Sustained Power Output:** Capable of delivering **500 kW (670 hp) consistently** throughout each stint.
- **Optimised Energy Deployment:** Advanced **Battery Management System (BMS)** regulates discharge rates to **prevent overheating or power loss** over long-duration races.
- **Enhanced Thermal Management:** Active cooling and **phase-change thermal regulation** keep the battery **within optimal operating temperatures**, preventing **performance drops due to excessive heat**.
- **High-Cycle Durability:** Designed for **multiple race cycles**, ensuring that **power output remains stable throughout the endurance event**.

Benefits of High-Discharge Capability in Endurance Racing

- **Consistent Power Output** – No drop-off in performance, allowing teams to **maximize acceleration, energy deployment, and lap times**.
- **Superior Heat Resistance** – Prevents **thermal overload**, ensuring that **battery swaps do not become necessary due to overheating concerns**.
- **Reliable Performance Over 24 Hours** – Teams can confidently **push their cars to the limit** without concerns about **battery fade or energy depletion mid-stint**.

Redefining Battery Technology for Endurance Motorsport
The Automobili La'Bergitla Endurance Series battery system stands at the cutting edge of **electric endurance racing technology**, delivering a **breakthrough combination of high energy density, ultrafast charging, and sustained power output**.

What This Technology Proves:

- **Solid-state batteries are the future of endurance EV racing, offering superior energy density and safety.**
- **Ultra-fast charging at 600–800 kW makes EV endurance racing viable without long delays.**
- **High-discharge capability ensures continuous peak performance without overheating or degradation.**

This system ensures that **The Automobili La'Bergitla Endurance Series** remains a **high-intensity, strategic, and technologically advanced championship**, pushing the limits of **what is possible in all electric endurance motorsport**.

3.8 Thermal Management System

Optimizing Battery Temperature for Maximum Performance

The Automobili La'Bergitla Endurance Series battery system is engineered with an **advanced thermal management system** to ensure **peak performance, efficiency, and safety** under extreme endurance racing conditions. Managing heat is critical in high-power electric racing, as excessive temperatures can lead to **power loss, efficiency reduction, and potential safety risks**.

This system integrates multiple **state-of-the-art cooling technologies**, ensuring that **battery cells operate within optimal temperature ranges** while maintaining high power output over extended stints.

3.8.1 Active Liquid Cooling System

Precision Cooling for High-Power Performance

The **primary cooling mechanism** in **The Automobili La'Bergitla Endurance Series battery pack** is its **active liquid cooling system**, which is designed to efficiently regulate temperatures **during rapid energy discharge and recharging**.

Key Features

- **Integrated Cooling Channels** – The battery features **a network of liquid cooling channels** embedded within the cell structure, ensuring even temperature distribution across all battery modules.
- **High-Efficiency Coolant Circulation** – A specialised **low-viscosity dielectric coolant** circulates through the pack, removing excess heat without electrical interference.
- **Adaptive Flow Regulation** – **Dynamic cooling adjustments** based on temperature sensors allow real-time **flow rate optimization** for efficient heat dissipation.
- **Enhanced Heat Exchangers** – **External heat exchangers** expel collected heat, keeping battery temperatures **within safe operational limits** during race stints.

Benefits of Active Liquid Cooling in Endurance Racing

- **Prevents Overheating:** Keeps battery temperature within **ideal operating conditions**, avoiding **thermal stress and energy loss**.
- **Supports Ultra-Fast Charging:** Allows for **higher charging speeds** without excessive heat build-up, ensuring **fast pit stop turnaround**.
- **Extends Battery Longevity:** Reduces **thermal degradation**, improving **battery lifespan over multiple race cycles**.

3.8.2 Integrated Phase-Change Materials (PCM)

Passive Thermal Regulation for Sustained Performance

To further **enhance cooling efficiency**, **The Automobili La'Bergitla Endurance Series battery pack** incorporates **phase-change materials (PCM)**, which absorb and dissipate excess heat **without requiring external energy input**.

How PCM Technology Works

- **Heat Absorption: PCM absorbs heat** as the battery reaches high temperatures, preventing **rapid thermal spikes**.
- **Phase Transition:** As PCM reaches its threshold, it changes phase **(solid to liquid or liquid to gas)**, **dispersing stored heat** throughout the cooling system.
- **Self-Regulation:** Once the battery cools, the PCM **returns to its original state**, ready to absorb heat again.

Benefits of PCM in Endurance Racing

- **Energy-Efficient Cooling:** Works **passively** without drawing additional energy, enhancing **battery efficiency**.
- **Prevents Localised Overheating:** Ensures **uniform heat dissipation** across all battery cells, preventing **hot spots**.
- **Supports Extended Race Stints:** Helps maintain **consistent power output**, allowing teams to **push battery performance to the limit**.

3.8.3 Thermoelectric Cooling Modules

Active Temperature Stabilization in Extreme Conditions

To further **enhance cooling precision**, **The Automobili La'Bergitla Endurance Series battery pack** incorporates **thermoelectric cooling modules**, which utilize the **Peltier effect** to provide **active temperature control**.

How Thermoelectric Cooling Works

- **Dual-Sided Temperature Regulation:** The **cold side absorbs excess heat** from battery cells, while the **hot side dissipates it through external cooling channels**.

- **Adaptive Cooling Mechanism: Real-time thermal sensors** activate thermoelectric modules **only when needed**, optimizing energy usage.
- **Compact & Lightweight Design:** Thermoelectric modules are **integrated within battery cells**, adding **minimal weight while maximizing cooling efficiency**.

Advantages of Thermoelectric Cooling

- **Instant Response to Heat Spikes:** Provides **real-time cooling adjustments** during high-power demand phases.
- **Enhances Battery Longevity:** Prevents **thermal cycling damage**, ensuring **consistent performance across multiple race stints**.
- **Energy-Efficient Operation:** Consumes **minimal power**, maintaining **race efficiency**.

3.8.4 Emergency Thermal Runaway Protection

Ensuring Maximum Safety Under Extreme Conditions
In addition to **active and passive cooling technologies**, **The Automobili La'Bergitla Endurance Series battery system** incorporates **multiple fail-safe mechanisms** to prevent and mitigate **thermal runaway incidents**.

Key Safety Features

- **Automated Cooling Activation** – If temperatures exceed **predefined safety limits**, the cooling system **automatically increases intensity** to rapidly reduce heat.
- **Multi-Layer Fire Suppression System** – Built-in **fire-retardant barriers, gas suppression systems, and chemical fire extinguishers** protect against thermal failures.
- **High-Voltage Isolation Protocol** – In case of extreme overheating, the **Battery Management System (BMS) automatically isolates the affected battery module** to prevent further escalation.
- **Impact-Resistant Housing** – The **carbon fibre-reinforced polymer (CFRP) casing** is engineered to withstand **high-speed crashes** without compromising **battery integrity**.

Benefits of Thermal Runaway Protection

- **Ensures Driver and Crew Safety:** Eliminates risks of **thermal failure during racing or pit stops**.
- **Maintains Race Continuity:** Prevents **battery shutdowns or performance loss** due to overheating concerns.
- **Complies with FIA Safety Standards:** Fully adheres to **global motorsport battery safety regulations**, ensuring **maximum protection**.

A Benchmark in Thermal Management

The Automobili La'Bergitla Endurance Series battery system establishes a **new standard in endurance racing thermal management**, integrating **state-of-the-art cooling technologies** to maintain **optimal performance, reliability, and safety** under extreme conditions.

Key Takeaways:

- Liquid cooling ensures stable temperatures during high-power operation and fast charging.
- Phase-change materials absorb excess heat, providing passive, energy-efficient cooling.
- Thermoelectric modules enable real-time temperature adjustments for peak performance.
- Multi-layer safety systems protect against thermal runaway incidents.

With this **cutting-edge thermal management system**, **The Automobili La'Bergitla Endurance Series championship** ensures that **all-electric endurance racing remains competitive, safe, and technologically advanced**, delivering **unmatched efficiency and reliability over 24 hours of racing**.

3.9 Modular Design for Maintenance and Upgrades

Future-Proofing Endurance Racing Battery Technology

The Automobili La'Bergitla Endurance Series battery system is engineered with a **modular architecture**, ensuring that **teams can perform maintenance, repairs, and technology upgrades** without requiring a complete battery replacement. This **flexible, serviceable design** is critical in endurance racing, where reliability, efficiency, and continuous performance improvements play a pivotal role in success.

By implementing a **standardised modular system**, the championship allows **rapid integration of next-generation energy storage advancements** while maintaining **cost efficiency and competitive fairness** across the grid.

3.9.1 Modular Construction for Easy Maintenance

Optimised for Rapid Serviceability

To minimize downtime and ensure **continuous performance**, **The Automobili La'Bergitla Endurance Series battery pack** is built from **interchangeable modules** rather than a single monolithic unit. This enables **targeted repairs and component replacements**, significantly reducing costs and improving overall **battery longevity**.

Key Features

- **Independent Battery Modules:** The battery pack is divided into **multiple removable modules**, each containing **a subset of high-density cells**.
- **Rapid Component Replacement: Faulty or degraded modules** can be quickly swapped without affecting the **entire pack's integrity**.
- **Service-Friendly Configuration:** Battery maintenance can be performed **without requiring chassis modifications**, streamlining **pit garage operations**.
- **Reduced Maintenance Costs:** Teams **only replace individual modules** rather than purchasing **entire new battery packs**, lowering long-term expenditures.

Benefits of Modular Battery Design

- **Ensures longevity** – Batteries can be serviced over multiple race seasons, reducing waste and costs.
- **Enhances reliability** – Quick identification and replacement of defective modules prevent mid-race failures.
- **Improves sustainability** – Allows **recycling and refurbishment** of battery components rather than full disposal.

3.9.2 Standardised Architecture for Seamless Upgrades

Future-Proofing Through Interoperability

A major challenge in electric motorsport is **ensuring long-term technological viability** while keeping competition fair. **The Automobili La'Bergitla Endurance Series battery platform** is designed with **standardised physical and electrical interfaces**, allowing teams to **integrate next-generation technology without modifying core vehicle architecture**.

Key Standardization Aspects

- **Universal Battery Dimensions & Mounting:** All battery packs follow **fixed size and mounting specifications**, ensuring **compatibility across all race cars**.
- **Standardised Voltage & Communication Protocols:** All packs operate at **800V nominal voltage** with **regulated power output (500 kW max)**, ensuring energy deployment fairness.
- **Backward & Forward Compatibility:** New cell chemistries and battery technologies can be **integrated without requiring significant chassis modifications**.
- **Open Development Pathways:** Future iterations of the championship can **introduce higher density batteries** while maintaining **compatibility with existing infrastructure**.

Advantages of Standardised Battery Architecture

- **Allows seamless upgrades** – New battery cell technology can be integrated **without redesigning vehicle platforms**.
- **Maintains competitive fairness** – Standardised packs prevent **unbalanced performance gains** between teams.
- **Encourages long-term investment** – Teams can **develop powertrain technologies** around a **consistent battery standard**, reducing R&D costs.

3.9.3 Quick Disassembly for Minimal Downtime

Streamlining Pit Stop & Garage Maintenance

To ensure **rapid servicing and minimal race disruption**, **The Automobili La'Bergitla Endurance Series battery system** is designed for **quick disassembly and reassembly**.

Key Features

- **Tool-Free Battery Module Locking System** – Modules use a **quick-release mechanism** for **fast removal and replacement**.
- **Automated Diagnostic Systems** – Each module contains **self-monitoring electronics** that **alert teams to potential failures** before issues escalate.
- **Predictive Maintenance Software** – Teams receive **real-time data on module health**, allowing them to plan **pre-emptive replacements during pit stops**.
- **Cooling System Integration** – Modules include **individual cooling interfaces**, ensuring **optimal heat dissipation** when swapped or serviced.

Efficiency Benefits in Racing Operations

- **Minimizes pit stop time** – Teams can **service or replace** battery modules between sessions **without extensive downtime**.
- **Optimizes performance management** – Battery health data allows **strategic planning for energy deployment**.
- **Reduces waste** – Instead of discarding **entire battery packs**, teams can **recondition and reuse** individual modules.

A Modular, Future-Proof Energy Solution

The Automobili La'Bergitla Endurance Series battery system is designed **not just for today's competition but for the evolution of endurance racing technology**. By utilizing a **modular, standardised, and serviceable design**, this system ensures:

- **Efficient maintenance & repairs**, reducing race disruptions.
- **Seamless integration of next-gen battery technology** without structural changes.
- **Sustainable long-term racing strategies**, lowering costs and environmental impact.

This **revolutionary approach to electric endurance racing** guarantees that **teams remain competitive, technologically adaptable, and cost-efficient**, setting a **new benchmark in motorsport energy solutions**.

4. Regenerative Energy Research for Le Mans

Le Mans Track Overview & Braking Zones

Introduction: The Circuit de la Sarthe – A High-Speed Endurance Challenge

The **Circuit de la Sarthe**, home to the legendary **24 Hours of Le Mans**, is a **13.626 km (8.467 mi) track** known for its unique blend of **high-speed straights and technical corners**. The circuit's hybrid nature—partly public roads, partly permanent racetrack—creates a **challenging racing environment** that tests the limits of endurance, aerodynamics, and braking efficiency.

In an **all-electric endurance racing format**, managing **energy recovery through regenerative braking** becomes a **critical performance factor**. Unlike traditional fuel-based endurance racing, where braking is primarily a heat-dissipating process, electric prototypes have the ability to **convert kinetic energy back into stored electrical energy**, significantly enhancing efficiency.

This section analyses the **major braking zones** at Le Mans and explores how they contribute to energy regeneration opportunities in **The Automobili La'Bergitla Endurance Series**.

4.1 Key Braking Zones & Regenerative Energy Potential

The **high-speed nature of Circuit de la Sarthe** results in multiple **hard braking zones**, where vehicles shed **substantial kinetic energy** before navigating tight corners. These zones provide **ideal conditions** for regenerative braking systems to recapture energy efficiently.

Major Braking Zones Per Lap

Each lap at **Le Mans** consists of approximately **seven major braking zones**, where vehicles decelerate **from speeds exceeding 250 km/h down to as low as 60 km/h**. These deceleration phases **generate significant energy recovery potential** in an all-electric endurance race.

1. Dunlop Chicane (After Front Straight)

- **Braking from:** ~250 km/h → ~100 km/h
- **Regenerative Energy Potential:** High
- **Details:** Following the start-finish straight, the Dunlop Chicane is the first significant braking zone, requiring drivers to rapidly decelerate before transitioning into the sweeping curves of the Esses.

2. First Mulsanne Chicane

- **Braking from:** ~330 km/h → ~150 km/h
- **Regenerative Energy Potential:** Very High
- **Details:** The **Mulsanne Straight**, one of the longest high-speed sections in motorsport, is interrupted by two chicanes. The first chicane requires heavy braking from speeds over 330 km/h, making it one of the most significant energy recovery points.

3. Second Mulsanne Chicane

- **Braking from:** ~330 km/h → ~150 km/h
- **Regenerative Energy Potential:** Very High
- **Details:** Nearly identical to the first chicane, this braking zone presents another critical moment for **recapturing kinetic energy** before re-accelerating.

4. Mulsanne Corner

- **Braking from:** ~300 km/h → ~70 km/h
- **Regenerative Energy Potential:** Extremely High
- **Details:** The end of the Mulsanne Straight leads into the tight **Mulsanne Corner**, requiring one of the most aggressive deceleration phases on the circuit. This presents an **optimal opportunity** for regenerative braking, with vehicles shedding **massive amounts of energy**.

5. Indianapolis

- **Braking from:** ~270 km/h → ~160 km/h
- **Regenerative Energy Potential:** Moderate to High
- **Details:** A challenging, high-speed left-hand kink followed by a heavy braking zone into the Indianapolis right-hander. This zone offers **substantial but slightly less regenerative potential** compared to the Mulsanne braking zones.

6. Arnage

- **Braking from:** ~180 km/h → ~60 km/h
- **Regenerative Energy Potential:** Moderate
- **Details:** The slowest corner on the track, **Arnage** requires **strong but brief braking**. While the overall **energy dissipation is lower**, this remains an important point for **regeneration**.

7. Ford Chicanes (Final Chicanes)

- **Braking from:** ~200 km/h → ~80 km/h
- **Regenerative Energy Potential:** Moderate
- **Details:** The final set of chicanes before the main straight, this section requires a final braking phase, ensuring **some energy recovery before acceleration back onto the start-finish straight**.

4.2 Energy Recovery Potential in an All-Electric Le Mans Race

How Braking Zones Influence Regenerative Energy Efficiency

Regenerative braking works by converting the **kinetic energy lost during braking** into **electrical energy**, which is then stored in the vehicle's battery or supercapacitors for later use. **Three key factors determine the effectiveness of regenerative braking at Le Mans:**

1. **Deceleration Intensity** – Faster speed reductions yield **higher energy recovery**.

2. **Braking Duration** – **Prolonged braking zones** allow for more gradual and efficient energy recapture.
3. **System Capacity** – **Supercapacitor buffers** play a role in storing excess recovered energy for immediate use.

Estimated Energy Recovery Per Lap

Based on typical endurance racing speeds and **energy dissipation calculations**, an electric prototype could **regenerate between 9–12 MJ per lap** from braking alone.

Breakdown of Estimated Regenerative Energy per Braking Zone

Braking Zone	Deceleration (km/h)	Estimated Energy Recovered (MJ)
Dunlop Chicane	250 → 100	~2.0 – 2.5 MJ
First Mulsanne Chicane	330 → 150	~3.0 MJ
Second Mulsanne Chicane	330 → 150	~3.0 MJ
Mulsanne Corner	300 → 70	~3.0 – 3.3 MJ
Indianapolis	270 → 160	~1.8 MJ
Arnage	180 → 60	~1.1 MJ
Ford Chicanes	200 → 80	~1.0 – 1.3 MJ
Total Per Lap	**Various**	**~15 – 17 MJ dissipated**

With a regenerative efficiency of 60–70%, an all-electric Le Mans prototype can recover approximately 9–12 MJ per lap.

Braking Zones as Key Regenerative Energy Sources

The **Circuit de la Sarthe's braking zones** play a **pivotal role** in energy management for electric endurance racing. With **multiple high-speed deceleration points per lap**, regenerative braking can significantly extend **energy reserves**, improving **efficiency and race strategy**.

As **The Automobili La'Bergitla Endurance Series** pioneers the **transition to electric endurance racing**, **maximizing energy recovery through braking zones** will be a critical factor in optimizing **battery usage, reducing pit stop frequency, and maintaining competitive lap times**.

The next section will further explore **how energy recovery extends beyond braking zones** by integrating **innovative regenerative systems** such as **suspension-based energy harvesting**.

Electric Prototype Weight & Performance vs. LMH/LMDh

Introduction: The Shift to Fully Electric Endurance Racing

Modern **Le Mans Hypercars (LMH/LMDh)** represent the pinnacle of endurance racing performance, featuring **highly efficient hybrid powertrains**, **lightweight chassis materials**, and **aerodynamic advancements** that allow them to compete over 24-hour race distances at blistering speeds. However, as **The Automobili La'Bergitla Endurance Series** transitions to a **fully electric endurance format**, new challenges and opportunities arise in terms of **vehicle weight, performance, and overall race strategy**.

While the **power output of electric prototypes** will remain comparable to **current LMH/LMDh cars (~500 kW or 670 hp)**, key performance differentiators will come from **battery weight, torque characteristics, energy recovery, and aerodynamic efficiency**.

4.3 Weight Considerations: The Battery vs. Internal Combustion

Weight is a crucial factor in endurance racing, impacting **acceleration, braking, energy efficiency, and tire degradation**.

Comparison of Weight Distributions

Vehicle Type	Powertrain	Weight (kg)
LMH/LMDh (Hybrid)	ICE + Hybrid System (~50 kWh)	~1,030 – 1,040 kg
Electric Prototype (EV)	Full Electric (~100 kWh battery)	~1,100 – 1,200 kg

LMH/LMDh Weight Factors:

- Hybrid Hypercars rely on a **small hybrid system (~50 kWh battery)** combined with an **internal combustion engine (ICE)**.
- Since **fuel load decreases over the race**, overall vehicle weight reduces, affecting **handling characteristics** as stints progress.

EV Prototype Weight Factors:

- **Fully electric endurance racers must carry their entire energy supply** in battery packs, increasing **static weight**.
- **Battery capacity (~100 kWh per pack)** is significantly higher than in hybrid cars, adding **300– 400 kg more mass**.
- **Weight remains constant** throughout a stint (unlike fuel-burning hybrids), requiring **a consistent handling approach**.

Battery Weight Trade-offs

- **High-capacity battery (100 kWh)** → Increases race duration but adds mass (~1,100–1,200 kg total vehicle weight).
- **Lower-capacity battery (~70–80 kWh)** → Reduces weight but necessitates more frequent battery swaps.
- **Solid-state battery advancements** could help reduce weight while maintaining high energy density in the future.

While electric endurance prototypes may **start heavier than LMH/LMDh cars**, their **weight distribution remains constant throughout a race stint**, meaning teams must fine-tune **energy efficiency, aerodynamics, and suspension setups** to compensate.

4.4 Acceleration & Torque Delivery: The Electric Advantage

One of the most significant advantages of **electric endurance prototypes** over their **hybrid LMH/LMDh counterparts** is their ability to **deliver power instantly**.

Instantaneous Torque & Acceleration

- **Electric motors deliver peak torque at 0 RPM**, unlike internal combustion engines, which require rev-building.
- **Faster acceleration out of corners** due to immediate torque deployment.
- **No gear shifts** → Seamless acceleration with fewer mechanical interruptions.
- **Precise power control** with advanced **torque vectoring**.

Vehicle Type	0-100 km/h Time
LMH/LMDh (Hybrid)	~2.8 – 3.2 sec
Electric Prototype (EV)	~2.5 – 2.8 sec

While the weight penalty may **slightly reduce top-end acceleration**, the ability of EVs to **recover speed faster out of corners** could lead to **lap time advantages** under race conditions.

Advanced Torque Vectoring for Enhanced Traction

Electric prototypes can **distribute power between all four wheels independently**, allowing for:

- **Superior cornering grip and rotation**.
- **Reduced tire wear** due to optimised power application.
- **Improved stability in wet or mixed conditions**.

Current LMH/LMDh hybrids utilize **front-axle hybrid systems** for partial torque vectoring, but a fully electric powertrain can enable **multi-motor AWD configurations**, further enhancing traction and efficiency.

4.5 Top Speed: Matching LMH/LMDh on the Mulsanne Straight

Top speed in endurance racing is primarily dictated by **power output and aerodynamic drag** rather than powertrain type. Since **The Automobili La'Bergitla Endurance Series prototypes will be capped at 500 kW (~670 hp)**—the same as current **LMH/LMDh** regulations—their **terminal velocities on high-speed sections like the Mulsanne Straight** should remain competitive.

Projected Top Speeds

Vehicle Type	Top Speed (km/h)
LMH/LMDh (Hybrid)	~330–342 km/h
Electric Prototype (EV)	~330+ km/h

Drag & Aero Efficiency Are Key

- **Higher vehicle weight requires optimised aerodynamics** to maintain top speed without excessive energy loss.
- **Active aerodynamics** (adjustable wings, shutters) may be critical for balancing **downforce and top-speed efficiency**.
- **Battery cooling management** becomes crucial, as sustained high-speed operation generates **significant thermal loads**.

A Competitive Shift in Endurance Racing

The transition to **fully electric endurance racing** introduces a **new era of performance dynamics**, with **advantages and challenges** compared to LMH/LMDh cars.

Advantages of EV Prototypes:

- **Instant acceleration and torque vectoring** provide superior handling in corners.
- **Consistent vehicle weight** throughout stints leads to predictable handling characteristics.
- **Energy recovery potential** through regenerative braking increases efficiency.

Challenges to Overcome:

- **Higher vehicle mass (~1,100–1,200 kg)** requires refined **suspension and aerodynamic strategies**.
- **Battery cooling and energy management** must be carefully optimised to sustain **peak performance over 24 hours**.

Ultimately, while electric endurance prototypes may **approach racing from a different engineering philosophy**, their **performance potential matches—or even surpasses—that of current hybrid Hypercars**. By leveraging **instantaneous torque, torque vectoring, and optimised aerodynamics**, **The Automobili La'Bergitla Endurance Series will redefine what's possible in high-speed endurance racing**.

4.6 Regenerative Energy in Racing

Revolutionizing Energy Management in Endurance Racing

In the world of endurance racing, where efficiency is just as crucial as outright speed, **energy management** plays a defining role in a team's success. **The Automobili La'Bergitla Endurance Series**, as a fully electric endurance series, presents a **unique technical challenge**: how teams **recover, store, and deploy energy** over the course of a 24-hour race while maintaining competitive performance.

Unlike traditional endurance racing, where cars refuel at pit stops and rely on internal combustion engines for sustained energy delivery, an **all-electric endurance format** must maximize every possible avenue for **recapturing and reusing kinetic energy**. **Regenerative braking, suspension energy harvesting, and optimised power deployment** become critical tools in **extending battery life, reducing the frequency of battery swaps, and maintaining a strategic advantage.**

This section explores how regenerative energy technologies will **redefine endurance racing strategy**, providing a detailed analysis of the energy recoverable per lap at Le Mans and how teams will integrate this into their race operations.

The Energy Challenge at Le Mans

Le Mans' **Circuit de la Sarthe** is one of the most demanding endurance racing circuits in the world. With its **high-speed straights, heavy braking zones, and technical corners**, the track presents **significant opportunities for regenerative energy recovery**.

Energy Throughput Per Lap

- A single lap at Le Mans demands an estimated **120–130 MJ of energy** for a hybrid hypercar.
- In an all-electric scenario, battery energy supply will be the sole propulsion source, meaning that every **joule of recovered energy** reduces overall battery consumption.
- **Teams must optimize regenerative energy strategies** to extract **the maximum possible recovery per lap**, ensuring that energy deployment remains **as efficient as possible** without over-reliance on battery swaps.

Key Energy Recovery Methods

The primary focus for energy recapture in this series will be:

- **Regenerative Braking** – Capturing kinetic energy as cars decelerate into braking zones.
- **Suspension Energy Harvesting** – Converting vertical suspension movement into usable electrical energy.
- **Aerodynamic Energy Recovery (Future Development)** – Exploring energy harvesting from airflow using **active aero-electric systems**.

Each of these technologies will contribute to **reducing total energy demand per lap**, allowing teams to extend battery life, improve race stints, and optimize strategic decision-making.

A New Era of Race Strategy: Deploying Regenerated Energy

Just as fuel strategy has historically defined endurance racing, **regenerative energy recovery and deployment will dictate race tactics in The Automobili La'Bergitla Endurance Series**.

Three Pillars of Regenerative Energy Strategy

- **Recovery Efficiency** – Maximizing energy recapture without compromising braking stability or handling.
- **Storage Optimization** – Ensuring recovered energy is efficiently stored in the battery and supercapacitors.
- **Strategic Deployment** – Deploying stored energy at key points (exits of corners, high-speed sections) for performance gains.

By fine-tuning these elements, teams will not only **extend the lifespan of their battery packs** but also **enhance acceleration and top speed while minimizing energy waste**.

The Future of Sustainable Endurance Racing

The Automobili La'Bergitla Endurance Series championship represents the next evolutionary step in endurance racing—one that **merges sustainability with high-performance motorsport**. Regenerative energy systems will be **at the heart of every competitive strategy**, determining how teams **balance efficiency, speed, and battery longevity** over the gruelling 24-hour race.

By **recovering and redeploying significant amounts of kinetic energy**, this championship will not only **push the boundaries of electric endurance racing** but also serve as a **testbed for future roadgoing EV innovations**. In essence, **the challenge is no longer about refuelling efficiency but about perfecting the art of energy recycling—lap after lap, hour after hour.**

4.7 Energy Recovery from Regenerative Braking

In an all-electric endurance racing format like **The Automobili La'Bergitla Endurance Series**, **regenerative braking** serves as the primary method for recapturing kinetic energy lost during deceleration. Unlike traditional braking systems, which dissipate energy as heat through friction, **regenerative braking utilizes motor-generators** to convert kinetic energy into electrical energy, which is then stored in either the **battery pack or integrated supercapacitors** for later use.

At **Circuit de la Sarthe**, the high-speed straights are punctuated by heavy braking zones, making the track **one of the most efficient circuits for regenerative braking utilization**. The frequent and intense deceleration events provide teams with numerous opportunities to **recover significant energy per lap**, ultimately extending battery range and reducing energy reliance from pit stops.

Energy Recovery Estimates Per Lap

To quantify the potential energy recovery, we analyse the major braking zones at **Le Mans**, where **vehicles decelerate from extreme speeds before entering corners**:

Key Braking Zones and Energy Recovery Potential

Braking Zone	Deceleration (km/h)	Kinetic Energy Lost (MJ)
Dunlop Chicane	250 → 100	**2.0 – 2.5 MJ**
First Mulsanne Chicane	330 → 150	**≈3.0 MJ**
Second Mulsanne Chicane	330 → 150	**≈3.0 MJ**
Mulsanne Corner	300 → 70	**3.0 – 3.3 MJ**
Indianapolis	270 → 160	**≈1.8 MJ**
Arnage (Slowest Corner)	180 → 60	**≈1.1 MJ**
Porsche Curves	High-speed bends	**Minimal (~0.3 MJ total)**
Ford Chicanes	200 → 80	**1.0 – 1.3 MJ**

Summing these braking events, the total **kinetic energy lost per lap is approximately 15–17 MJ**. However, **not all this energy is recoverable** due to factors such as:

- **Friction braking usage** for vehicle stability in extreme deceleration.

- **Regeneration saturation**, where the system reaches its maximum recovery threshold.
- **Energy conversion losses** inherent in electrical systems.

Realistic Energy Recovery Expectations
Given an estimated **60–70% regenerative braking efficiency**, the **actual recoverable energy per lap** is projected to be: **9–12 MJ per lap**, depending on optimization levels.

Comparison to Hybrid Racing Energy Recovery
Le Mans has previously set energy recovery limits for **hybrid prototypes** under **LMP1-H regulations**. Vehicles like the **Porsche 919 Hybrid** and **Toyota TS050** were restricted to a **maximum of 8 MJ per lap** of energy deployment from their hybrid systems.

In contrast, **The Automobili La'Bergitla Endurance Series does not impose a strict cap on regenerative energy recovery**. Instead, teams are encouraged to **maximize recapture efficiency through advanced all-wheel regenerative braking strategies**, enabling energy recovery to **exceed 10 MJ per lap**.

Maximizing Regenerative Braking Performance
To optimize energy recovery, teams must fine-tune:

- **All-Wheel Regeneration** – Using front and rear motors for balanced braking energy recapture.
- **High-Efficiency Motor-Generators** – Ensuring minimal energy loss in conversion.
- **Intelligent Brake Bias Management** – Adapting regen and mechanical braking ratios dynamically.
- **Supercapacitor Energy Storage** – Smoothing power output and allowing immediate redeployment of stored energy.

By **integrating cutting-edge regenerative braking technologies**, The Automobili La'Bergitla Endurance Series ensures that electric endurance racing remains **strategically dynamic, energy efficient, and performance-driven**, setting new benchmarks for sustainable motorsport.

4.8 Energy Recovery from Suspension (Shock Absorbers)

In addition to regenerative braking, energy can also be **harvested from the car's suspension system**, leveraging the constant motion and oscillations of the vehicle as it navigates the **demanding terrain of Le Mans**. Traditionally, suspension dampers dissipate vibrational energy as heat to stabilize the car's movement over bumps, curbs, and uneven surfaces. However, by **integrating energy-recovering shock absorbers**, this wasted energy can be converted into usable electricity, contributing to the vehicle's overall efficiency.

This **secondary source of energy recovery** is particularly valuable in endurance racing, where every unit of stored energy can impact strategy, performance, and overall energy consumption.

How Suspension Energy Recovery Works

Modern **electromagnetic and piezoelectric regenerative dampers** are used in place of conventional hydraulic shock absorbers. These advanced systems capture **kinetic energy from vertical and lateral suspension movements**, converting it into electrical energy that can be stored in the battery or a **secondary supercapacitor system** for instant reuse.

Key Methods of Suspension Energy Recovery:

- **Electromagnetic Dampers:** Utilize linear electric generators to transform suspension travel into electrical power.
- **Piezoelectric Shock Absorbers:** Use stress-activated materials that generate electricity when compressed or flexed.
- **Hydraulic Energy Recovery Systems:** Channel damper fluid through a generator to extract energy from compression and rebound cycles.

Unlike regenerative braking, which recovers **large bursts of energy in braking zones**, suspension energy recovery is a **continuous process**—gathering small amounts of power throughout a lap.

Suspension Energy Recovery at Le Mans

Le Mans' **Circuit de la Sarthe** includes **public road sections** with inherent surface irregularities, as well as dedicated race track sections with aggressive curbs at **the chicanes and corners**. This combination makes it an ideal environment to extract meaningful energy from **suspension movements**.

Research suggests a **wide range of energy recovery potential**, depending on road surface quality and the aggressiveness of the suspension system.

Energy Recovery Estimates Per Lap

Track Condition	Energy Recovery Potential
Smooth Asphalt (Main Straights)	Minimal recovery (~46 W total for all dampers)
Bumpy Terrain (Public Road Sections, Mulsanne, Indianapolis, Arnage)	Up to **7.5 kW** in peak moments
Le Mans Racing Speeds (Average Lap Conditions)	**0.5 – 1 kW total output** (~100–200 kJ per lap)

Assuming **each of the four shock absorbers** captures **~50 kJ per lap**, the **total suspension energy recovery per lap** is estimated at **~200 kJ (0.2 MJ per lap)**.

While this figure is significantly lower than **regenerative braking (9–12 MJ per lap)**, it is still **useful energy that would otherwise be wasted**. Over the course of a **24-hour race**, the cumulative impact of suspension energy recovery can be substantial:

- **24 Hours of Racing (~380 Laps): ~76 MJ recovered per car**
- **Grid of 10 Cars: ~760 MJ of total recovered energy**

This additional energy can be stored in the **vehicle's supercapacitor system** and **redeployed instantly** for small bursts of power, such as assisting acceleration out of slow corners.

Advantages of Suspension Energy Recovery in Endurance Racing

1. **Continuous Energy Harvesting:** Unlike braking regen, which is event-based, suspension recovery operates throughout the lap.
2. **Improved Energy Efficiency:** Converts vibrational waste energy into useful power, reducing overall energy consumption.
3. **Integration with Regenerative Braking Systems:** Works alongside braking regen, feeding stored energy into supercapacitors or batteries for reuse.
4. **Long-Term Impact:** Small recoveries per lap accumulate significantly over long-distance endurance races.

Enhancing Energy Recovery Beyond Braking
While **suspension energy recovery alone** does not provide a game-changing power boost, its **cumulative impact over a full endurance race** is significant. The ability to capture and reuse energy from **track vibrations, curbs, and road irregularities** ensures that **The Automobili La'Bergitla Endurance Series prototypes maximize every possible source of energy efficiency**, reinforcing the series' commitment to **high-performance, zero-emission endurance racing**.

4.8.1 Total Recoverable Energy per Lap

In the context of **The Automobili La'Bergitla Endurance Series**, energy recovery plays a critical role in extending vehicle range and improving overall race efficiency. By integrating both **regenerative braking and suspension energy harvesting**, electric endurance prototypes can significantly reduce reliance on stored battery power.

The recoverable energy per lap at **Le Mans' Circuit de la Sarthe** is estimated based on the cumulative impact of **braking zones** and **suspension movements** over a full lap.

Energy Recovery Breakdown Per Lap
The primary sources of energy recovery in an electric endurance prototype come from:

1. **Regenerative Braking (Major Braking Zones)**
2. **Suspension Energy Harvesting (Shock Absorbers & Chassis Oscillations) Total Energy**

Recovery Estimates

Source	Recoverable Energy Per Lap
Regenerative Braking	**9 – 12 MJ per lap** (assuming near-optimal recovery efficiency)
Suspension Energy Harvesting	**0.1 – 0.3 MJ per lap** (dependent on track roughness and damper efficiency)
Total Energy Recovery Potential	**9 – 12.3 MJ per lap**

Regenerative Braking (9 – 12 MJ per Lap)

Braking remains the dominant energy recovery method due to the high kinetic energy shed when decelerating from **speeds exceeding 300 km/h**.

- The **Mulsanne Chicanes** and **Mulsanne Corner** alone contribute nearly **9 MJ of recoverable energy**.
- In an optimal energy recovery scenario, the total braking energy regained per lap can **reach up to 12 MJ**.
- Real-world recovery depends on **motor-generator efficiency, traction conditions, and braking distribution** between front and rear axles.

Suspension Energy Harvesting (0.1 – 0.3 MJ per Lap)

- While relatively small compared to braking recovery, suspension energy harvesting contributes **continuous energy gains** throughout a lap.
- On **bumpier sections** such as **public road segments and high-curb chicanes**, the **peak energy recovery can reach 0.3 MJ per lap**.
- This energy is primarily stored in **supercapacitors** for short bursts of acceleration or auxiliary systems.

Impact Over an Entire Race

The **accumulated energy recovery** across a **full 24-hour endurance race** is a substantial factor in race strategy and efficiency.

24-Hour Energy Recovery Estimate (Per Car)

Energy Source	Total Recovery Over 24 Hours (~380 Laps)
Regenerative Braking	**3,420 – 4,560 MJ (~950 – 1,265 kWh)**
Suspension Energy Harvesting	**38 – 114 MJ (~10.5 – 31.7 kWh)**
Total Energy Recovered	**3,458 – 4,674 MJ (~960 – 1,297 kWh)**

This translates to over **1.2 MWh of total recovered energy per car** throughout a 24-hour race.

If **10 cars** participate in the event, the total energy saved across the field would exceed **12 MWh**, enough to power multiple homes for an entire year.

Strategic Advantages of Energy Recovery

- **Reduced Battery Consumption** → Less reliance on external charging or battery swaps.
- **Extended Stints Between Swaps** → Maximizing laps per battery swap window.
- **Improved Energy Efficiency** → Lower overall energy demand across race duration.
- **Regeneration-Optimised Driving Strategies** → Tailoring braking techniques for maximum energy recovery.

Maximizing Energy Recovery in Endurance Racing
By combining **regenerative braking and suspension harvesting**, The Automobili La'Bergitla Endurance Series ensures that each car maximizes its energy efficiency, extending performance capabilities while maintaining the spirit of endurance racing.

This **hybrid energy recovery model** aligns with the championship's **commitment to sustainable high-performance motorsport**, proving that **all-electric endurance racing can deliver both strategic complexity and cutting-edge technology** on par with traditional internal combustion racing.

4.9 Comparison to Grid Energy Consumption and Savings

Energy consumption and efficiency play a pivotal role in endurance racing, particularly in an all-electric format where energy management directly influences **race strategy, battery swap intervals, and overall performance longevity**. The transition from **fuel-powered hypercars to fully electric endurance prototypes** provide an opportunity to significantly **reduce overall energy demand**, thanks to **advanced regenerative systems**.

Energy Comparison: Traditional Hypercars vs. Electric Endurance Prototypes

Modern **Le Mans Hypercars (LMH/LMDh)** operate within a **120–130 MJ per lap** fuel energy consumption range. By contrast, an all-electric prototype consumes stored battery energy, but **regeneration technology recovers a substantial portion of this energy per lap**, reducing the total power demand from external sources.

Vehicle Type	Total Energy Draw Per Lap	Recoverable Energy Per Lap	Net External Energy Demand Per Lap
Le Mans Hypercar (LMH/LMDh) (Hybrid ICE + Battery Assist)	**120 – 130 MJ**	**~8 MJ (Hybrid System Limitations)**	**112 – 122 MJ**
All-Electric Endurance Prototype (With Regen & Swappable Battery System)	**~60 MJ**	**9 – 12 MJ (Braking & Suspension Recovery)**	**48 – 51 MJ**

- **Regenerative braking and suspension energy harvesting allow electric endurance prototypes to cut their net external energy demand by ~20%.**
- **Unlike fuel-burning hypercars, electric prototypes continuously recover energy and reuse it, reducing overall grid demand.**

Energy Savings Over a 24-Hour Race
With approximately **380 laps** completed in a full **24-hour endurance race**, energy savings from regenerative systems scale dramatically.

Per Car Energy Recovery Over 24 Hours

- **Total Energy Consumed Without Regen: 22,800 MJ (~6,333 kWh)**
- **Energy Recovered Per Lap (~10 MJ) → 3,800 MJ Recovered (~1,050 kWh)**

- **Final Net External Energy Demand Per Car: 19,000 MJ (~5,280 kWh)**
- **Energy Savings Per Car: ~1.05 MWh of energy recovered per race.**

Total Energy Savings (Full Race Grid – 10 Cars)

- If **10 electric prototypes** participate in The Automobili La'Bergitla Endurance Series, total grid energy savings would exceed **10.5 MWh**.
- **This amount of recovered energy is equivalent to powering a typical household for over a year** (average home consumption: **10 MWh annually**).

Impact on Race Strategy & Sustainability

1. **Reduced Pit Stop Frequency** – By decreasing net external energy requirements per lap, teams can extend stints between battery swaps, optimizing race strategy.
2. **Lower Overall Energy Consumption** – Unlike fuel-powered cars, electric prototypes **reuse** a significant portion of their expended energy, decreasing reliance on grid power.
3. **Sustainability Benchmark** – Regenerative energy systems make **electric endurance racing more sustainable than traditional fuel-driven endurance formats**, demonstrating that high-performance motorsport can align with environmental efficiency.

Regenerative Energy as a Core Performance Advantage
The Automobili La'Bergitla Endurance Series endurance format showcases how **high-performance electric race cars can achieve significant energy savings through advanced regenerative technologies**.

- **Energy regeneration reduces overall race grid demand by over 20%.**
- **Each electric prototype can recover over 1 MWh of energy per 24-hour race.**
- **A full grid of 10 cars recovers over 10.5 MWh, proving the viability of electric endurance racing as an efficient and sustainable alternative to traditional formats.**

By implementing cutting-edge regenerative braking and suspension energy recovery, this championship **not only validates the feasibility of all-electric endurance racing at Le Mans but also accelerates the development of next-generation EV technologies**. The lessons learned from these energy systems will **directly impact the future of high-efficiency road-going electric vehicles**, setting new standards in sustainability, efficiency, and performance-driven innovation.

5. Regenerative Shock Absorber Technology

5.1 Overview: How Regenerative Shock Absorbers Work

In traditional racing vehicles, shock absorbers function solely to dampen vibrations, dissipating excess kinetic energy as heat. **Regenerative shock absorbers**, however, transform this normally wasted energy into usable electrical power by leveraging **electromagnetic induction and piezoelectric materials**.

This technology presents a **breakthrough in endurance racing**, particularly in all-electric formats, where energy recovery is critical to extending race stints, minimizing pit stops, and optimizing overall vehicle efficiency.

Core Functionality

Regenerative shock absorbers operate by converting **suspension movement into electrical energy**, feeding this energy back into the vehicle's power system. This process is achieved through two primary methods:

1. **Electromagnetic Regeneration**
   - Uses a **linear generator design**, where the suspension motion moves a **magnet through a coil**, inducing electrical current.
   - The generated electricity is stored in the battery or **supercapacitors** for later use.
2. **Piezoelectric Energy Harvesting**
   - Piezoelectric materials embedded in the shock absorber generate voltage in response to mechanical stress from suspension compression and extension.
   - This system **enhances energy recovery efficiency** by utilizing vibrations and minor oscillations that occur throughout a race.

Advantages for Electric Endurance Racing

1. **Energy Recovery from Road Oscillations** – As race cars travel over curbing, bumps, and track imperfections, the regenerative shocks continuously convert these forces into electrical power.
2. **Optimised Performance in Variable Conditions** – On **public road sections of Le Mans (Circuit de la Sarthe)**, regenerative shocks capture **energy from uneven surfaces**, making them particularly useful in endurance formats.
3. **Integration with Regenerative Braking Systems** – The energy harvested from suspension movements complements braking energy recovery, creating a **multi-source regeneration system** that improves overall efficiency.

4. **Longer Battery Life & Reduced Heat Dissipation** – Instead of purely relying on braking for energy recovery (which generates heat), regenerative shocks provide an **alternative, continuous source of power regeneration**, reducing thermal load on the braking system.

Competitive Edge in 24-Hour Endurance Racing

The inclusion of **regenerative shock absorbers in The Automobili La'Bergitla Endurance Series** enhances energy recovery efficiency, contributing **100–200 kJ per lap**. While this may seem minor compared to braking regeneration (~9–12 MJ per lap), over a full 24-hour race:

- A **single car** can recover **38–76 MJ** from suspension movement alone.
- A **grid of 10 cars** could collectively generate **380–760 MJ**, significantly offsetting external energy needs.

By continuously harvesting energy from **track vibrations, curb strikes, and high-speed oscillations**, regenerative shock absorbers ensure that endurance EVs **operate at peak efficiency** while maximizing energy savings throughout the race.

5.2 Shock Absorber Power Generation Mechanism

The regenerative suspension system in **The Automobili La'Bergitla Endurance Series** is engineered to capture kinetic energy from suspension movements and convert it into **usable electrical power**. This system employs a multi-faceted energy recovery mechanism that integrates **electromagnetic induction, piezoelectric materials, and mechanical generators** to maximize efficiency.

Key Energy Conversion Mechanisms

Electromagnetic Induction Coils

- Embedded within the **damper assembly**, these coils generate electricity as the shock absorber **compresses and rebounds** during suspension travel.
- The vertical motion of the suspension **moves a magnetic core through conductive coils**, inducing an electric current that is transferred to the vehicle's battery or supercapacitor system.

Piezoelectric Elements

- Piezoelectric materials generate an electric charge **when subjected to mechanical stress**.
- As the suspension system absorbs road irregularities and cornering forces, the **mechanical deformation of these materials produces electrical energy**, which is then harvested and stored.

Linear or Rotary Generators

- Depending on design specifications, regenerative shock absorbers can utilize either:
  - **Linear generators**, where **suspension movement drives a piston-like mechanism** that converts vertical displacement into electrical output.
  - **Rotary generators**, where the **suspension motion rotates a small generator** attached to the damper, converting kinetic energy into electricity.
- These generators work in conjunction with **electromagnetic coils and piezoelectric components** to **maximize power output** from every suspension movement.

Energy Harvesting in Real-World Racing Conditions

When the car's wheels encounter uneven surfaces, vertical displacement in the suspension activates these regenerative mechanisms, ensuring a **continuous stream of energy recovery throughout a lap**. The electricity generated is then **stored in the vehicle's battery or supercapacitor system**, where it can be deployed for acceleration, energy buffering, or onboard electronics.

Le Mans Track-Specific Applications:

- **Curbing & Chicanes** – High-speed sections such as the **Ford Chicanes and Mulsanne Corner** generate significant suspension travel, maximizing energy recovery.
- **Public Road Sections** – Bumps and surface irregularities from the **non-permanent road portions of Circuit de la Sarthe** provide additional opportunities for regenerative power capture.
- **Braking & Acceleration Zones** – As the suspension compresses under braking and rebounds during acceleration, **shock absorber generators continuously feed power back into the system**.

Impact on Endurance Racing Performance

The integration of **electromagnetic and piezoelectric regenerative shock absorbers** results in:

- **Reduced energy consumption** – Capturing suspension energy minimizes the load on battery storage.
- **Enhanced range extension** – Small but continuous energy recovery offsets overall power draw.
- **Improved braking synergy** – Works alongside regenerative braking for a **multi-source energy recovery strategy**.

By leveraging these **cutting-edge power generation technologies**, The Automobili La'Bergitla Endurance Series ensures that **no energy is wasted**, enhancing both efficiency and performance across an entire **24-hour endurance race**.

5.3 Efficiency and Power Output per Corner of the Car

The **power output of regenerative shock absorbers** is influenced by several factors, including **track surface characteristics, suspension tuning, vehicle weight, and driving style**. While the efficiency of these systems is lower compared to regenerative braking, their **continuous operation throughout a lap** provides a steady contribution to the overall energy recovery strategy.

Factors Affecting Energy Recovery from Regenerative Shock Absorbers

Track Smoothness & Bump Intensity

- **Smooth tracks (e.g., Silverstone, Monza)** generate minimal suspension movement, resulting in **lower energy recovery**.
- **Rougher circuits (e.g., Sebring, Nürburgring Nordschleife)** create greater vertical displacement, **maximizing power generation per damper**.

Car Setup & Suspension Tuning

- **Stiffer suspension setups** reduce energy absorption but **enhance handling precision**.
- **Softer suspensions** allow **greater movement**, leading to **higher energy recovery**, though at the cost of **reduced aerodynamic stability**.

Curb Usage & Vertical Load Transfer

- **Aggressive curb usage**, especially at high-speed chicanes like those at Le Mans, induces **suspension compression and rebound**, boosting energy recovery.
- **Lighter vehicles with lower vertical loads** will produce **less energy per impact** compared to heavier endurance prototypes.

Typical Power Output Estimates

On Smooth Tracks (e.g., Monza, Paul Ricard)

- **100–200 W per damper**
- **Total energy per lap: ~0.1–0.2 MJ**

On Bumpier Circuits (e.g., Sebring, Nürburgring)

- **Peak outputs exceeding 1 kW per damper** during severe oscillations
- **Higher total energy recovery per lap (~0.5 MJ or more depending on conditions)**

At Le Mans (Circuit de la Sarthe Specifics)

- Given **its relatively smooth surface** but **frequent high-speed curb strikes**, expected power generation is:
  - **200–300 kJ per lap across all four dampers**
  - Equivalent to **~0.2–0.3% of total race energy consumption per car**

Impact on Race Strategy & Energy Efficiency

Supplemental Energy Recovery

- While not a **primary energy source**, **regenerative shock absorbers contribute to the overall efficiency strategy** of endurance EVs.

Potential for Adjustable Suspension Mapping

- Teams can **tune suspension settings to balance handling stability with energy recovery potential**, especially for circuits with significant elevation changes and curb impacts.

Cumulative Effect Over a Stint

- Across a **10–14 lap stint**, **energy recovery from suspension alone** could contribute **2–3 MJ of additional usable energy**, equivalent to **extending a stint by an additional lap over a full race distance**.

While regenerative braking remains the **dominant form of energy recovery**, **suspension-based energy harvesting** provides an **additional layer of efficiency** in electric endurance racing. The **predictable, continuous energy recovery from shock absorbers** enhances **energy strategy and stint optimization**, demonstrating the role of **integrated energy harvesting technologies** in future high-performance EV endurance racing.

5.4 Real-World Application: Energy Harvesting Over Le Mans Distance

In a **24-hour endurance race at Le Mans**, the cumulative impact of **regenerative shock absorber technology** becomes increasingly significant. While the individual energy contribution per lap is relatively modest, the **compounding effect over an entire race distance** provides measurable efficiency gains.

Estimated Energy Recovery Over a Full Race

A **car completing 350 laps** at Le Mans could generate:

- **200–300 kJ per lap** × **350 laps** = **70–105 MJ of recovered energy**
- **Equivalent energy in kilowatt-hours (kWh): 19.5–29.2 kWh**
- **Percentage of a full battery charge (~100 kWh pack): 20–30%**

This demonstrates that **suspension energy harvesting can regenerate up to a third of a single full battery charge** over an entire endurance race.

Strategic Benefits of Recovered Energy

While this amount of energy is **not enough to power a car for an entire stint**, it provides key **efficiency gains** that influence race strategy:

Supplementing Propulsion Power

- **Less battery energy is required for acceleration**, reducing overall drain on the battery pack.

Reducing Load on the Main Battery

- **Auxiliary systems** (e.g., telemetry, cooling pumps, lighting, inverters) can **draw power directly from recovered energy**, minimizing their impact on the propulsion battery.

Extending Stint Lengths

- By reducing the total power drawn from the main energy storage system, **teams can stretch the duration of each stint**, **reducing the number of mandatory pit stops** and improving race efficiency.

Long-Term Implications for Endurance Racing

Efficiency at Scale:

- If **10 cars** compete in the championship, total energy recovered from suspension technology alone could exceed **1 GJ (~300 kWh) over a full race**, enough to **power multiple homes for a day**.

Optimised Race Strategy:

- **Teams that maximize energy recovery** through optimised suspension tuning and shock absorber design will have a **competitive edge in stint length and energy efficiency**.

Technology Transfer to Road Cars:

- **Electric road vehicles** could integrate similar systems to **increase range, reduce battery size requirements, and improve overall efficiency** in real-world conditions.

While **suspension-based regenerative energy recovery is not the primary source of propulsion power**, its contribution over a **full Le Mans race distance is significant**. By recovering **up to 105 MJ of energy per car**, teams gain valuable **efficiency advantages**, allowing them to **optimize stints, reduce pit stops, and enhance vehicle performance**.

In the broader context, this **regenerative technology represents a breakthrough in electric endurance racing**, reinforcing **The Automobili La'Bergitla Endurance Series mission** to push **EV efficiency and performance to unprecedented levels**.

5.5 Integration with the Battery and Supercapacitor System

The integration of **regenerative shock absorbers** into the vehicle's **energy storage system** is a critical component of maximizing efficiency in endurance racing. The energy harvested from suspension movements must be **effectively managed and distributed** to ensure it contributes meaningfully to propulsion, auxiliary power, or strategic deployment.

Energy Flow and Distribution

Supercapacitor Buffer for Short-Duration Energy Bursts

- Supercapacitors are ideal for storing the **high-frequency, short-duration energy spikes** generated by regenerative shock absorbers.
- When the car encounters a bump or curb, the **suspension absorbs mechanical energy, which is immediately converted into electrical energy** and stored in the **supercapacitor system**.
- This energy is then **rapidly discharged** to assist in acceleration or power auxiliary systems, such as active aerodynamics, electronic differentials, or cooling pumps.

Battery Storage for Long-Term Energy Retention

- Unlike supercapacitors, the **main battery system stores energy over longer durations**, making it suitable for handling the cumulative energy harvested throughout a race.

- The **Battery Management System (BMS)** continuously monitors energy input, ensuring that surplus power from regenerative suspension is either used **immediately** or stored **for later deployment**.
- The energy harvested from suspension is typically **low compared to regenerative braking**, but over long stints, it provides **a meaningful efficiency boost**.

Battery Management System (BMS) Optimization

The **BMS plays a vital role** in managing the distribution of energy recovered from the suspension system:

Real-Time Monitoring & Dynamic Allocation

- The BMS dynamically **prioritizes power flow** based on the vehicle's current energy demands.
- If the supercapacitors reach capacity, excess energy is redirected into the **main traction battery** to prevent **energy loss through dissipation**.

Overcharge and Overheat Prevention

- The system prevents **excessive charge accumulation** in the suspension energy recovery circuit.
- If energy input from regenerative shock absorbers is higher than what can be stored, the BMS **limits power intake** to prevent **thermal stress** on components.

Integration with Vehicle Electronics

- The recovered energy can also **power auxiliary systems**, reducing strain on the **primary traction battery** and extending **effective driving range**.
- Non-propulsion systems such as **steering assist, telemetry, and cooling pumps** can benefit from this secondary energy source.

Strategic Benefits of Integration

Energy Efficiency Gains Over a Full Stint

- While the energy contribution from suspension is relatively small per lap, over a full **stint of 10–14 laps**, the recovered power could **offset a measurable portion of battery energy consumption**, allowing teams to **optimize their battery swap strategy**.

Enhanced Performance & Power Consistency

- By leveraging the **supercapacitor buffer**, drivers experience **less variation in power output**, leading to **more predictable vehicle behaviour** across long stints.

Reduced Wear on Primary Energy Storage

- Since supercapacitors handle transient power surges, the main battery experiences **less stress**, extending its operational efficiency and reliability.

The **integration of regenerative shock absorbers with supercapacitors and the main battery system** enhances overall energy efficiency while improving vehicle performance and strategic flexibility. The **Battery Management System (BMS)** plays a crucial role in ensuring that **harvested energy is efficiently utilised**, preventing waste, and maximizing range.

By incorporating these advanced energy recovery and management techniques, **The Automobili La'Bergitla Endurance Series demonstrates that endurance EV racing can be as much about intelligent energy deployment as outright speed and power**.

5.6 Advantages Over Traditional Suspension Systems

The adoption of **regenerative shock absorbers** in endurance racing provides significant **efficiency, performance, and sustainability advantages** over conventional hydraulic dampers. By capturing and reusing energy that would otherwise be lost as heat, these systems contribute to a more **energy efficient and high-performance** racing environment.

Efficiency Gains

Energy Recovery Instead of Dissipation

- Traditional shock absorbers dissipate vibrational energy as **heat**, contributing nothing to vehicle performance. Regenerative dampers **convert this lost energy into usable electrical power**, **offsetting battery consumption** over a full stint.
- By integrating electromagnetic and piezoelectric energy recovery, this system **reduces the vehicle's total energy demand**, leading to **longer stints** between battery swaps or allowing teams to **deploy more power for performance gains**.

Reduction in Net Battery Draw

- Even a **small percentage** of energy recovered per lap accumulates into **a significant offset** over a full race distance. This means cars can **reduce reliance on external energy replenishment** while maintaining **optimal power output**.
- Over a **24-hour race**, regenerative suspension can save enough energy to **power critical vehicle systems**, reducing the strain on the primary traction battery.

Performance Improvements

Reduced Brake Wear and Heat Generation

- While regenerative braking remains the primary method of energy recovery, regenerative shock absorbers further aid by **absorbing and storing some of the kinetic energy** that would otherwise need to be dissipated as **brake heat**.
- This secondary energy recovery **reduces overall brake system wear**, extending the lifespan of brake components while maintaining **consistent performance throughout long stints**.

Improved Handling Stability

- The system **maintains all the traditional damping functions** of high-performance suspension while adding **energy recovery functionality**.

- Unlike passive hydraulic dampers, which **simply absorb impact forces**, regenerative suspension actively **manages energy flow**, helping the vehicle maintain **stability under heavy loads, cornering forces, and high-speed oscillations**.
- This enhanced **damping control** allows cars to **maximize traction, minimize pitch and roll, and sustain higher speeds through complex cornering sequences**.

Sustainability and Longevity

Extended Component Lifespan

- Traditional hydraulic dampers experience **mechanical wear and oil degradation** over time. Regenerative shock absorbers **replace conventional damping fluids with electromagnetic or solid-state systems**, resulting in **less degradation and longer operational lifespan**.
- By **reducing mechanical friction and wear**, teams benefit from **lower maintenance costs** and **fewer component replacements** over a racing season.

Application to Road Car Development

- The regenerative suspension technology developed for **The Automobili La'Bergitla Endurance Series** has **direct applications for road-going electric vehicles (EVs)**.
- The same principles that improve **energy efficiency and performance in endurance racing** can be applied to **commercial EVs**, allowing manufacturers to design vehicles that recover energy from everyday driving conditions—such as potholes, speed bumps, and rough road surfaces.
- By **demonstrating the feasibility of regenerative suspension in high-performance motorsport**, this technology **accelerates its potential integration into mainstream automotive design**, contributing to the development of **more efficient and sustainable electric vehicles**.

The **advantages of regenerative suspension systems over traditional hydraulic dampers** extend beyond racing performance—offering **efficiency gains, improved vehicle handling, and a more sustainable engineering approach**. By capturing **previously wasted energy** and feeding it back into the vehicle's electrical system, this innovation **reduces reliance on external energy sources while enhancing race strategy and vehicle longevity**.

As electric endurance racing continues to evolve, **technologies like regenerative suspension will play a crucial role in optimizing performance, extending battery range, and ensuring that EV racing remains as competitive and exciting as its combustion-engine predecessors**.

5.7 Impact on Ride Quality and Vehicle Handling

One of the key challenges in integrating **regenerative suspension technology** into high-performance endurance racing is ensuring that energy recovery **does not compromise** ride quality, stability, or handling precision. The Automobili La'Bergitla Endurance Series regenerative shock absorber system is designed to function seamlessly with **advanced damping control**, ensuring that the suspension maintains its **primary role in vehicle dynamics** while simultaneously harvesting energy.

Maintaining Ride Quality and Comfort

Active Damping Control

- The system utilizes **intelligent adaptive damping**, which continuously adjusts to driving conditions, ensuring that energy harvesting does not negatively affect **ride comfort, stability, or driver control**.
- Unlike traditional hydraulic dampers, which passively absorb forces, the regenerative system actively **manages damping forces**, **improving handling precision** on a variety of track conditions.

Customizable Suspension Settings

- Teams have full control over **tuning recovery rates**, allowing them to adjust how much energy is harvested **without compromising performance**.
- Recovery levels can be **calibrated based on track conditions, driving style, and strategic requirements**, ensuring the best balance between **energy efficiency and mechanical grip**.

Minimised Impact on Driver Feel

- Because regenerative suspension **absorbs** and **stores kinetic energy dynamically**, rather than simply dissipating it, it allows for **more controlled body motion**—reducing excess bouncing or instability.
- The system is engineered to **minimize intrusive effects**, ensuring that drivers retain **the same level of feedback and responsiveness** as they would with conventional high-performance suspension.

Optimizing Handling Stability and Performance

Dynamic Load Balancing

- The system automatically **distributes damping forces across all four corners**, ensuring that energy recovery does not affect **cornering precision or weight transfer**.
  This means that energy harvesting does not interfere with essential vehicle dynamics, such as:
  - **Braking efficiency** – ensuring that weight shift under braking remains **consistent and predictable**.
  - **Cornering stability** – preventing excessive roll or loss of traction.
  - **High-speed control** – maintaining stability over curbs, bumps, and fast direction changes.

Adaptive Response for Endurance Racing

- The ability to **fine-tune** regenerative suspension settings allows teams to **optimize** their race strategy depending on **track conditions, weather, and energy demands**.
- On smoother circuits, settings can be adjusted to **prioritize suspension compliance and grip**, while on bumpier sections, higher energy recovery can be **enabled to maximize efficiency**.

Regenerative shock absorber technology **marks a significant advancement** in electric endurance racing, providing a **dual benefit** of improving efficiency while maintaining **top-tier ride quality and handling performance**. By continuously harvesting energy from suspension movement, the system **extends**

range, reduces reliance on external charging, and enhances vehicle dynamics without sacrificing stability or driver control.

Over a **24-hour race**, the cumulative energy recovery from regenerative suspension **can contribute significantly** to the overall energy strategy, complementing regenerative braking and reducing the frequency of battery swaps. This **enhances race efficiency, minimizes downtime, and reinforces the sustainability of electric endurance racing**.

Beyond motorsport, this technology has **far-reaching applications** for road-going electric vehicles. By integrating regenerative suspension into **commercial EVs**, automakers can develop **more efficient, self-sustaining energy systems**, further improving vehicle range and sustainability in everyday driving.

As **The Automobili La'Bergitla Endurance Series** continues to **push the boundaries of endurance racing**, regenerative suspension **solidifies its place** as a key innovation in the transition to **fully electric, high-performance motorsport**. This breakthrough underscores the championship's commitment to **efficiency, sustainability, and cutting-edge engineering**, proving that the **future of endurance racing is not just electric—but smarter and more advanced than ever before**.

6. Vehicle Powertrain and Energy Management

Electric endurance racing in The Automobili La'Bergitla Endurance Series is built around a new generation of **high-speed electric drivetrains** that combine ultra-high-RPM traction motors with a **homologated electro-mechanical multi-speed transmission system**.

Unlike conventional EV race platforms that rely on single-speed reductions, this championship defines a technical direction based on **multi-ratio mechanical efficiency, high-RPM motor operation, and software-controlled clutchless shifting**. This architecture allows electric powertrains to operate within optimal efficiency and performance bands across the full range of racing speeds encountered during endurance competition.

To ensure both innovation and parity, the series establishes:

Standardised Core Architecture

- Homologated 6-speed electro-mechanical sequential transmission
- Dog-ring clutchless engagement system
- Standardised swappable battery platform

Open Development Areas

- Electric motor design and configuration
- Inverter technology and control electronics
- Torque modulation and shift coordination software
- Thermal management systems
- Energy recovery and deployment strategies

This framework ensures that success is determined by **efficiency, control intelligence, and endurance reliability**, rather than hardware escalation.

6.1 Regulated Freedom in Electric Powertrain Development

Teams are permitted to develop custom electric drive units within the boundaries of the championship's homologated drivetrain architecture.

While the **transmission concept and battery system are standardised**, teams retain design freedom in the elements that most influence performance efficiency and vehicle behaviour.

Motor Configuration and Placement

- Teams may utilize **single-motor rear-drive** or **multi-motor all-wheel-drive** configurations.
- Front and rear drive units may be independently controlled for traction and regenerative optimisation.
- Motor designs may prioritise power density, efficiency, or sustained endurance output depending on team strategy.

High-Speed Motor Architecture

The championship platform is designed around **high-speed electric traction motors** capable of operating at rotational speeds exceeding **20,000 RPM**, with architectures extending toward **30,000 RPM**.

This high-RPM philosophy:

- Reduces motor mass and rotor inertia
- Enables higher power density
- Expands the usable performance window when paired with multi-speed gearing
- Improves overall drivetrain efficiency across varying track speeds

Integration with the Homologated Multi-Speed Transmission

All vehicles must integrate the **championship-homologated electro-mechanical 6-speed sequential gearbox**.

This transmission:

- Utilizes **dog-ring engagement mechanisms**
- Operates **without friction clutches or synchronizers**
- Uses **electro-mechanical actuation** for gear selection
- Relies on **precise motor torque modulation** to enable clutchless shifting

The gearbox allows high-RPM motors to remain within their most efficient operating range during:

- Low-speed acceleration zones
- Mid-range endurance pacing
- High-speed straight-line operation

Teams may not alter the gearbox architecture, but they may optimize:

- Motor torque curves
- Shift timing strategies
- RPM operating windows
- Software-based torque reduction during gear changes

Torque Vectoring and Power Distribution

- Electronic torque vectoring through independent motor control is permitted.
- Mechanical torque-biasing devices inside the gearbox are not permitted.
- Power deployment may be dynamically adjusted based on grip, tire condition, battery state, and race strategy.

Electro-Mechanical Shift Control and Torque Coordination

Gear changes are executed through **software-controlled torque modulation**, not through mechanical clutch interruption.

- The vehicle control system must momentarily reduce or shape motor torque during shifts
- This ensures smooth dog-ring engagement without shock loading
- Shift quality, speed, and efficiency become areas of software and control system innovation

This makes **control intelligence** a defining competitive factor.

Cooling Systems and Thermal Management

Sustained high-RPM motor operation and multi-speed transmission use demand advanced cooling.

Teams may develop proprietary cooling systems for:

- Electric motors
- Inverters
- Transmission lubrication systems

Cooling technologies must not act as energy storage systems and must comply with packaging and safety regulations.

Software-Driven Energy Deployment

Energy management is governed by intelligent software strategies that coordinate:

- Motor efficiency mapping
- Gear selection and shift timing
- Regenerative braking integration
- Battery and supercapacitor deployment

Driver-selectable modes may allow tactical decisions between performance, efficiency, and component preservation over long race stints.

6.2 Standardised Battery Integration with Unique Vehicle Designs

All competitors must integrate the championship's **standardised underside-mounted swappable battery system**, ensuring:

- Equal baseline energy storage
- Consistent vehicle mass and centre of gravity
- Uniform safety and high-voltage architecture

While energy storage is standardised, teams retain freedom in:

- Chassis integration
- Thermal management design
- Powertrain packaging

- Aerodynamic solutions
- Control software governing energy deployment

The battery provides a **common energy platform**, while performance differences arise from **how effectively teams convert stored electrical energy into mechanical performance through the high-speed, multi-speed drivetrain architecture**.

Battery Specifications and Key Features

1. Chemistry and Capacity

- The battery pack will use **next-generation lithium-ion or solid-state cell technology**, offering a balance between **high energy density, rapid charge/discharge rates, and long-term durability**.
- **Capacity:** Each pack will store **100 kWh (±5%)**, providing sufficient energy for extended stints while ensuring **energy management remains a key strategic factor**.
- **Power Output:** The pack will be capable of delivering **up to 500 kW (670 hp)**, aligning with current **Le Mans Hypercar (LMH) performance levels**.

2. Standardised Interchangeability and Swapping Efficiency

- To maintain **race parity**, all teams will use **identical battery dimensions, mounting points, and electrical interfaces**, allowing for universal compatibility across different car designs.
- The battery is **underside-mounted**, ensuring a **low centre of gravity for optimal handling and stability**.
- **Rapid Swap System:** The standardised design allows for **battery swaps in under 60 seconds**, ensuring **minimum downtime during pit stops**.

3. Advanced Thermal Management

- The battery is equipped with **liquid cooling and integrated phase-change materials** to prevent **thermal runaway** and maintain **optimal temperature stability** over long stints.
- Heat generated from **rapid discharge and regenerative braking** is managed through **active cooling loops**, which interface with each vehicle's **custom cooling system**.
- Teams may develop **aerodynamic enhancements** to **improve airflow and heat dissipation** around the battery housing.

4. Real-Time State of Charge (SoC) Monitoring

- Teams are required to adhere to **strict energy usage regulations**, with **real-time telemetry data** monitored by race officials to ensure compliance.
- **State of Charge (SoC) tracking** allows teams to manage energy deployment efficiently, preventing excessive power usage while optimizing race strategy.
- The Battery Management System (BMS) actively **balances cell voltage, monitors health, and prevents overcharging or deep discharge conditions**.

Balancing Standardization with Innovation

While all teams must integrate the **homologated battery pack**, they are free to **optimize their vehicle's aerodynamics, cooling systems, and powertrain design** to **maximize efficiency and performance**. This approach ensures that **energy management and strategy remain critical components of competition**, **rather than outright energy capacity**.

By enforcing **standardised battery integration**, The Automobili La'Bergitla Endurance Series ensures that **races are won through engineering ingenuity, driver skill, and strategic execution—rather than purely through battery development budgets**.

6.3 The Role of Dual Supercapacitors in Power Delivery

To complement the **standardised battery pack**, teams in The Automobili La'Bergitla Endurance Series are permitted to integrate **dual supercapacitor systems** to enhance **energy efficiency, power delivery, and regenerative braking recovery**. Supercapacitors are highly effective in **handling short-term energy demands** by rapidly storing and discharging energy, ensuring that power is available **precisely when needed without excessive strain on the battery**.

Unlike lithium-ion or solid-state batteries, which have **slower charge/discharge cycles**, supercapacitors are designed for **rapid energy transfer**, making them an essential tool for **high intensity race scenarios** such as **overtakes, corner exits, and peak acceleration phases**.

Advantages of Supercapacitors in Endurance Racing

1. Instantaneous Power Discharge for Acceleration and Overtaking

- Supercapacitors **store and release energy almost instantly**, delivering a burst of power **during acceleration or overtaking manoeuvres**.
- This allows the **main battery to operate more efficiently**, without experiencing sudden voltage drops that could impact overall performance.
- Unlike traditional battery systems, which **experience degradation from frequent high current loads**, supercapacitors can **repeatedly discharge peak power without significant wear**.

2. Efficient Regenerative Braking Energy Storage

- Supercapacitors excel at capturing and storing **energy from regenerative braking**, which is then deployed for acceleration **without needing to cycle through the main battery**.
- By capturing this energy efficiently, teams can **maximize energy recovery potential**, reducing waste and increasing the car's effective range.
- This setup also allows **for more aggressive braking strategies**, knowing that a significant portion of braking energy will be immediately reused.

3. Prolonged Battery Lifespan by Handling Peak Power Demands

- By diverting **high-power surges** to supercapacitors instead of the main battery, **battery degradation is reduced**, ensuring **consistent performance over long endurance stints**.
- Batteries are most efficient when operating under **steady-state conditions**, and supercapacitors help by **absorbing sudden power fluctuations** and **protecting battery cells from excessive thermal build-up**.
- Over the course of a **24-hour endurance race**, this system significantly improves **battery longevity and energy efficiency**, reducing the risk of **capacity loss due to excessive high current draw**.

Dual Supercapacitor System Architecture

The integration of **dual supercapacitors** allows for more precise power management and ensures that key vehicle systems remain **operational even during pit stops and battery swaps**.

Primary Supercapacitor (Battery-Integrated Buffer System)

- Installed **within the battery unit**, this capacitor **smooths out power fluctuations** and assists in maintaining a **stable voltage output**.
- It absorbs **sudden energy surges**, preventing **overload scenarios** and **minimizing thermal stress** on the battery pack.

Secondary Supercapacitor (Vehicle-Integrated System)

- Positioned **within the vehicle's energy distribution system**, this capacitor serves as an **instant power reservoir** to support **critical functions** such as:
  - **Powering electronics, cooling systems, and telemetry** during pit stops.
  - **Maintaining propulsion power when the main battery is temporarily disconnected** (e.g., during a swap).
  - **Ensuring that the car remains responsive in energy-demanding situations**, such as high-speed cornering and rapid acceleration.

Strategic Implementation in Race Scenarios

Supercapacitors provide a **competitive edge** by enabling teams to **strategically deploy energy** at crucial points in the race:

- **On the Mulsanne Straight**, where full-throttle acceleration is required after chicanes, stored supercapacitor energy can provide an extra boost without depleting the battery.
- **During pit stops**, the secondary capacitor ensures that all essential systems (cooling, telemetry, and controls) remain powered, reducing downtime and complexity.
- **Under braking,** rapid energy absorption improves overall regeneration efficiency, meaning that less energy is lost as heat.

Enhancing Endurance Racing Performance with Supercapacitors

The **dual supercapacitor system** in The Automobili La'Bergitla Endurance Series represents a significant technological advancement in electric endurance racing. By **handling high-power demands efficiently,**

reducing battery strain, and optimizing regenerative braking storage, these systems contribute to **longer-lasting energy reserves, improved acceleration, and superior race strategy execution**.

By integrating **cutting-edge power storage solutions**, this championship pushes the boundaries of **energy efficiency, sustainability, and high-performance racing**, solidifying its role as a **proving ground for next-generation EV technologies**.

6.4 Optimizing Regenerative Braking Systems for Endurance Racing

Regenerative braking is a critical energy recovery system in **The Automobili La'Bergitla Endurance Series**, designed to enhance vehicle efficiency and extend battery range during endurance races. Given the **long straights and heavy braking zones** at **Le Mans**, the ability to **recapture and store kinetic energy** efficiently will be **a key differentiator in race strategy and performance**.

Unlike traditional endurance racing, where friction brakes convert kinetic energy into heat and dissipate it, **electric prototypes can recover a significant portion of braking energy**, feeding it back into the battery or supercapacitor system. This **reduces overall energy consumption**, minimizes battery drain, and extends **stint length** between pit stops.

Regenerative Braking Strategy for Endurance Racing

1. Front and Rear Axle Recovery for Maximum Energy Harvesting

- Unlike **previous hybrid systems** that primarily recovered energy from **the front axle**, The Automobili La'Bergitla Endurance Series permits teams to utilize **full-axle regenerative braking** on both **front and rear wheels**.
- This setup significantly **increases the energy recovery potential** by distributing regenerative forces across all four wheels, rather than relying on just one drivetrain source.
- **Independent axle control** allows for fine-tuned recovery, enabling teams to **adjust braking balance dynamically** to optimize efficiency **based on track conditions and race strategy**.

2. Brake-by-Wire System for Precision Braking Control

- A **fully electronic brake-by-wire system** will manage the **seamless integration of regenerative and friction braking**, preventing performance inconsistencies caused by mechanical wear.
- The system **automatically modulates braking force**, ensuring that the **maximum amount of kinetic energy** is recovered before activating the traditional hydraulic brakes.
- Electronic braking control allows teams to implement **customizable braking maps**, adapting to factors such as **tire wear, track temperature, and vehicle load balance**.

3. High-Power Motor-Generators for Enhanced Recovery

- Each **electric prototype** will be equipped with **high-output motor-generators** to maximize regenerative braking efficiency.
- These motor-generators convert **kinetic energy into electrical charge** with **minimal conversion losses**, improving overall system efficiency.

- The powertrain control unit (PCU) will determine **optimal braking zones** to deploy **maximum regenerative braking**, ensuring the highest energy recovery without compromising **handling or cornering stability**.

Strategic Benefits of Optimised Regenerative Braking

Extending Battery Range and Reducing Energy Consumption

- By recovering up to **9–12 MJ per lap**, teams can **offset their total energy consumption**, extending **stint duration,** and reducing the need for frequent battery swaps.
- This energy can be directly **stored in the battery pack or supercapacitors**, allowing for **more aggressive power deployment** when needed.

Minimizing Brake Wear and Heat Build-up

- Since regenerative braking reduces reliance on friction brakes, **brake pads and discs experience significantly less wear**, leading to **fewer component changes during the race**.
- Less friction braking also means **less heat build-up in the braking system**, improving vehicle **thermal efficiency and reliability** over long stints.

Optimised Cornering and Stability

- The ability to adjust **braking balance between front and rear axles** ensures that **drivers maintain stability when entering high-speed corners**.
- Regenerative braking allows for **smoother deceleration**, reducing weight transfer and **helping maintain tire grip under heavy braking zones**.

A Game-Changer for Electric Endurance Racing

By fully optimizing **regenerative braking** with **front and rear axle energy recovery, electronic brake by-wire control, and high-efficiency motor-generators**, The Automobili La'Bergitla Endurance Series ensures that electric endurance racing is **not just sustainable—but strategically superior**.

With **every major braking zone** presenting an opportunity for energy recovery, teams that **master regenerative braking** will gain an **edge in efficiency, race pace, and overall energy management**.

This innovation further cements **the role of electrification in high-performance endurance racing**, bridging the gap between **motorsport technology and real-world EV advancements**.

6.5 How Energy Recovery Enhances Performance and Efficiency

Energy recovery systems play a **pivotal role** in **The Automobili La'Bergitla Endurance Series**, allowing teams to **maximize efficiency and extend race stints** through advanced regenerative technologies. By carefully managing **recovered energy**, teams can gain a **strategic advantage**, reducing reliance on frequent battery swaps while maintaining peak performance.

Given the unique layout of **Le Mans' Circuit de la Sarthe**, teams will leverage two key energy recovery mechanisms: **regenerative braking** and **regenerative suspension**. Each contributes significantly to **offsetting energy consumption**, ultimately improving overall vehicle efficiency.

Energy Recovery & Deployment at Le Mans

The **Circuit de la Sarthe** offers multiple opportunities for energy regeneration, particularly in heavy braking zones and suspension-based energy harvesting. Proper management of these **regeneration systems** ensures that vehicles remain efficient while still delivering high performance over **a full 24hour race**.

1. Regenerative Braking Yield

- **Up to 8 MJ per lap** can be recovered under optimal braking conditions.
- This equates to approximately **2.2 kWh of energy regained per lap**, **significantly reducing battery drain**.
- Optimised braking zones such as **Mulsanne Corner, Arnage, and the Dunlop Chicane** will be critical for **maximizing energy recovery**.
- By recapturing this energy and **reusing it for acceleration**, teams can reduce their reliance on stored battery energy, extending the length of each race stint.

2. Regenerative Suspension Yield

- An additional **0.1–0.2 MJ per lap** can be harvested through **electromagnetic or piezoelectric shock absorbers**.
- Over a **24-hour race**, this could result in the recovery of **70–105 MJ**, equivalent to approximately **20–30% of a full battery charge**.
- This additional energy savings could translate into **fewer pit stops** by reducing battery depletion rates.
- **Adjustable dampers** may be used to fine-tune **suspension energy capture** without compromising vehicle **stability and handling**.

3. Total Recoverable Energy

- Combined braking and suspension recovery systems can yield **up to 8.2 MJ per lap**.
- This accounts for **approximately 15-20% of total energy consumption per lap**, depending on driving conditions and race strategy.
- **Strategic energy deployment** ensures that this recovered energy is used for **boosting acceleration**, **extending battery range**, and **reducing pit stops**.

Energy Deployment Strategy

Teams will carefully **manage how recovered energy is deployed** to **maximize performance while staying within regulatory limits**. This strategic energy management can significantly impact **lap times and race strategy**.

- **Acceleration Strategy**
  - **Recovered energy will be strategically deployed** on long straights such as the **Mulsanne Straight** to maximize **speed and overtaking opportunities**. o **Energy conservation** will be prioritised in sectors where **high power output is less critical**, allowing for **more efficient energy usage** over a full stint.

- **Regulatory Compliance**
    - Each vehicle will have an **energy-per-lap limit**, ensuring that teams **do not exceed the predefined recovery allowance**.
    - **Race officials will monitor** telemetry data in real-time to **enforce compliance and ensure fair competition**.
- **Battery Management**
    - Teams must ensure that **batteries are optimally depleted** by the end of each stint, preventing **unused energy from going to waste**.
    - **Efficient energy deployment strategies** will allow teams to extend their stints, potentially completing **fewer total pit stops** than competitors.

Regulatory Guidelines for Energy Recovery

To maintain competitive fairness while encouraging technological advancement, a **set of regulatory measures** will be in place:

1. **Per-Lap Energy Recovery Limits** – Ensures that no team gains an unfair advantage by exceeding the allowed regenerative energy per lap.
2. **Total Energy Usage Monitoring** – Prevents excessive energy consumption, enforcing strict power management strategies.
3. **Unrestricted Deployment of Recovered Energy** – While recovery limits exist, teams can **deploy recovered energy freely within power output limits**.
4. **Tech Standardization vs. Freedom** – Teams have **design flexibility** within strict **safety and efficiency regulations**, allowing them to develop **innovative powertrain solutions**.

Thermal Management and System Reliability

Endurance racing presents **unique thermal challenges**, requiring teams to develop **highly efficient cooling solutions** to **maintain battery and braking performance over extended race stints**.

- **Battery Cooling Optimization**
    - **Repeated high-power charge and discharge cycles** generate significant heat, necessitating **advanced liquid and phase-change cooling systems**.
    - Proper thermal regulation will ensure that batteries **maintain peak efficiency without performance degradation**.
- **Brake System Management**
    - The integration of **brake-by-wire regenerative braking** ensures that mechanical brakes are **only used when necessary**, reducing wear.
    - Teams must carefully manage **the balance between regenerative and mechanical braking** to prevent **brake overheating or energy losses**.
- **Software-Based Optimization**
    - **Intelligent power output controls** will automatically **adjust energy deployment** based on **battery state, race conditions, and track temperature**.

- Predictive software models will help **manage thermal stress**, ensuring **consistent performance across long stints**.

Energy Recovery as the Key to Endurance Racing Success

Vehicle powertrain and energy management will be at the heart of electric endurance racing, requiring teams to carefully **balance high-performance output with energy efficiency**.

By leveraging:

- **Regenerative braking**,
- **Supercapacitor-assisted power bursts**,
- **Suspension-based energy recovery**, and
- **Intelligent deployment strategies**,

teams will **optimize lap times** while **reducing pit stop frequency**, ultimately enhancing their **race winning potential**.

With a **blend of regulatory oversight and engineering freedom**, manufacturers will have the opportunity to **push the boundaries of endurance racing technology**, ensuring that **The Automobili La'Bergitla Endurance Series remains the premier proving ground for electric motorsport innovation**.

6.6 Homologated Multi-Speed Transmission System

To ensure competitive parity, cost containment, mechanical reliability, and a clear technological direction consistent with the objectives of The Automobili La'Bergitla Endurance Series, all competing vehicles **shall be equipped with the championship-homologated electro-mechanical multi-speed transmission architecture** as defined in this Article and Appendix T.

The homologated transmission system forms a **mandatory core component of the vehicle powertrain** and establishes a standardised mechanical interface between the electric traction motor(s) and the driven wheels. Its purpose is to define a common high-performance drivetrain foundation suitable for ultra-high-speed electric propulsion while maintaining controlled development costs and long-term technical stability within the championship.

While the mechanical transmission architecture is standardised, teams retain regulated freedom in the following areas, subject to the Technical and Sporting Regulations:

- Electric traction motor design and electromagnetic architecture
- Motor control, inverter control, and torque modulation software
- Energy deployment, regeneration strategy, and thermal management systems
- Gear ratio selection within the homologated gearbox framework

No vehicle may compete with an alternative transmission concept, single-speed reduction drive, continuously variable transmission, or any drivetrain system not compliant with this homologated architecture.

The intent of this regulation is to ensure that performance differentiation arises from **efficiency, control strategy, reliability, and energy management**, rather than from divergent transmission concepts or mechanical cost escalation.

6.6.1 Mandatory Transmission Architecture

All competing vehicles **shall be equipped with a homologated multi-speed, sequential mechanical transmission** conforming to the technical specification defined in Appendix T.

The transmission system must meet the following architectural requirements:

- The gearbox shall be of **sequential configuration**, employing a fixed gear order in which ratios are engaged in a defined sequence without the possibility of direct non-sequential selection.
- Torque transfer between selectable gearsets and the output shaft shall be achieved through **positive mechanical dog-ring (dog-clutch) engagement mechanisms**.
- The transmission shall operate **without the use of friction clutches, multi-plate clutch packs, or slipping torque-transfer devices** for torque transmission during gear engagement.
- A maximum of **six (6) forward gear ratios** shall be implemented per transmission unit.
- The transmission shall incorporate **at least one reverse gear ratio**, capable of propelling the vehicle in reverse under its own electric power in compliance with safety regulations.

For the avoidance of doubt:

- **Single-speed reduction transmissions are prohibited.**
- **Continuously variable transmissions (CVT), dual-clutch transmissions, planetary automatic transmissions, and hydraulic torque converter systems are prohibited.**

This mandatory architecture ensures a common mechanical performance platform across all competitors while enabling regulated innovation in motor control, energy deployment, and vehicle integration.

6.6.2 Actuation System

Gear selection and engagement within the homologated transmission shall be executed exclusively by an **electro-mechanical shift actuation system** compliant with Appendix T.

The actuation system must meet the following requirements:

- Gear engagement shall be achieved through an **electrically powered actuator** driving a mechanical linkage that produces axial movement of selector forks and associated dog rings within the gearbox.
- The actuator must transmit motion via a **direct mechanical connection**, such as a shift rod, selector shaft, or equivalent rigid linkage.
- The actuation system may be mounted externally or internally to the gearbox casing, provided the final engagement of gears remains purely mechanical.

The following systems are **not permitted**, unless specifically approved in writing by the championship for reliability or safety reasons:

- Electro-hydraulic shift actuation systems
- Pneumatic shift actuation systems
- Purely hydraulic shift mechanisms

Driver-operated **shift-by-wire interfaces** are permitted. These may include steering wheel paddle shifters, electronic sequential levers, or other electronic driver input devices, provided that:

- All driver shift requests are processed through the homologated vehicle control system, and
- Final gear engagement is achieved solely by the approved electro-mechanical actuator within the gearbox.

No system may bypass the mechanical selector mechanism or engage gears through electromagnetic, hydraulic-only, or non-mechanical means.

The intent of this regulation is to ensure consistent shift performance, prevent escalation toward complex hydraulic race systems, and maintain the reliability and cost-control objectives of the homologated transmission platform.

6.6.3 Torque Coordination

All gear changes within the homologated transmission system shall be executed through **electronic torque modulation of the electric traction motor(s)** in coordination with the approved electro-mechanical shift actuation system.

The following requirements apply:

- Prior to and during gear disengagement and engagement, motor torque must be reduced, removed, or otherwise modulated exclusively via inverter control to permit safe and reliable dog-ring engagement.
- Torque modulation strategies may include torque ramp-down, torque phase matching, and speed synchronization, provided such strategies are implemented solely through the homologated motor and inverter control systems.
- Following confirmation of gear engagement, torque may be progressively restored in accordance with the declared shift control strategy.

The use of **any external mechanical device to interrupt or modulate torque flow** between the motor and transmission during a shift is strictly prohibited. This includes, but is not limited to:

- Friction clutches
- Multi-plate clutch packs
- Electromagnetic clutches
- Hydraulic torque interruption devices

All torque reduction and restoration strategies employed during shifts must remain within the championship's **maximum power deployment and energy usage limits** as defined in the Technical and Sporting Regulations. Shift control may not be used to create temporary power increases, traction advantages, or energy deployment outside permitted limits.

The intent of this regulation is to ensure that clutchless shifting is achieved through advanced motor control and software precision, maintaining mechanical simplicity, reliability, and competitive parity across all vehicles.

6.6.4 High-Speed Motor Compatibility

The homologated transmission system shall be designed and installed to operate reliably with **high-speed electric traction motors** consistent with the championship's high-performance electric drivetrain philosophy.

The following requirements apply:

- The transmission must be fully compatible with electric traction motors capable of sustained operation at rotational speeds **exceeding 20,000 RPM**, and up to the maximum limits defined in Appendix V – *Homologated Motor Operating Envelope & RPM Limits*.
- All rotating components within the gearbox, including input shafts, gearsets, bearings, and lubrication systems, must be engineered to withstand the declared maximum motor input speed without loss of structural integrity, lubrication performance, or durability over endurance race distances.

Mechanical coupling between the motor and transmission shall meet the following conditions:

- **Direct spline coupling** between the motor shaft and gearbox input shaft is permitted and encouraged to reduce drivetrain inertia, improve packaging efficiency, and minimise mechanical losses.
- Flexible couplings, dampers, or intermediate shafts are permitted for vibration control and durability, provided they do not incorporate torque-interrupt or slipping clutch mechanisms.

Integrated electric drive unit architectures are permitted:

- **Integrated motor-inverter assemblies** mounted directly to or within the transmission housing are allowed and encouraged for efficiency, reduced electrical losses, and improved thermal and packaging performance.
- Such integration must not compromise serviceability, safety isolation, or compliance with high-voltage protection requirements defined elsewhere in the regulations.

The intent of this regulation is to ensure that the homologated transmission platform supports ultra-high-speed electric motor technology, promotes compact and efficient drivetrain integration, and maintains reliability under the extreme rotational speeds associated with modern endurance electric racing.

6.6.5 Mechanical Layout

The homologated transmission shall conform to a strictly defined mechanical layout to ensure parity, reliability, and alignment with the championship's high-performance electric drivetrain philosophy.

The following requirements apply:

- The gearbox shall be of **sequential mechanical configuration**, employing a fixed order of engagement for all forward gear ratios. Gear selection must occur through stepwise progression (upshift or downshift) and may not allow direct non-sequential ratio selection by the driver or control system.
- All forward gear ratios shall be **discrete, fixed mechanical ratios** established by physical gear pairs. No mechanism may alter the effective ratio of a gear once engaged.

The following transmission architectures and systems are **explicitly prohibited**:

- **Continuously Variable Transmissions (CVT)**, including belt, chain, toroidal, or hydrostatic types
- **Dual-clutch transmissions (DCT)** or any system using multiple friction clutches to pre-select or transfer torque between ratios
- **Planetary automatic transmissions** capable of ratio changes via clutch packs or brake bands
- **Hydraulic torque converter systems**, whether lock-up equipped or not
- Any transmission employing **fluid, magnetic, or electronically controlled slipping elements** as a primary means of torque transfer between ratios

No system may combine multiple ratio paths in parallel or use overlapping torque-transfer mechanisms to simulate seamless or continuously variable ratio changes.

The intent of this regulation is to ensure that all competitors utilize a **mechanically direct, sequential geartrain architecture**, preserving the character of high-performance endurance racing while preventing escalation toward complex, high-cost automatic or continuously variable systems.

6.6.6 Driveline Integration

The homologated multi-speed transmission system may be integrated into a variety of electric drivetrain layouts, provided all installations comply with the architectural intent and control limitations defined in these regulations.

The following configurations are permitted:

- The homologated transmission may be installed on the **rear axle, front axle, or on both axles** in vehicles employing single-motor or multi-motor drive architectures.
- In multi-motor vehicles, each driven axle may utilize its own homologated transmission unit, subject to all ratio, actuation, and control requirements defined in this Article and Appendix T.

Final drive and differential integration shall comply with the following:

- A **mechanical differential** may be integrated downstream of the gearbox output shaft, either within the same casing or as a separate final drive assembly.
- Open, limited-slip, or electronically controlled differentials are permitted, provided their operation does not conflict with the torque control principles defined below.

To maintain parity and ensure that torque distribution remains primarily a function of electric drive control:

- **Torque vectoring must be achieved through electronic motor control strategies**, including independent torque control of front and rear drive units where applicable.

- Active mechanical torque-biasing devices located within the gearbox, such as hydraulically actuated clutch packs or continuously variable torque-splitting mechanisms, are prohibited unless explicitly approved by the championship.
- No mechanical system may dynamically vary torque distribution between left and right wheels in a manner that substitutes for or overrides the intended electronic torque vectoring strategies.

The intent of this regulation is to allow flexibility in vehicle layout and axle configuration while ensuring that **driveline complexity does not escalate through hidden mechanical torque vectoring systems**, preserving competitive balance, and emphasizing software-controlled electric performance.

6.6.7 Lubrication and Cooling

The homologated transmission system shall operate within a controlled lubrication and thermal management environment suitable for sustained high-speed and high-load endurance racing conditions.

The following requirements apply:

- The gearbox must utilize a **sealed lubrication system**, designed to retain all lubricants under all operating conditions, including high lateral and longitudinal accelerations typical of endurance racing.
- Lubrication systems may employ **splash, pressure-fed, or spray-bar delivery methods** to ensure adequate oil supply to gears, bearings, and dog-ring engagement mechanisms.
- Dry sump or scavenged lubrication configurations are permitted, provided they remain closed-loop and do not serve any secondary performance function.

Transmission oil cooling is permitted under the following conditions:

- **Dedicated transmission oil cooling systems**, including liquid-to-air or liquid-to-liquid heat exchangers, are allowed to maintain lubricant temperature within safe operating limits.
- Cooling circuits may be integrated with vehicle thermal management systems, provided their primary function is temperature control and reliability.

However:

- Transmission lubrication or cooling systems must **not function as thermal or energy storage devices** capable of being exploited for performance gain.
- The use of phase-change materials, heat sinks, or fluid reservoirs specifically designed to absorb heat for later release in a manner that enables temporary increases in permitted power or torque is prohibited.
- No lubrication or cooling system may interact with the electrical energy storage system or provide any form of auxiliary propulsion or energy recovery.

All lubrication and cooling components must be securely mounted, leak-free, and compliant with fire safety and environmental containment standards defined elsewhere in the Technical Regulations.

The intent of this regulation is to ensure drivetrain reliability and longevity under extreme endurance conditions while preventing the use of thermal systems as a hidden performance enhancement mechanism.

6.6.8 Control System Interface

All gear selection and shift control functions of the homologated transmission system shall be managed through the vehicle's approved electronic control architecture in accordance with Appendix U – *Homologated Shift Control & Torque Modulation Software Requirements*.

The following driver interfaces for initiating gear changes are permitted:

- Steering wheel-mounted **paddle shifters**
- **Sequential mechanical or electronic gear levers**
- Approved **electronic gear selection devices**

These interfaces may generate shift requests only. Final authority for executing any gear change shall rest with the vehicle's control system.

Shift strategy operation is governed as follows:

- **Fully automatic shift strategies are permitted**, including software-controlled upshifts and downshifts based on vehicle speed, motor speed, torque demand, or energy optimization strategies.
- Semi-automatic strategies, where the driver initiates shifts but the system determines the exact execution timing, are also permitted.
- Manual driver override of safety-critical shift protection logic is prohibited.

All gearbox and shift control systems must comply with the following integration requirements:

- The transmission control system must interface directly with the **homologated Vehicle Control Unit (VCU)**.
- All shift commands, torque modulation requests, and gear position confirmations must pass through the VCU for validation, logging, and compliance monitoring.
- Independent control units capable of executing gear shifts or modifying torque outside the VCU's authority are not permitted.

No system may:

- Bypass the VCU to trigger gear engagement directly
- Implement hidden or undeclared shift strategies within secondary control modules
- Use gearbox control logic to circumvent power, torque, or energy deployment limits defined in the Technical or Sporting Regulations

The intent of this regulation is to ensure that while teams may innovate in shift strategy and control sophistication, **all transmission behaviour remains transparent, monitorable, and governed by the championship's central control architecture**.

6.6.9 Homologation Requirements

All transmission systems used in competition must undergo formal homologation in accordance with Appendix T prior to participation in any official session.

Each team shall submit a **Transmission Homologation Declaration** for approval by the championship, including the following mandatory technical information:

- The complete **gear ratio set** for all forward gears (maximum six), expressed as numerical ratios
- The **maximum permitted input shaft rotational speed (RPM)** for which the transmission is designed and intended to operate
- The **shift actuator type, manufacturer, and configuration**, including actuation method, linkage arrangement, and position feedback system
- The **lubrication system configuration**, including lubrication method (e.g., splash, pressure-fed, spray-bar), oil specification, and cooling system arrangement

The declared configuration shall define the transmission's approved specification for the season or homologation cycle.

Following homologation approval:

- No variable, adaptive, or self-adjusting gear ratio mechanisms may be introduced.
- Gear ratios, internal gear geometry, and engagement architecture may not be modified without prior written approval from the championship.
- Changes to actuation hardware or lubrication system design that affect performance, reliability, or compliance must be resubmitted for homologation review.

Routine maintenance, replacement of worn components with identical parts, and reliability-driven reinforcements that do not alter performance characteristics are permitted, subject to scrutineering inspection.

The intent of this regulation is to ensure cost control, technical stability, and competitive fairness by preventing ongoing transmission development once the homologated specification has been approved.

6.6.10 Safety

All homologated transmission systems must be designed, constructed, and installed to meet the championship's safety and containment standards appropriate for high-speed electric endurance racing.

The following safety requirements apply:

- The gearbox casing shall be of **structural containment design**, capable of retaining fragments in the event of gear, shaft, bearing, or dog-ring failure. The casing material, wall thickness, and fastening design must be appropriate for the maximum declared input speed and torque loads.
- All rotating components within the transmission, including input shafts, output shafts, gearsets, and engagement mechanisms, must comply with the championship's **rotational containment and mechanical integrity standards**. Components must be rated for the declared maximum RPM and endurance duty cycle.

- Any external covers, inspection panels, or actuator mounting interfaces must provide equivalent containment strength and may not represent a structural weak point in the event of internal failure.

Installation and system integration must also meet safety requirements:

- The transmission assembly must be securely mounted to the chassis or subframe using structural fasteners designed to withstand race loads and impact conditions.
- The gearbox must be positioned and shielded to minimize risk to the driver in the event of catastrophic failure.
- Adequate protection must be provided to prevent lubricant discharge onto hot electrical components or track surfaces in the event of seal or casing damage.

Electrical safety integration:

- The transmission must maintain **physical and functional separation from all high-voltage components**, cabling, and enclosures.
- Any integrated motor, inverter, or sensor systems associated with the transmission must comply with the high-voltage isolation and protection standards defined elsewhere in these regulations.

Compliance verification:

- All transmission systems must pass scrutineering inspection for **structural integrity, containment capability, mounting security, and electrical separation** before being approved for competition.
- The championship reserves the right to require non-destructive testing, material certification, or design documentation to verify compliance with safety standards.

The intent of this regulation is to ensure that the homologated transmission system maintains the highest levels of mechanical and electrical safety under extreme endurance racing conditions, protecting drivers, officials, and other competitors.

6.6.11 Regulatory Intent

The homologated multi-speed transmission architecture defined in this Article is implemented as a cornerstone of the Automobili La'Bergitla Endurance Series technical identity.

Its purpose is to:

- Promote the development of **high-efficiency electric drivetrain systems** optimised for endurance competition
- Ensure **sustained high-speed performance capability** appropriate for long-duration racing at the limits of electric propulsion
- Enhance **driver engagement and vehicle control** using sequential, performance-oriented shifting
- Maintain **mechanical reliability and durability** under extreme motor speeds and endurance race duty cycles

- Establish a clear and distinctive **technological direction and identity** for the championship's electric racing platform

This homologated architecture is intended to create a stable, high-performance mechanical foundation upon which teams may innovate in motor design, control systems, energy management, and vehicle integration.

It is **not** the intent of this regulation to encourage performance disparities arising from alternative transmission concepts, escalating mechanical complexity, or cost-intensive drivetrain development outside the approved framework.

Accordingly, any transmission system, layout, or operating principle that does not conform to the requirements of this Article and Appendix T shall be deemed non-compliant and is not permitted for use in competition.

7. Impact on Racing Strategy

7.1 Regenerative Energy Utilization in Race Strategy

One of the most significant advantages of electric endurance racing is the ability to recapture and reuse energy through regenerative systems. Unlike traditional internal combustion engines (ICE), which continuously consume fuel with no ability to recover lost energy, electric powertrains allow teams to recover kinetic energy during braking and suspension movement and strategically redeploy it to optimize race performance.

Maximizing Regeneration for Competitive Advantage

Regenerative braking and suspension-based energy harvesting will play a pivotal role in defining race strategy. Teams will need to develop precision energy management techniques that align with stint length, power deployment, and pit stop timing.

Key factors include:

- **Regenerative Braking Optimization:**
  - Energy recovery efficiency depends on braking zone usage and deceleration rates.
  - Harder braking zones (e.g., **Mulsanne Corner, Arnage**) provide **greater energy recovery,** allowing teams to extend stints.
  - Teams will **fine-tune brake-by-wire systems** to **maximize regeneration** without **sacrificing stopping performance**.
  - Excess energy recovered can be stored in supercapacitors for immediate acceleration boosts or routed to the battery for gradual deployment.
- **Suspension-Based Energy Recovery:**
  - Cars will recover small amounts of energy from shock absorbers, particularly when driving over curbs or rough track sections.
  - While this contributes only 0.1–0.2 MJ per lap, over a 350-lap race, this adds up to over 70 MJ—equivalent to a small but crucial energy advantage.
  - Suspension energy recovery will reduce reliance on battery swaps, extending usable energy over a stint.

Gear-Dependent Regeneration and Drivetrain Efficiency (Homologated 6-Speed Influence)

The homologated 6-speed transmission introduces a unique strategic dimension to regenerative recovery. Unlike single-speed EV platforms — where motor RPM is dictated directly by vehicle speed — a multi-ratio drivetrain allows teams to keep the motor within its most efficient regeneration band across a wider range of speeds and braking events.

- Key strategic impacts include:
  Optimised Regen RPM Window: Teams can select ratios that keep the traction motor in its strongest regenerative efficiency zone under braking, improving energy recovery consistency across different corners and braking severities.

- **Reduced High-RPM Regen Saturation:** At very high vehicle speeds, downforce and braking loads increase dramatically. Multi-speed ratio selection prevents the motor from being forced into inefficient ultra-high RPM regen regions where recovery becomes thermally costly or electronically limited.
- **Regen-to-Capacitor Targeting:** Gear selection can be used to shape regen spikes, improving capture by the supercapacitor buffers (fast acceptance) before routing energy to the battery (slower acceptance).
- **Stability Under Braking:** With correct ratio strategy, regen can be applied more progressively, reducing transient lock-up risk, and improving rear stability under high decel.

Practical racing effect: teams will develop "regen maps by sector" — using ratio selection to maximize recovered energy in high-value braking zones without compromising brake feel or stability.

Strategic Deployment of Recovered Energy

Unlike fuel-driven endurance racing, where teams manage fuel flow and consumption, electric endurance racing will focus on strategic energy redeployment. Teams will determine how best to utilize their recovered energy to gain an advantage:

1. **Acceleration Boosts and Overtaking:**
    - Deploying stored regenerative energy at key overtaking zones (e.g., Hunaudières Straight) can give a temporary power increase for passing slower cars.
    - Teams may save excess recovered energy for use in high-power demand sectors, allowing for short bursts of extra performance when needed.
2. **Sustained Energy Efficiency Gains:**
    - Instead of using all recovered energy instantly, teams may opt to gradually redeploy power over a stint, maximizing range and efficiency.
    - Intelligent Energy Management Systems (EMS) will optimize when and where energy should be used, ensuring teams do not exceed per-lap energy limits.
3. **Stint Length Optimization and Pit Strategy:**
    - By extending battery life through energy recovery, teams may delay pit stops compared to competitors who deplete their charge sooner.
    - Regenerative energy deployment strategies will determine whether teams opt for longer stints with fewer swaps or faster sprint stints with more aggressive energy use.

Regulatory Constraints on Energy Deployment

To maintain competitive balance, The Automobili La'Bergitla Endurance Series will enforce strict energy usage regulations:

- Per-lap energy recovery limits: Preventing teams from exceeding set recovery rates.

- Maximum energy usage per stint: Ensuring that no team gains an unfair advantage by deploying excessive recovered energy beyond their allocated limit.
- Software-Based Power Allocation: Teams will be required to pre-program energy recovery and deployment strategies to prevent mid-race manipulation beyond set parameters.
- Live Monitoring by Race Officials: Ensuring compliance with standardised power limits and preventing excessive deployment of recovered energy beyond fair-use thresholds.

Challenges and Trade-offs in Regenerative Energy Utilization

Although regenerative energy provides a critical efficiency advantage, teams must carefully balance recovery and deployment to avoid potential performance trade-offs:

- **Braking Performance vs. Energy Recovery:**
  - Aggressive regen braking may interfere with optimal braking performance, requiring teams to find the right balance between energy recovery and mechanical braking efficiency.
  - Excessive reliance on regen braking may cause brake temperature imbalances, affecting handling and stopping distances.
- **Supercapacitor vs. Battery Storage Efficiency:**
  - Storing energy in supercapacitors allows for instant deployment but is limited in total capacity.
  - Storing energy in the battery ensures longer-term energy reserves but requires careful thermal management to prevent overheating.
- **Energy Deployment Timing Considerations:**
  - Deploying stored regenerative energy too early in a stint may leave the car underpowered in later stages.
  - Optimal deployment zones must be identified to maximize strategic efficiency without overconsumption.

Regeneration as a Race-Deciding Factor

Regenerative energy utilization will be a race-defining strategy in electric endurance racing. Unlike traditional endurance racing, where pit stop timing and fuel strategy dictate the outcome, energy recovery efficiency and deployment will determine stint lengths, overtaking opportunities, and pit stop frequency.

By integrating advanced energy recovery technology, teams will have the ability to:

- Extend stints and reduce battery swaps, improving long-term race efficiency.
- Deploy extra power strategically, optimizing acceleration for overtakes and key race moments.
- Optimize braking and suspension energy recovery, ensuring teams extract maximum usable power from every lap.

The success of a team's regeneration strategy will depend on their ability to fine-tune software, optimize braking performance, and strategically redeploy stored energy. In a championship where every fraction of a second matters, the teams that master energy recovery and deployment will have a clear advantage in the race for victory.

7.2 Trade-Off Between Power Output and Energy Efficiency

Endurance racing is defined by the delicate balance between **outright performance** and **energy conservation**. Unlike internal combustion engines (ICE), where fuel flow rates limit power output, electric endurance racing allows teams to deploy **full power at any time**. However, doing so comes at a cost—**increased battery depletion** and **more frequent pit stops**. The challenge lies in finding the **optimal balance between power output, energy efficiency, and race strategy**.

Key Trade-Offs in Energy Management

Electric endurance racing requires teams to **weigh the benefits of peak performance against energy sustainability**. Unlike ICE endurance racing, where fuel consumption decreases vehicle weight over a stint, electric cars maintain **constant weight throughout the race**. This fundamental difference shifts the focus from **weight reduction strategies to efficiency management**.

The **three primary trade-offs** in energy efficiency include:

1. **Multi-Speed Strategy: Peak Power Without Peak Waste**

With a 6-speed drivetrain, teams can achieve competitive acceleration and top-speed performance **without forcing the motor to operate inefficiently at the extremes** for long periods.

- **Lower Motor RPM at High Vehicle Speed:** Taller ratios reduce sustained motor RPM on straights, lowering inverter switching losses, reducing heat build-up, and improving endurance efficiency.
- **Higher Torque Multiplication at Low Speed:** Shorter ratios reduce the need for sustained high current at low speed, improving launch efficiency, reducing thermal loading, and improving drivability in traction zones.
- **Stint Efficiency Through Ratio Choice:** Instead of simply lowering power output to extend stints, teams can extend stints by optimizing which gears are used in which track sectors, maintaining lap time while reducing energy waste.

Strategic implication: the gearbox gives teams a third lever beyond "attack vs conserve":

1. power mapping, 2) regen strategy, **3) ratio strategy**.
   The best teams will maintain pace with fewer thermal penalties and fewer forced power reductions late in stints.

2. Energy Harvesting vs. Performance Stability

Regenerative braking and suspension-based energy recovery **improve efficiency**, but they also introduce **handling considerations** that teams must navigate:

- **Aggressive regenerative braking** recaptures significant energy, but excessive use may affect **brake feel, stopping distance, and driver confidence**.
- **Suspension-based energy recovery** can extend range, but tuning the system too aggressively may impact **ride quality and tire wear**, especially when striking curbs.
- The optimal **energy harvesting strategy** will depend on how much energy a team wants to regain without **compromising performance and vehicle stability**.

3. Thermal Management and Energy Efficiency

Battery temperature regulation is critical in endurance racing. Excessive power usage leads to **higher battery temperatures**, which can:

- **Reduce energy efficiency** (high heat increases resistance within the battery, reducing power output).
- **Shorten battery lifespan** over the race distance.
- **Trigger performance-limiting failsafe's**, causing the car to automatically reduce power to protect battery health.

Teams must **actively manage battery temperature** by:

- **Optimizing cooling systems** to handle repeated charge/discharge cycles.
- **Controlling power deployment** to prevent overheating.
- **Adjusting regenerative braking intensity** to balance energy recovery with heat build-up.

Strategic Implications of the Power vs. Efficiency Trade-Off

How teams manage this balance will directly affect race results. Over a **350-lap race at Le Mans**, even a **small gain in efficiency** could result in:

- **Fewer battery swaps** (saving 30–60 seconds per stop).
- **Reduced energy waste**, allowing more aggressive stints later in the race.
- **Optimised cooling**, preventing battery overheating and performance loss.

Teams that master this trade-off will have a clear advantage, proving that in endurance racing, **efficiency is just as important as outright speed**.

7.3 Pit Stop Execution and Efficiency Improvements

The introduction of **battery swapping** in electric endurance racing revolutionizes pit stop dynamics, replacing traditional **refuelling** while maintaining the strategic importance of pit lane efficiency. Given the high speeds and long stints of **Le Mans-style endurance racing**, teams must develop **precise, rapid, and safe pit stop procedures** to minimize downtime and ensure optimal energy deployment.

Battery Swap Pit Stop Regulations

To maintain **competitive fairness, efficiency, and safety**, the following **battery swap regulations** will be enforced across all teams:

1. Swap Procedure

- **Vehicle Immobilization**: Before battery removal, the car must come to a complete stop in the designated pit box.
- **Lifting and Securement**: The vehicle will be lifted off the ground using a standardised automated lifting system, ensuring safe and efficient access to the underside-mounted battery.
  - **High-Voltage Shutdown**: The **Battery Management System (BMS)** will automatically disconnect power, isolating the high-voltage system before any physical interaction with the battery.
- **Battery Exchange**:
  - **Manual Swaps**: Teams using manual pit crew operations may employ a limited number of crew members (typically **2-4** mechanics) to detach, remove, and install a fresh battery.
  - **Automated Swaps**: Teams opting for **robotic-assisted battery swaps** can use preapproved semi-automated systems, reducing human intervention and increasing precision.

2. Concurrent Pit Work

Unlike **internal combustion engine (ICE) pit stops**, where refuelling and tire changes must often be **staggered for safety reasons**, electric pit stops allow for **simultaneous servicing**, streamlining the process:

- **Tire Changes**: Teams can replace all four tires while the battery swap is taking place.
- **Driver Changes**: A new driver can enter the car while the battery is being exchanged, optimizing overall pit stop duration.
- **Brake Cooling Adjustments**: As electric race cars rely heavily on regenerative braking, cooling components may be checked and adjusted simultaneously during a pit stop.

This **multitasking capability** ensures that overall **pit stop times remain competitive with traditional endurance racing**, typically ranging between **30-60 seconds per stop**.

Transmission Thermal Conditioning and Post-Swap Readiness

Battery swaps reset available energy, but they do not reset drivetrain temperature. A multi-speed endurance drivetrain introduces additional thermal and mechanical readiness considerations that directly affect pit strategy.

- **Gearbox Oil Temperature Management:** Teams may choose to "cool-down shift" prior to pit entry (ratio selection that lowers motor RPM and load) to reduce transmission oil temperature before the stop.
- **Post-Swap Torque Management:** After a swap, teams may run a short "re-initialization window" where torque delivery and shift aggressiveness are temporarily limited to protect dog-ring interfaces and stabilise temperatures.
- **Shift System Health Checks:** Automated diagnostics may verify actuator position, gear confirmation, and dog-ring engagement timing during the pit sequence to prevent post-exit shift failures.

- **Pit Exit Ratio Strategy:** Teams may select pit exit gearing to prioritize reliability and traction rather than immediate peak acceleration, especially in wet conditions or heavy traffic.

Strategic implication: pit stops become not only energy resets, but also **drivetrain reset opportunities**, where teams decide whether to prioritize immediate pace or drivetrain longevity for the next stint.

3. Safety Measures

- **FIA Electric Safety Marshals**: Battery swaps will be **closely monitored** by designated FIA marshals to enforce strict **high-voltage safety protocols**.
- **Damage Inspection Protocols**: If a battery shows signs of damage (e.g., overheating, casing deformation, or voltage irregularities), it must be **immediately removed from circulation** and inspected before reuse.
- **Thermal Management**: Heat from **rapid charge and discharge cycles** will be closely monitored to **prevent thermal runaway incidents**, with **active cooling** applied post-removal.
- **Automated High-Voltage Lockout**: Before handling, the BMS will engage a **high-voltage isolation mode**, ensuring **no live current is present** in the battery connectors.

4. Battery Rotation and Recharge Strategy

- **Charging & Energy Rotation**: Unlike ICE teams that refuel at each stop, electric endurance teams will **rotate batteries**—removing depleted units and replacing them with freshly charged packs.
- **Battery Stock Limits**: To **prevent excessive battery swapping advantages**, the **total number of available battery packs per team** may be **regulated** (e.g., a **three-battery limit per car** for the entire race).
- **Charging Constraints**: Removed batteries will undergo **high-speed recharging** in the paddock, subject to **FIA-mandated maximum charging rates** to ensure **equal energy access** across all competitors.

Strategic Implications of Efficient Pit Stops

The efficiency of battery swaps will play a **pivotal role** in race strategy:

- **Well-executed pit stops** can minimize time loss and **maintain track position**.
- **Optimizing swap frequency** versus **stint length** will determine race-winning strategies.
- **Teams that master synchronised pit operations** (battery swaps, tire changes, and driver rotations) will gain **crucial seconds per stop**, adding up to significant advantages over a 24hour race.

The introduction of **battery swap-based pit stops** ensures that electric endurance racing maintains the **high-intensity strategy** of traditional Le Mans racing while leveraging **cutting-edge EV technology**. With standardised **safety measures, battery management protocols, and advanced pit stop techniques**, The Automobili La'Bergitla Endurance Series retains the **thrill, precision, and unpredictability** of endurance motorsport while ushering in a **new era of electric competition**.

7.4 Driver Strategy Adjustments Based on Energy Management

In **electric endurance racing**, the role of the driver extends beyond speed and consistency—**energy management becomes a crucial tactical component**. Unlike traditional internal combustion engine (ICE) racing, where **fuel consumption dictates pit strategy**, electric racing introduces **dynamic energy deployment strategies**, making **real-time decision-making** critical for race success.

Use of Recovered Energy

One of the **unique advantages** of electric endurance racing is that **regenerated energy** from braking and suspension recovery can be deployed **without restrictions**. This allows drivers to **incorporate recovered energy into their driving strategy** to maximize efficiency and **gain competitive advantages** throughout a stint.

Tactical Energy Deployment Approaches:

Strategic Energy Surplus:

- Drivers may choose to **conserve energy** in the early laps of a stint to **build a power reserve**.
- This extra stored energy can then be used for **push laps, overtakes, or strategic final-lap sprints**.
- Just as fuel-saving tactics are critical in ICE racing, **energy-saving techniques** in electric racing will influence the **timing of high-performance runs**.

Regenerative Braking Optimization:

- Drivers must adjust their **braking technique** to **maximize energy recovery**.
- **Early braking vs. late braking trade-off**:
  - **Early braking** increases regen efficiency but may compromise cornering speed.
  - **Late braking** maintains speed but limits energy recovery.
- **Brake-by-wire systems** will allow **precise regeneration control**, meaning that teams and drivers can customize **brake balance settings** to suit different driving styles.

Tire Management via Regenerative Braking:

- Unlike ICE vehicles that lose weight as they burn fuel, **electric cars maintain a consistent mass** throughout a stint.
- This changes **tire degradation dynamics**, requiring drivers to adjust their **energy recovery tactics** to avoid excessive wear.
- Over-aggressive regen settings may cause **uneven tire wear**, forcing drivers to balance regen efficiency against **tire longevity**.

Reliability vs. Maximum Attack

While **drivers may be tempted to always push full power**, **battery and motor thermal management** will ultimately define **how aggressively they can race**. Endurance racing is about **balancing speed and efficiency**, and in an electric format, **thermal limitations add a new layer of complexity**.

Key Factors in Energy and Heat Management:

Battery and Motor Cooling Considerations

- High-power deployment generates **significant heat**, affecting both **battery performance and longevity**.
- Running at **maximum attack mode** for extended periods may lead to **overheating**, **power loss**, or **battery degradation**.
- Teams will monitor **live telemetry** to instruct drivers when to **conserve energy** for thermal stability.

Driver-Controlled Shifting as a Strategic Weapon

The homologated 6-speed sequential system increases driver influence over both performance and efficiency. Gear choice is no longer purely a speed tool — it is an energy and thermal tool.

- **Overtake Mode via Ratio Selection:** Drivers can choose a lower gear for short bursts of acceleration when deploying supercapacitor energy for overtakes, then shift early to reduce sustained current draw.
- **Thermal Management Through Shifting:** Early upshifts reduce motor and inverter thermal load during long stints; delayed shifts may be used briefly in qualifying-style "push laps" but at increased thermal cost.
- **Traction Control Through Gear Choice:** In low-grip conditions, drivers can select a taller gear to reduce wheel torque, improving stability and tyre preservation.
- **Regeneration Feel and Balance:** Drivers can select ratios that keep regen predictable under braking, improving brake confidence and reducing tyre flat-spot risk.
- **Dog-Ring Protection Driving Style:** Because engagement is clutchless, drivers must work within calibrated shift windows; aggressive throttle during shifts risks shock loading and long-stint degradation.

Strategic implication: your best endurance drivers will be those who can run consistent lap time while using gears to manage temperature, traction, and energy — not merely to chase peak acceleration

Controlled Energy Deployment for Endurance Stints

- Unlike sprint races where energy can be fully depleted, **endurance racing demands strategic power allocation**.
- A driver running at peak output **early in a stint** may be forced to **reduce power output** later to avoid overheating.
- Teams may implement **software-limited power curves** that **gradually adjust** energy deployment based on **remaining stint length**.

Adaptive Driving Based on Track and Weather Conditions

- Cooler ambient temperatures may allow for **higher power deployment** due to improved **battery cooling efficiency**.
- Warmer conditions may require **drivers to back off slightly** to avoid thermal cut-offs.
- **Rain conditions** change regen effectiveness—**teams must adjust strategies** to prevent lockups or **instability under braking**.

The strategic depth of **electric endurance racing** mirrors that of **traditional endurance motorsport**, but with **new dimensions of battery management, energy recovery, and pit stop execution**.

1. **Weight Dynamics & Tire Strategy:** Unlike ICE cars that burn fuel and reduce weight over a stint, electric race cars **maintain a consistent mass**. This alters tire degradation patterns, requiring a **fresh approach to tire and grip management**.
2. **Battery Swap Considerations:** With **pit stops revolving around battery swaps rather than refuelling**, **teams must coordinate swap timing carefully** to **maximize race performance without losing track position**.
3. **Aggression vs. Efficiency Balance:** Since there are **no artificial deployment restrictions**, **teams must create their own balance** between **energy conservation and all-out attack mode** to optimize race stints.

The future of **Le Mans-style endurance racing** is here, and it is **powered by electricity**—demanding a **fusion of strategy, technology, and driving expertise** to claim victory.

7.5 Multi-Speed Drivetrain Strategy and Gear Usage Planning

The homologated 6-speed electro-mechanical transmission introduces a new strategic layer to electric endurance racing. Gear selection is no longer purely a function of vehicle speed, but a critical tool for managing **energy efficiency, regenerative recovery, thermal load, and drivetrain reliability** across a full race distance.

Teams must develop integrated **gear usage strategies** that balance performance demands with long-term component protection.

Sector Gear Plans (Track-Specific Optimization)
Teams will create **sector-by-sector gear usage maps** tailored to each circuit layout.

These plans define:

- **Optimal gear selection zones** to maintain the motor within peak efficiency RPM ranges
- **High-speed ratio usage** to reduce sustained motor RPM and inverter thermal load on long straights
- **Low-speed ratio strategy** to improve torque multiplication while minimizing current spikes out of slow corners
- **Corner-exit gear choices** that balance traction, tire preservation, and energy draw

Sector gear plans become a key performance differentiator, as the most efficient ratio usage over a lap can reduce total energy consumption without sacrificing lap time.

Attack vs Conserve Shift Profiles
Teams may program multiple **shift behaviour profiles** within regulatory limits, allowing the car to adapt to different race phases.

Attack Profile

- Later upshifts to maximize acceleration
- Faster torque reinstatement after shifts
- Increased supercapacitor deployment during lower-gear exits
- Higher thermal and energy consumption

Conserve Profile

- Earlier upshifts to lower motor RPM
- Smoother torque ramps during gear changes
- Reduced current spikes and drivetrain stress
- Improved thermal stability and extended stint length

Drivers may switch between approved profiles depending on traffic, overtaking needs, or endurance phase of the race.

Regen-by-Gear Calibration

The multi-speed drivetrain allows teams to fine-tune regenerative braking characteristics through gear selection.

- Lower gears may increase motor RPM during braking, improving regen response in medium-speed deceleration zones
- Higher gears can moderate regen torque at very high speeds, improving stability and reducing rear-axle lock risk
- Gear-dependent regen mapping allows smoother energy recovery transitions, reducing tire slip and brake temperature imbalance
- Teams may calibrate regeneration routing between supercapacitors and battery storage based on gear, braking severity, and thermal state

This makes regeneration not only a braking system parameter, but also a **transmission-linked energy recovery strategy**.

Reliability and Operational Safeguards

To ensure durability of the dog-ring engagement system and electro-mechanical actuator, the following reliability principles apply:

Shift Windows

- Gear changes must occur within approved motor torque and RPM thresholds
- The control system must prevent engagement outside calibrated speed differentials to avoid dog-ring shock loading

Gear Confirmation Logic

- All shifts must be verified through position sensors or actuator feedback
- Incomplete engagements must trigger automatic torque limitation until confirmed

Actuator Health Monitoring

- Shift actuator position, response time, and current draw must be continuously monitored
- Abnormal actuator behaviour must trigger a failsafe strategy limiting shift aggressiveness

Driver Override Restrictions

- Driver-initiated shifts that would cause mechanical over-rev or unsafe engagement conditions must be electronically rejected

These safeguards ensure that aggressive race strategy does not compromise long-term drivetrain integrity during endurance competition.

Strategic Significance

The multi-speed drivetrain transforms gear selection into a **core endurance management tool**.

Teams that successfully integrate sector planning, adaptive shift strategies, regen-by-gear calibration, and reliability management will gain measurable advantages in:

- Energy efficiency
- Thermal stability
- Tire longevity
- Overtaking capability
- Drivetrain durability

In The Automobili La'Bergitla Endurance Series, the gearbox is not merely a transmission — it is a **strategic energy and performance management system** that shapes how races are won over long distances.

7.6 Thermal and Drivetrain Preservation Strategy

In electric endurance racing, outright speed alone does not determine success. Long-term performance depends on a team's ability to manage **thermal load and mechanical stress** across the entire drivetrain system — including the battery, motors, inverters, and the homologated multi-speed transmission.

Unlike short sprint formats, endurance racing rewards teams that maintain **consistent operating temperatures, stable efficiency, and component reliability** over extended stints and varying environmental conditions.

Thermal and drivetrain preservation therefore become fundamental elements of race strategy.

Integrated Thermal Management Philosophy

All major propulsion components operate within interconnected thermal limits. Excessive heat in one system can cascade into others, reducing efficiency and increasing failure risk.

Key interconnected thermal relationships include:

- **Battery Temperature ↔ Power Delivery**
  Elevated battery temperatures increase internal resistance, reducing efficiency and potentially triggering power derating.

- **Motor Temperature ↔ Gearbox Load**
  Sustained high motor torque and RPM increase thermal load in both the motor windings and the transmission gear meshes.
- **Inverter Temperature ↔ Current Efficiency**
  Higher inverter temperatures increase switching losses, reducing overall drivetrain efficiency, and increasing cooling demand.
- **Transmission Oil Temperature ↔ Mechanical Durability**
  Excessive gearbox temperatures reduce lubrication effectiveness and increase wear on dog-ring engagement surfaces and gear teeth.

Teams must manage these systems as a **single thermal ecosystem**, not as isolated components.

Stint-Based Thermal Planning

Endurance strategy requires teams to plan not only energy usage but also **thermal cycles across each stint**.

- **Opening Phase Management**
  Drivers may avoid sustained maximum deployment early in a stint to allow drivetrain temperatures to stabilize after pit exit.
- **Mid-Stint Thermal Equilibrium**
  Teams aim to operate within an optimal temperature band where efficiency is highest and cooling systems can maintain balance without excessive drag or power draw.
- **End-of-Stint Protection**
  As temperatures rise late in a stint, teams may reduce peak deployment or adjust shift profiles to prevent thermal spikes before the next pit stop.

Gearbox-Specific Preservation Techniques

The homologated 6-speed electro-mechanical transmission introduces additional preservation considerations:

- **Shift Aggressiveness Control**
  Smoother torque modulation during shifts reduces shock loading on dog-ring engagement surfaces.
- **RPM Management Through Ratio Selection**
  Taller gears on long straights reduce sustained motor and gearbox rotational speeds, lowering thermal build-up.
- **Pre-Pit Cooldown Strategy**
  Drivers may adopt a reduced-load shift profile before pit entry to lower transmission oil temperature ahead of service periods.
- **Lubrication System Efficiency**
  Teams must ensure transmission oil cooling remains effective without creating excess aerodynamic drag or parasitic energy loss.

Battery and Power Electronics Preservation

Thermal control of the battery and inverter directly influences stint length and late-race performance.

- **Controlled Power Deployment**
  Continuous maximum output increases battery temperature and may trigger automatic derating. Strategic pacing helps maintain stable output over longer periods.
- **Regeneration Balance**
  Excessive regenerative input can increase battery thermal load. Teams must balance recovery with cooling capacity.
- **Cooling System Trade-Offs**
  Aggressive cooling improves component longevity but may increase aerodynamic drag or energy draw from auxiliary systems.

Driver Role in Drivetrain Longevity

Drivers play an active role in preserving drivetrain systems through:

- Smooth throttle application to reduce torque spikes
- Compliance with shift timing cues from the control system
- Adjusting pace in response to thermal warnings or energy management instructions
- Modulating braking style to balance regeneration with stability

Endurance drivers must combine speed with mechanical sympathy, ensuring that performance today does not compromise reliability hours later.

Strategic Impact Over a 24-Hour Race

Effective thermal and drivetrain preservation can yield decisive advantages:

- Fewer forced power reductions due to overheating
- More consistent lap times late in stints
- Reduced risk of mechanical or electrical failure
- Greater flexibility in attack phases during the closing stages of the race

In The Automobili La'Bergitla Endurance Series, victory will not belong solely to the fastest car, but to the team that best manages **heat, energy, and mechanical stress** across the full endurance distance.

Thermal discipline is therefore not a defensive tactic — it is a **performance strategy in its own right**.

8. Alignment, Safety, and Charging Infrastructure

As **electric endurance racing** transitions into a high-performance, 24-hour format, **race infrastructure must evolve** to accommodate the **unique requirements of battery-powered prototypes**. Unlike traditional **internal combustion engine (ICE) endurance racing**, where **refuelling and pit stops** revolve around liquid fuel storage and flow rates, **electric racing demands specialised charging, alignment, and safety protocols** to ensure smooth, efficient, and safe race operations.

This section examines **the technological advancements and regulations** governing **battery alignment, charging infrastructure, and safety protocols**—each designed to **minimize downtime**, **reduce operational risks**, and **enhance competitive fairness** in The Automobili La'Bergitla Endurance Series.

Core Areas of Alignment, Safety, and Charging Protocols

Battery Alignment Systems for Swapping Efficiency

- **Standardised Quick-Connect Mounting**: Battery packs must align perfectly with **chassis integrated docking points** to ensure secure and **fast replacement** during pit stops.
- **Automated Locking and Release Mechanisms**: To **eliminate human error**, pit crews will use **precision-guided locking systems** that securely attach battery packs to the vehicle with minimal effort.
- **High-Precision Sensors for Docking Accuracy**: **Magnetic and optical sensors** ensure that the battery swap process is **seamless**, preventing misalignment that could lead to **power connection faults**.

Automated and High-Speed Charging Infrastructure

- **Off-Track Charging Stations**: Unlike conventional fast-charging solutions, **swappable batteries will be charged outside of the vehicle** in **dedicated high-power charging hubs**.
- **Ultra-Fast Charging (600–800 kW)**: Battery packs will be charged at speeds significantly faster than road-going EVs, ensuring **quick turnaround** between stints.
- **Battery Rotation Strategy**: Each team is allocated a fixed number of battery packs, requiring them to manage **charging cycles efficiently** while ensuring compliance with race energy limits.

Safety Mechanisms and Fail-Safe Protocols

- **High-Voltage Isolation Systems**: Before any pit work, the **battery's electrical system automatically disconnects**, ensuring that no high-voltage power remains active during a swap.
- **Thermal Monitoring & Fire Suppression**: Integrated **cooling systems and suppression materials** mitigate the risk of **thermal runaway** in extreme race conditions.
- **Emergency Shutdown Features**: In the event of a **collision or system failure**, an **automatic safety cut-off** disengages power to protect the driver, pit crew, and race marshals.

With **advanced alignment, safety, and charging protocols**, **The Automobili La'Bergitla Endurance Series** is setting a **new benchmark for electric endurance racing operations**. **Efficient battery swaps**, **high-speed off-track charging**, and **robust safety measures** ensure that teams can **push the limits of performance while maintaining safety and fairness**.

As **electric endurance racing continues to evolve**, the **standardization of infrastructure and safety technologies** will become the **foundation for future global electric racing series**, paving the way for a **sustainable, high-performance future** in motorsport.

8.1 Advanced Ultrasonic and Machine Vision-Based Alignment System

To ensure **fast, precise, and seamless battery swaps** or **conductive charging sessions**, an **automated alignment system** is implemented, positioning the car **within millimetre precision** inside the pit box. This technology eliminates the need for **manual adjustments**, ensuring **smooth and efficient docking, charging, and battery exchange operations**.

In high-speed endurance racing, where **seconds gained in the pit lane** can make the difference between **victory and defeat**, an **intelligent, automated alignment system** is crucial for minimizing downtime and preventing misalignment errors.

Key Components of the Alignment System

Ultrasonic Sensors for Real-Time Positioning

- **High-frequency ultrasonic sensors** are installed around the pit box and battery-swapping station to detect the car's **exact position** as it enters.
- These sensors **measure distance and trajectory**, ensuring the car aligns **perfectly** with the **battery docking rails or conductive charging contacts**.
- **Automated calibration systems** adjust the docking position dynamically, allowing for **real-time correction** if minor misalignment occurs.

Machine Vision and LIDAR-Based Positioning

- A **high-speed camera system** paired with **LIDAR (Light Detection and Ranging)** scans the car's entry **speed, angle, and position** upon arrival.
- **Machine learning-based image recognition** processes vehicle trajectory, allowing for **instant corrections** if the car approaches at a suboptimal angle.
- **Heads-Up Display (HUD) Driver Feedback**: Real-time **guidance overlays** on the **driver's HUD** or **steering display**, ensuring optimal entry positioning **without requiring pit crew intervention**.

Magnetic and RFID-Based Docking Indicators

- **Embedded magnets and RFID chips** inside the pit lane provide **secondary verification**, ensuring the vehicle **aligns correctly** with either the **charging station** or **battery swap mechanism**.
- **Docking confirmation system** triggers **audible and visual alerts** when the car is **accurately positioned**, signalling the crew or automated system to begin the swap, or charging process immediately.

Advantages of the Alignment System

Minimised Pit Stop Delays

- **Automated precision docking** allows for **instant battery swaps or charging**, ensuring pit stops remain within the target **30–60 second range**.

Prevents Misalignment Errors

- Eliminates **manual alignment issues** that could delay swaps or conductive charging, ensuring **maximum efficiency**.

Enhanced Driver Assistance

- Reduces reliance on **pit crew hand signals**, allowing the driver to focus entirely on **exit timing and re-joining the race at optimal track position**.

Seamless Compatibility with Automated Pit Systems

- Facilitates **future robotic pit crew operations**, enabling **AI-driven battery swaps and automated maintenance** without manual intervention.

The **Advanced Ultrasonic and Machine Vision-Based Alignment System** ensures that **battery swaps and high-speed charging operations** remain **precise, efficient, and error-free**. By leveraging **ultrasonic positioning, LIDAR scanning, machine vision, and RFID docking**, this system eliminates **costly misalignments**, **optimizes pit stop execution**, and **enhances team strategy**.

With this **next-generation alignment technology**, **The Automobili La'Bergitla Endurance Series** reinforces its **commitment to innovation**, ensuring that **EV endurance racing matches or surpasses the operational efficiency of traditional endurance racing** while setting **new benchmarks for precision and automation** in motorsport.

8.2 Automatic Switching Between Inductive and Conductive Charging

While **battery swapping** remains the **primary method for in-race energy replenishment**, **inductive (wireless) charging** serves as the **default charging solution** during maintenance stops, pit lane prerace preparation, and between qualifying sessions. Conductive (plug-in) charging is also available in specific scenarios where rapid replenishment is required.

A **smart automatic switching system** ensures that the **most efficient charging method** is selected based on **real-time race conditions, battery state-of-charge (SoC), and strategic energy management needs**.

Inductive Charging (Wireless Charging) – The Default Charging Method

Inductive charging is the **primary energy replenishment system** for all non-race charging situations. Using **resonant magnetic coupling**, it transfers energy wirelessly, ensuring **seamless battery charging** without the need for mechanical connectors.

Key Features of Inductive Charging:

- **Default Charging Mode** – Used for all stationary energy replenishment, including **garage charging, pit lane maintenance, and overnight race preparation**.
- **No Mechanical Wear or Connector Risks** – Eliminates wear and tear, misalignment issues, and mechanical failures associated with plug-in systems.
- **High-Efficiency Energy Transfer** – Uses **resonant magnetic coupling** to ensure fast, seamless charging with minimal energy loss.
- **Supports Ultra-Fast Charging Rates (300 kW+)** – Capable of providing significant energy top-ups over short durations, making it ideal for non-race scenarios.
- **Alignment Safety Measures** – The system automatically disables charge transmission if the vehicle is not correctly positioned, preventing energy waste and misalignment errors.

Ideal Use Cases:

- **Charging between qualifying sessions and race stints.**
- **Pre-race battery conditioning to ensure optimal SoC before the start.**
- **Energy replenishment during extended maintenance or safety car periods.**
- **Non-competitive endurance testing where rapid energy restoration is unnecessary.**

Conductive Charging (Plug-In / Fast Charging Dock) – The Alternative for Rapid Energy Top-Ups

For specific situations where **battery swapping is impractical** and **inductive charging cannot meet energy demands**, conductive DC fast charging provides a **high-speed, direct power transfer** solution.

Key Features of Conductive Charging:

- **Ultra-Fast DC Charging (800V–1000V architecture)** – Enables high-speed replenishment of battery energy levels, reducing downtime.
- **600 kW+ Charging Rates** – Provides rapid charging for specific use cases, ensuring a **significant charge boost in minutes**.
- **Conductive Charging Plate Located on the Base of the Battery** – Ensures seamless docking with pit lane charging infrastructure.
- **Fully Automated or Manual Connection Options** – Allows compatibility with both **robotic pit crew systems** and **manual team-assisted operations**.
- **Fail-Safe Auto-Disconnect System** – Automatically disengages charging if misalignment occurs or if the connection is improperly secured.
- **Liquid- and Air-Cooled Charging Connectors** – Prevents overheating, ensuring safe and efficient energy transfer under extreme loads.

Ideal Use Cases:

- **Emergency charging situations if battery swaps are unfeasible due to race conditions.**
- **Strategic long pit stops where a high-power charge is needed instead of a swap.**
- **Supplementary energy replenishment when inductive charging alone is insufficient.**

Smart Switching Mechanism: Optimizing Energy Replenishment

A **real-time Charging Control System** manages the automatic switching between inductive and conductive charging based on:

- **Race Conditions** – Pit stop duration, tire changes, driver swaps, and overall strategy.
- **Battery State-of-Charge (SoC)** – Whether a top-up or full recharge is required.
- **Infrastructure Availability** – Ensuring the most efficient energy transfer method is used at any given time.

Automated Selection Criteria:

- **Inductive Charging → Default mode for non-race pit stops, garage maintenance, and extended downtime.**
- **Conductive Charging → Activated when energy replenishment is required but battery swapping is impractical.**
- **Battery Swapping → Always prioritised for in-race pit stops to ensure instant energy refresh.**

Failsafe Priority Protocols:

- **Inductive charging remains the primary choice** for all non-competitive energy replenishment.
- **Battery swapping is prioritised during race pit stops** unless otherwise dictated by strategy.
- **Conductive charging serves as a backup option** when inductive charging alone is insufficient, or a rapid charge is required.

By integrating **inductive, conductive, and swappable battery systems**, **The Automobili La'Bergitla Endurance Series** provides teams with **unparalleled flexibility** in managing energy replenishment.

The **inductive charging system**, embedded in **pit lane and garage infrastructure**, ensures **safe, efficient, and high-speed wireless energy transfer**, making it the **default charging method** for all **non-race** situations. Meanwhile, **conductive charging plates** provide **an alternative for rapid energy top-ups**, complementing **battery swaps** as the **primary race energy replenishment method**.

This **multi-layered charging strategy** optimizes **efficiency, reliability, and competitive fairness**, reinforcing **electric endurance racing's** commitment to **cutting-edge energy management solutions** while maintaining the **historic strategic depth of Le Mans racing**.

8.3 Smart Charging Base Design and Integration

The **charging bases** located in pit garages and paddocks are engineered to seamlessly integrate **inductive and conductive charging** while adhering to **strict safety, efficiency, and regulatory standards**. These smart charging bases ensure **precise alignment, rapid power transfer, and real-time data monitoring**, enabling teams to optimize their **energy replenishment strategies** during race and non-race conditions.

Core Features of the Smart Charging Base

1. Automated Charging Docking Interface

To eliminate manual errors and ensure **seamless energy transfer**, the **charging base automatically adjusts to the car's position**, providing a **secure and reliable connection** for both inductive and conductive charging.

Key Capabilities:

- **Motorised, Retractable Conductive Connectors:** The charging base features self-adjusting **conductive charging plates** that align with the **underside-mounted battery** for direct power transfer.
- **Self-Aligning Auto-Lock Mechanisms:** Secure connection points prevent **accidental disconnections**, ensuring uninterrupted energy transfer.
- **Auto-Release Safety Function:** If the car starts moving prematurely, the charging system automatically disengages, preventing damage to the vehicle or charging base.
- **Dual-System Compatibility:** Works **seamlessly with both inductive and conductive** charging technologies, allowing flexible race strategies.

2. Adaptive Charging Speeds & Load Balancing

To prevent **overloading** the energy infrastructure and to **optimize battery longevity**, the smart charging base dynamically adjusts its power delivery based on **real-time energy demands and race conditions**.

Key Capabilities:
Automatic Power Adjustment: Charging speed is dynamically regulated based on:

- **Battery Temperature** – Ensuring cells remain within an optimal thermal range.
- **State of Charge (SoC)** – Adjusting power input to prevent overcharging.
- **Real-Time Racing Strategy** – Prioritizing rapid charge or slow trickle charge based on team decisions.
    - **Dynamic Load Balancing:** The system **distributes power** efficiently across **multiple charging stations**, preventing infrastructure overload.
    - **Battery Pre-Conditioning:** Ensures **optimal temperature regulation** before the car re-enters the race, enhancing battery efficiency and performance.

3. Race-Specific Energy Storage Integration

To support high-power charging without stressing the electrical grid, the **pit lane charging stations** integrate **energy storage solutions**, enabling **fast, consistent power delivery**.

Key Capabilities:
High-Capacity Energy Buffers: Each charging base is equipped with either:

- **Supercapacitors** – To handle short bursts of high-power demand.
- **Battery Storage Units** – To store excess energy and deliver it when needed.
    - **Grid-Friendly Charging:** The system **draws power gradually from the main grid** while ensuring immediate **high-power output** during peak demand periods.
    - **Multi-Team Energy Allocation: Smart grid technology** ensures that power is distributed fairly among all teams, **preventing power supply bottlenecks**.

4. Wireless Data Synchronization & Telemetry

Real-time **data monitoring and AI-driven analytics** allow teams and race control to track **charging status, energy flow, and predictive maintenance needs**.

Key Capabilities:

- **Automated Charge Logging:** Every **charging event is logged**, creating a **detailed energy usage record** for performance optimization.
- **Real-Time Battery Status Tracking:** The charging base transmits **live data** to race engineers, enabling:
  - **Instant charge status updates**
  - **Battery health monitoring**
  - **Optimised energy deployment planning**
    - **AI-Driven Predictive Analytics:** Smart algorithms help teams determine **ideal timing for battery swaps or pit charging**, factoring in **energy consumption trends and race strategy**.

The **smart charging base system** represents a **technological leap forward** in electric endurance racing, ensuring that **charging infrastructure supports high-performance, energy-efficient, and safety-compliant operations**.

By **seamlessly integrating inductive and conductive charging**, **automated alignment systems**, and **real-time telemetry**, **The Automobili La'Bergitla Endurance Series** delivers a **cutting-edge energy replenishment strategy** that maximizes efficiency while preserving the **competitive balance of endurance racing**.

This **advanced energy ecosystem** ensures that teams can **recharge, monitor, and optimize battery performance** with minimal downtime, allowing them to **focus on racing** while pushing the limits of **electric endurance competition**.

8.4 Safety Features: Over-Current, Over-Voltage, and Fire Suppression Systems

Safety is a top priority in high-performance electric racing. Given the high-voltage systems, energy density, and extreme race conditions, **The Automobili La'Bergitla Endurance Series** incorporates **multiple fail-safe mechanisms** to **prevent electrical hazards, thermal incidents, and system failures**. These safety measures protect **drivers, pit crews, and race officials** while ensuring the reliability and integrity of the competition.

1. Over-Current and Over-Voltage Protection

Electric race cars operate at extremely high voltages (800V-1000V) and power outputs (500kW+). Uncontrolled **voltage spikes or excessive current draw** can **damage battery cells, power electronics, and high-voltage components**. To prevent such failures, the system employs **real-time monitoring and automatic shutdown protocols**.

Key Safety Mechanisms:

Battery Management System (BMS) Oversight:

- Continuously tracks voltage, current, and power flow to prevent **overload conditions**.
- Predictive algorithms **anticipate failures** before they occur, reducing the risk of sudden system shutdowns.

Active Current-Limiting Circuits:

- Automatically adjusts power draw to prevent **excessive electrical loads**, protecting both the **battery and vehicle electronics**.
- Reduces stress on **supercapacitors and auxiliary electrical systems** during high-demand phases.

Automatic Power Cut-off:

- If unsafe voltage or current levels are detected, the **BMS immediately shuts down power flow** and **alerts the team and race control**.
- Isolation switches ensure that **only affected systems are shut down**, allowing other vehicle components to continue operating safely.

2. Automatic Fire Suppression System

Lithium-ion and solid-state batteries pose **unique fire risks** due to the potential for **thermal runaway** if a cell becomes damaged or overheated. To mitigate this, **all race cars, charging stations, and pit garages** are equipped with **specialised fire suppression technologies** tailored for high-energy battery systems.

Key Safety Mechanisms:
Thermal Camera Monitoring:

- **Real-time temperature scanning** of all battery cells, with AI-driven **hotspot detection**.
- If abnormal heat build-up is detected, **early-warning alerts** are issued to teams and race control before reaching critical temperatures.

Multi-Stage Fire Suppression:

- **Inert Gas Deployment:** Floods battery compartments with **argon or nitrogen gas**, **displacing oxygen** and reducing fire spread.
- **Dielectric Coolant Spray:** Releases **non-conductive coolant** directly onto overheated battery cells to **neutralize runaway reactions**.
- **Automatic Disconnection from the Power Source:** If overheating is detected, **the car's electrical system isolates itself** from the battery to prevent further energy transfer.

Battery Fire Containment Protocols:

- Pit garages feature **dedicated battery fire containment stations**, designed to **quarantine damaged or overheated battery packs**.
- Damaged batteries can be **isolated in thermal-resistant enclosures** until they can be safely cooled or removed.

3. Emergency Shutdown and Isolation Systems

In the event of **electrical faults, crashes, or pit lane incidents**, an **emergency shutdown mechanism** ensures that all **high-voltage components are instantly deactivated** to prevent injury or further damage.

Key Safety Mechanisms:
High-Voltage Disconnect Switches:

- **Instant manual or automatic shut-off** of the car's electrical system in case of a critical failure.
- Ensures pit crews and emergency responders can handle the vehicle safely.

Cell-Level Isolation Technology:

- If a **single battery module is damaged**, the system **isolates that specific module** while allowing the rest of the battery pack to continue functioning.
- Prevents **cascading damage** that could lead to total battery failure.

Failsafe Venting Mechanisms:

- Designed to **reduce internal pressure build-up** in overheating battery cells, preventing **explosive failures**.
- Ensures **controlled heat dissipation** in extreme operating conditions.

Safety Lock-Out Procedures:

- Pit crews **cannot access battery compartments** unless the **high-voltage system is fully discharged and secured**.
- **Remote shutdown capabilities** allow race control to disable a car's electrical system if needed.

Ensuring Safety, Efficiency, and Competitive Integrity

The integration of **machine vision-based alignment, adaptive charging systems, and robust safety protocols** ensures that **electric endurance racing is as safe, efficient, and reliable as possible**.

Key Safety Benefits:

- **Rapid and precise battery swaps** with **millimetre-accurate docking** to prevent misalignment issues.
- **Flexible, adaptive charging infrastructure** that adjusts dynamically to race conditions.
- **Fail-safe electrical isolation** to prevent high-voltage hazards.
- **Comprehensive fire suppression and emergency shutdown systems** to protect drivers, teams, and officials.
- **Future-proofed technology**, allowing for **seamless integration of next-generation batteries and charging advancements**.

By **pushing the boundaries of electric vehicle safety**, **The Automobili La'Bergitla Endurance Series** sets new standards for **EV endurance racing**, ensuring that high-performance competition remains **both thrilling and secure**. The **future of endurance motorsport is electric**, and it is built on **cutting-edge safety engineering, meticulous design, and innovative technology**.

9. Competitive Balance and Performance Regulations

As **The Automobili La'Bergitla Endurance Series** pioneers the future of electric endurance racing, maintaining **competitive fairness** while fostering **technological innovation** is critical. Unlike traditional endurance racing, where fuel flow rates, engine configurations, and Balance of Performance (BoP) measures ensure parity, this **fully electric championship requires a unique regulatory framework** tailored to battery-powered endurance prototypes.

The governing body will oversee **performance standardization, energy allocation limits, and enforcement mechanisms** to create **fair yet dynamic competition**. The goal is to allow manufacturers **technical freedom** within structured **regulatory parameters** that prevent excessive spending wars while ensuring exciting, strategic racing.

This section outlines the **key regulations governing competitive balance**, addressing standardization, energy management, and fair enforcement practices.

Core Principles of Competitive Balance

To create a **sustainable, competitive, and technologically progressive racing environment**, the following principles will guide all **performance regulations**:

Fairness Across All Teams

- No single manufacturer or team should have a **disproportionate advantage** based on proprietary energy storage or powertrain technologies.
- Standardised components, such as **battery packs and charging infrastructure**, ensure energy parity while allowing **freedom in vehicle design, aerodynamics, and software management**.

Encouraging Technological Innovation

- While **battery and power limits** will be enforced, teams can innovate in **powertrain design, regenerative efficiency, and energy deployment strategies**.
- **Advanced driver-assist systems**, such as AI-assisted energy recovery management, may be permitted if they align with fair competition regulations.
- **Drivetrain innovation is permitted** within energy and power limits, allowing teams to pursue single-speed simplicity or multi-speed efficiency strategies without altering peak performance parity.

Energy Management as a Core Performance Metric

- Instead of limiting outright power, teams will be governed by **energy-per-stint or energy-per lap regulations**.
- Strategic **energy deployment and recovery** will be as important as **raw speed**, ensuring that race strategy remains at the forefront.

Scalability for Future Developments

- Regulations will **adapt over time** to accommodate **advancements in battery technology, charging speeds, and energy efficiency**.

- Performance balancing mechanisms will be **continuously refined** to prevent a technological arms race that favours wealthier teams.

Regulatory Oversight and Performance Monitoring

The series will implement **several key regulatory measures** to ensure performance equity and limit excessive spending while maintaining exciting, high-speed endurance competition.

Standardised Battery Packs & Charging Infrastructure

- All teams must use the **officially homologated swappable battery pack**, ensuring equal energy storage capacity.
- Battery specifications (capacity, voltage, discharge rate) will be **uniform** to prevent **excessive competitive disparities**.
- Teams will **not be allowed to modify or enhance the battery chemistry**, ensuring a controlled technological playing field.

Energy Allocation & Deployment Limits

- Instead of traditional fuel-flow limits, teams will have an **energy-per-lap or energy-per-stint limit** to prevent excessive power usage.
- The total **energy replenished via regeneration (braking, suspension, supercapacitors)** will be accounted for within the **maximum usable energy limit** per stint.
- Teams that **exceed energy allocation limits** will receive **lap time penalties or pit stop time adjustments**.

Power Output and Performance Limits

- To maintain performance parity with existing **LMH and LMDh** prototypes, maximum power output will be **capped at 500 kW (~670 hp)**.
- Acceleration and **torque vectoring systems** must comply with **traction control regulations**, ensuring fair racing conditions.
- **Supercapacitor discharge power limits** may be introduced to prevent short-term, extreme acceleration advantages.

Drivetrain Architecture and Transmission Regulations

To ensure competitive parity while promoting innovation in electric propulsion systems, The Automobili La'Bergitla Endurance Series permits advanced multi-speed electric drivetrains within defined regulatory boundaries.

Unlike most electric racing formats that rely exclusively on single-speed reduction gearboxes, this championship recognizes the performance, efficiency, and strategic advantages of multi-speed transmissions in endurance competition.

Permitted Transmission Architectures

- Teams may utilize **single-speed or multi-speed gearboxes** within their electric drive units.
- Multi-speed systems may include **sequential electro-mechanical transmissions** using dog-ring engagement, provided they operate without friction clutches.
- Hydraulic shift systems are prohibited; **electro-mechanical actuation only** is permitted to reduce complexity and maintain reliability standards.

Multi-Speed Gearbox Regulations

To ensure reliability and prevent excessive mechanical complexity:

- Maximum number of forward gears: **6 forward ratios**
- Reverse gear: **Mandatory**
- Shifting must be controlled by an **electronic control unit (ECU)** coordinating torque modulation and shift actuation
- Clutchless operation only — torque interruption must be achieved through motor control

Performance Balancing Rationale

Multi-speed transmissions provide:

- Improved **motor efficiency at high speed**
- Reduced **thermal load on motors and inverters**
- Enhanced **energy efficiency across varying circuit types**

Because these systems improve efficiency rather than peak power, they are considered an **endurance optimization tool**, not a raw performance advantage. Therefore, they are permitted without additional Balance of Performance penalties.

Strategic Role in Competition

Gear ratio selection and shift strategy become part of racecraft:

- Teams may implement **sector-specific shift maps**
- Gear usage influences **energy consumption and regenerative efficiency**
- Drivers must manage **thermal load and mechanical stress** through gear selection

This ensures that drivetrain strategy, not just battery management, becomes a core competitive factor.

Aerodynamic and Weight Regulations

- Cars will have a **minimum weight of ~1,100 kg**, ensuring that teams do not compromise safety in pursuit of weight reduction.
- **Active aero systems** may be regulated to prevent an unfair advantage while still allowing efficiency improvements.
- **Downforce-to-drag ratio regulations** will be introduced to maintain performance similarities across different vehicle concepts.

Real-Time Monitoring & Penalties

Live telemetry data from each car will be **monitored by race control** to ensure compliance with energy usage limits.

Teams exceeding **maximum energy deployment per stint** will receive either:

- **In-race time penalties.**
- **Mandatory longer pit stops.**
- **Post-race energy audits with potential disqualification.**
    - **Automated penalty enforcement** will be implemented via real-time FIA tracking to prevent post-race disputes.

Balancing Innovation and Fair Competition

By enforcing **energy regulations, standardised components, and balanced performance limits**, The Automobili La'Bergitla Endurance Series ensures that **competition remains fair, exciting, and technologically progressive**.

The key takeaways:

- **Technical freedom** is preserved, allowing teams to develop their own **powertrains, regenerative strategies, and aerodynamic designs**.
- **Energy allocation rules** create a **strategic balance between outright performance and endurance efficiency**.
- **Regulatory oversight** prevents excessive disparities while maintaining the integrity of **Le Mans-style endurance racing**.

With a structured yet **flexible performance framework**, this championship will push **electric endurance racing to new heights**—combining **cutting-edge EV technology** with **the legendary spirit of Le Mans competition**.

9.1 Why a Standardised Battery is Essential for Fair Competition

In electric endurance racing, **energy storage and deployment** play a defining role in overall vehicle performance. Unlike traditional internal combustion endurance racing, where fuel flow rates and hybrid deployment strategies influence competitive balance, electric vehicles rely entirely on their **battery capacity, discharge efficiency, and energy regeneration systems**.

To prevent **unfair performance disparities** and excessive spending on proprietary battery technologies, **The Automobili La'Bergitla Endurance Series** mandates a **standardised swappable battery system** for all competitors. This ensures that the **competition remains focused on driver skill, powertrain optimization, and race strategy** rather than energy storage superiority.

Key Reasons for a Standardised Battery System

Ensuring Equalised Performance Across Teams

- A **homologated battery pack** ensures that all cars start each stint with the **same energy storage capabilities**, preventing teams from gaining an advantage through superior battery chemistry, capacity, or charge efficiency.
- Unlike traditional endurance racing, where fuel consumption rates can vary by engine design, an **equalised battery ensures a level playing field**, shifting the competitive focus toward **powertrain efficiency and energy recovery strategies** rather than battery superiority.

Cost Control & Sustainable Development

- The development of **high-performance battery technology is costly**, and without standardization, wealthier teams could invest heavily in **cutting-edge, lightweight, high-capacity battery chemistries**, creating an **unfair technological gap**.
- By mandating a **standardised pack**, the series **reduces financial barriers**, allowing **smaller teams to remain competitive** while still encouraging **powertrain and drivetrain innovations**.
- The removal of **custom battery R&D** prevents an escalating **spending war**, ensuring that **competition remains accessible and sustainable**.

Simplified Regulations & Streamlined Race Strategy

- A **single, standardised battery design** simplifies **technical regulations**, making it easier for teams to comply with **energy usage rules, pit stop procedures, and charging protocols**.
- **Standardised battery swapping** ensures that **pit stops are governed by strategy and efficiency**, rather than **variable charging times or inconsistent energy replenishment methods**.
- Ensures **uniform safety procedures** for battery handling, reducing the complexity of in-race operations and post-race energy audits.

Enhanced Safety and Reliability

- The **homologated battery system** is designed to withstand **endurance racing conditions**, ensuring **thermal stability, impact resistance, and controlled energy output**.
- Without a **standardised battery**, different teams could deploy **experimental chemistries**, potentially leading to **thermal runaway risks, inconsistent degradation rates, or charging irregularities**.
- FIA-approved **fire suppression**, **over-voltage protection**, and **emergency isolation systems** are integrated into the standardised battery pack to **minimize safety hazards** across all competitors.

Allowing Innovation Beyond the Battery

While the **battery pack itself is standardised**, **teams are still free to innovate in other key areas**, including:

- **Powertrain Efficiency** – Teams can optimize **motor efficiency, inverter design, and torque vectoring** to gain an edge.

- **Energy Recovery Strategies** – Regenerative braking, **suspension energy harvesting**, and **supercapacitor integration** allow teams to **maximize energy usage** within regulations.
- **Aerodynamics & Chassis Design** – Teams retain **full freedom over vehicle aerodynamics**, ensuring a balance between **downforce, drag, and power efficiency**.
- **Software & Race Strategy** – **Power deployment strategies, AI-assisted energy management, and real-time telemetry adjustments** remain unrestricted, allowing for **advanced tactical decision-making**.

A Balanced Approach to Competition

A **standardised battery system** ensures that electric endurance racing remains **fair, cost-effective, and performance-focused**. By **equalizing energy storage capabilities**, teams must develop **race winning strategies** through:

- **Optimised energy deployment and regeneration**
- **Powertrain efficiency improvements**
- **Driver skill and race craft**
- **Innovative software-driven performance enhancements**

By **regulating energy storage while allowing flexibility in vehicle design**, **The Automobili La'Bergitla Endurance Series** ensures that the **spirit of endurance racing is preserved**, while pushing **cutting-edge EV technology to its limits** in a highly competitive motorsport environment.

9.2 Performance Parity Without Limiting Innovation

The Automobili La'Bergitla Endurance Series is committed to fostering **close, competitive racing** while allowing manufacturers and teams to push the **boundaries of electric racing technology**. To achieve this, the regulations aim to **equalize performance potential without stifling innovation**, ensuring that **engineering excellence, driver skill, and race strategy** determine success rather than budget size or access to exclusive technologies.

Unlike **one-make electric racing series**, where all vehicles use identical components, **The Automobili La'Bergitla Endurance Series** permits **teams to develop their own powertrains, aerodynamics, and energy recovery systems**, while enforcing **strict performance parity rules** to **maintain fair competition**.

Balancing Performance with Technical Freedom

To ensure **competitive parity**, key areas of vehicle design are **regulated**, while others remain **open for innovation**:

Motor and Powertrain Development

- Teams are **free to develop their own electric motors, inverters, and drivetrains**, provided they adhere to **power output and efficiency regulations**.
- Maximum power output is **capped at 500 kW (~670 hp)**, ensuring a level playing field across all competitors.

- **Torque vectoring and electronic differential control** are unrestricted, allowing teams to develop unique power delivery strategies.
- Manufacturers can **choose between single-motor (rear-wheel drive) or dual-motor (all-wheel drive) setups**, provided they remain within the energy usage limits.
- Teams may develop **multi-speed electric transmission systems** (up to six forward gears) to optimize efficiency, thermal management, and power delivery, provided all systems comply with clutchless electro-mechanical shift regulations.
- **Energy deployment strategies** are left to each team, allowing optimization for different track conditions.

Chassis and Aerodynamic Freedom

- Unlike spec-series racing, teams are **free to develop their own chassis and aerodynamic designs**, provided they conform to performance balance regulations.
- Aerodynamic elements (such as **active aero systems, downforce generation, and drag reduction**) are permitted but must remain within **set efficiency limits** to prevent excessive performance disparities.
- Minimum weight regulations ensure that **no team gains an unfair advantage through extreme weight-saving measures**.
- **Structural integrity and crash safety standards** must be met across all teams, ensuring **FIA approved vehicle safety** while maintaining **engineering freedom**.

Regenerative Energy Recovery Strategies

- While the **battery capacity is standardised**, teams have **full control over how they recover, manage, and deploy energy** throughout the race.
- **Regenerative braking systems** can be customised to maximize efficiency, but total energy recovery per lap must remain within FIA-set limits.
- Teams may integrate **regenerative suspension systems, energy buffering supercapacitors, and kinetic energy recovery systems (KERS)** to optimize energy efficiency.
- **Energy management software** remains unrestricted, allowing teams to develop unique strategies for balancing energy use and recovery.

Why This Approach Works

By **allowing freedom in design while capping performance metrics**, **The Automobili La'Bergitla Endurance Series** ensures:

- **Technology-Driven Competition** – Teams must find the most efficient ways to extract performance within the regulated power limits.
- **Fair Racing Without Artificial Equalization** – The **best-engineered cars and most skilled drivers** will prevail, rather than the best-funded teams.
- **Strategic Variability** – Different teams may **favour outright speed, energy conservation, or regeneration strategies**, leading to varied race strategies and unpredictable outcomes.

- **Continuous Innovation** – Unlike traditional Balance of Performance (BoP) measures that restrict progress, this system allows **cutting-edge electric racing technology** to evolve naturally.

Innovation Within a Competitive Framework

The Automobili La'Bergitla Endurance Series ensures that competition is **not dictated by financial muscle or proprietary technology dominance**, but by **engineering ingenuity, strategic brilliance, and driver ability**.

By **standardizing core performance metrics** while allowing **technical freedom in powertrain, aerodynamics, and energy recovery**, the series fosters a **thrilling, technologically advanced racing environment** where teams must **maximize efficiency, optimize race craft, and push the boundaries of electric endurance racing**.

9.3 Energy Allocation, Power Limits, and Balance of Performance (BoP)

To maintain **fair and competitive racing**, **The Automobili La'Bergitla Endurance Series** will implement a **Balance of Performance (BoP) system** that allows multiple engineering approaches to compete effectively. Given the nature of electric racing, **energy allocation, power limits, and efficiency strategies** will be carefully regulated to prevent one vehicle concept from becoming dominant.

Unlike traditional fuel-based endurance racing, where fuel tank size and refuelling speed can influence strategy, **electric endurance racing requires standardised battery energy limits and carefully controlled power outputs** to ensure close racing while allowing for **technical innovation**.

Key BoP Principles

To maintain fair and competitive racing, The Automobili La'Bergitla Endurance Series will implement a **Balance of Performance (BoP)** system that allows multiple engineering approaches within the Hypercar category to compete effectively.

Because this is a **single-class championship**, BoP is not used to separate classes, but instead to balance **different technical philosophies** — such as varying aerodynamic approaches, drivetrain layouts, cooling strategies, and energy efficiency solutions.

Unlike traditional fuel-based endurance racing, where fuel tank size and refuelling speed influence strategy, electric endurance racing requires **standardised battery energy limits**, **controlled power outputs**, and **regulated energy recovery** to ensure close racing while still allowing meaningful technical innovation.

Energy Allocation & Power Limits – Hypercar Class

All competitors race under the same core energy and power framework.

Maximum Power Output

- Maximum continuous power output: **500 kW (~670 hp)** delivered to the wheels

- Short-duration over-deployment beyond this limit is prohibited unless explicitly regulated via a future push-to-pass system

Regenerative Energy Limits

- Maximum permitted energy recovery: **8–10 MJ per lap**
- Limits apply to combined sources including braking regeneration, suspension energy harvesting, and supercapacitor buffering
- Prevents excessive advantages from extreme regeneration-focused setups

Total Energy Budget Per Lap / Stint

- Each car must operate within a defined **maximum usable energy allocation**
- This includes both battery discharge and regenerated energy
- Exceeding the allocation results in automated penalties

Minimum Vehicle Weight

- Minimum weight: **~1,100–1,200 kg including battery**
- BoP adjustments may include minor weight changes to balance different drivetrain layouts (single vs multi-motor, multi-speed vs single-speed

Drivetrain Concept Balancing

Because teams may pursue different efficiency philosophies — including **single-speed vs multi-speed gearboxes**, various motor counts, and differing aero strategies — BoP may consider:

- Energy consumption trends over stints
- Thermal degradation rates
- Acceleration vs efficiency trade-offs
- Regeneration effectiveness

This ensures that no single architecture dominates purely due to an efficiency loophole rather than overall engineering excellence.

Strategic Energy Deployment & Race Balance

By regulating energy use rather than dictating design, the series preserves strategic depth:

Power vs Endurance Trade-Offs

- Teams may run aggressive high-power strategies with more frequent swaps
- Or conserve energy for longer stints and fewer pit stops

Tactical Regeneration Usage

- Drivers and engineers must optimize braking zones and recovery settings without exceeding per-lap limits

Battery Swap Timing

- Energy strategy directly influences pit stop windows and race position

Fair Competition While Encouraging Innovation

This BoP framework ensures:

- **Close, single-class racing** without artificial class separation
- **Freedom in drivetrain, aero, and efficiency philosophy**
- **Energy strategy as a performance differentiator**
- **Prevention of runaway technical advantages**

Rather than equalizing cars into identical machines, The Automobili La'Bergitla Endurance Series balances **outcomes**, not **engineering creativity**.

This creates a championship where **innovation thrives**, but **victory is earned through efficiency, reliability, and racecraft** — not through regulatory loopholes.

Strategic Energy Deployment & Race Balance

By **carefully regulating energy use**, **The Automobili La'Bergitla Endurance Series** ensures that **racing remains a test of strategy, efficiency, and driver skill rather than just raw power output**.

Power vs. Endurance Trade-Offs:

- **Teams must decide between using full power for short, high-speed stints or conserving energy for longer runs**, reducing pit stops.
- Unlike **fuel-based endurance racing**, where weight decreases over a stint, **electric vehicles maintain a constant weight**, requiring different energy management strategies.

Tactical Regeneration Usage:

- **Drivers must optimize braking zones to maximize regen efficiency** without compromising handling or brake wear.
- **Suspension-based energy recovery** will allow small but valuable additional energy savings over a full race.

Pit Stop Planning Based on Energy Budgets:

- Teams will carefully plan **when to push and when to conserve** energy to **avoid unnecessary battery swaps**.
- **Regulatory oversight will ensure that teams adhere to per-lap energy budgets**, preventing excessive energy use outside of set limits.

Fair Competition While Encouraging Innovation

By **regulating energy allocation and ensuring performance parity** across different vehicle types, **The Automobili La'Bergitla Endurance Series** creates a **competitive and exciting endurance racing format** that rewards **efficiency, engineering brilliance, and strategic execution**.

- **Standardised energy budgets ensure fair racing across all teams.**
- **Balance of Performance regulations prevent technological disparities from dominating the series.**
- **Manufacturers retain freedom to innovate within clear performance limits.**
- **Drivers and teams must carefully manage power deployment and regeneration to maximize race performance.**

This balance ensures that **endurance racing remains competitive, unpredictable, and rewarding for both teams and fans**, setting a new benchmark for **electric endurance motorsport**.

9.4 Regulatory Framework for Compliance and Enforcement

Ensuring compliance with **The Automobili La'Bergitla Endurance Series** technical and sporting regulations is essential to maintaining a fair, competitive, and transparent racing environment. The **FIA technical stewards** will oversee all aspects of regulation enforcement, utilizing **advanced telemetry monitoring, pre- and post-race inspections, and strict penalty measures** for any violations.

This regulatory framework ensures that teams compete on **equal terms**, with **no undue advantage gained through excessive spending, energy overuse, or non-compliance with technical regulations**.

Key Enforcement Measures

To maintain integrity within the series, multiple layers of **compliance checks** will be applied:

Pre- and Post-Race Scrutineering

- All cars will undergo **detailed technical inspections** before and after each race.
- Officials will verify **weight, battery capacity, power output, aerodynamic components, and energy recovery system compliance**.

Telemetry-Based Monitoring & Real-Time Regulation Enforcement

- Each car is **monitored in real-time** using **advanced telemetry systems** that track **power output, energy usage, regenerative braking efficiency, and compliance with per-lap limits**.
- Race control receives **instant alerts if a car exceeds its energy allocation**, enabling **immediate intervention** if necessary.

Penalties for Power Overuse or Energy Mismanagement

- **Exceeding maximum power or energy usage limits** will result in escalating penalties:
  - **Minor infractions → Time penalties added to total race time.**
  - **Repeated violations → Drive-through or stop-go penalties.**
  - **Severe overuse or rule exploitation → Disqualification from results or exclusion from the race.**

Pit Stop Compliance & Battery Swap Oversight

- **Battery swaps must adhere to standardised procedural safety protocols**, including:
    - **Minimum stop times for safe handling of high-voltage systems.**
    - **Crew member limits to prevent pit stop imbalances.**
    - **Safe release procedures to avoid pit lane incidents.**
- **Pit lane rule violations** (e.g., unsafe releases, crew overreach) will result in **warnings, time penalties, or stop-go penalties** depending on severity.

Manufacturer Cost Cap Auditing

- To **prevent manufacturer teams from outspending privateer teams**, a **cost cap structure** will be **audited and enforced** by the FIA.
- This ensures that **factory-backed manufacturers cannot gain an unfair advantage** purely through financial means.

Driver Stint Regulations & Fatigue Management

- **Maximum and minimum stint lengths** will be strictly monitored to ensure fair driver rotation and prevent fatigue-related safety risks.
- Any team failing to comply will face **time penalties or driver-specific penalties** affecting their race classification.

Ensuring Competitive Integrity

The FIA and race organizers will **continuously monitor** the **effectiveness of the Balance of Performance (BoP) system**, ensuring **teams compete on a level playing field** while allowing for technical advancements.

Transparent BoP Adjustments

- **All Balance of Performance modifications** (e.g., weight, power adjustments) will be **fully disclosed to teams before each race** to maintain transparency.
- **BoP changes cannot be altered mid-race unless an extreme imbalance is detected** (e.g., unforeseen performance gaps due to a loophole or rule misinterpretation).

Mid-Season Adjustments & Technical Reviews

- **Post-race data analysis** will determine if **minor regulatory refinements** are needed for subsequent rounds.
- FIA **retains the right to make slight adjustments between events** to maintain competitive balance but will **not penalize successful teams retroactively**.

Grid Slot Fairness & Factory vs. Privateer Balance

- The championship **limits excessive factory entries** to **protect privateer competitiveness**.
- A **performance equalization system** prevents factory-backed teams from **dominating based solely on financial advantages**.

Technical Standardization in Safety-Critical Areas

- While teams have **freedom in powertrain and aerodynamic development**, certain **safety critical components** (e.g., **battery containment, emergency disconnects, high-voltage safety measures**) will be **common across all competitors**.
- This **ensures maximum safety** while preventing teams from gaining unfair advantages through expensive, proprietary safety technologies.

Ensuring Competitive and Engaging Racing

The **regulatory framework** governing **The Automobili La'Bergitla Endurance Series** ensures that **electric endurance racing remains a true test of skill, efficiency, and engineering ingenuity**.

1. **Standardised components ensure fair competition while still encouraging technical advancements.**
2. **Strict real-time monitoring enforces compliance with power, energy, and pit stop regulations.**
3. **Balance of Performance prevents one manufacturer or team from gaining an insurmountable advantage.**
4. **Transparent rule enforcement creates a level playing field for both privateer and manufacturer-backed teams.**

With a combination of **BoP, energy regulations, and cost cap enforcement**, this championship preserves **the core endurance racing principles of efficiency, strategic excellence, and driver ability**.

By **maintaining fairness and preventing regulatory exploitation**, **The Automobili La'Bergitla Endurance Series** championship **sets the gold standard for all-electric endurance racing**, ensuring that **technology, teamwork, and tactical brilliance determine success—not financial supremacy or rule loopholes**.

10. Marketing, Branding, and Sponsorship

As **The Automobili La'Bergitla Endurance Series** establishes itself as the premier **all-electric endurance racing championship**, a robust **marketing, branding, and sponsorship strategy** is vital. The series must **differentiate itself from traditional motorsport** while leveraging the growing global interest in **sustainability, electrification, and high-performance innovation**.

By strategically positioning the championship as a **technological showcase and an environmentally responsible alternative to traditional endurance racing**, it will **attract fans, commercial partners, and media coverage** while solidifying its place as a key player in motorsport's electric revolution.

This section explores the core initiatives designed to **increase visibility, drive fan engagement, and secure long-term sponsorship partnerships** that align with the series' values.

Key Marketing Objectives

Positioning the Championship as the Future of Endurance Racing

- **The Automobili La'Bergitla Endurance Series** will be promoted as the **pinnacle of electric endurance motorsport**, blending **sustainability, speed, and innovation**.
- The championship will emphasize **long-distance, high-performance electric racing**, contrasting shorter electric formats such as Formula E.
- The storytelling focus will highlight **cutting-edge battery technology, energy recovery advancements, and the strategic complexity of endurance racing**.

Sustainability as a Core Brand Identity

- The series will **actively promote its carbon-neutral objectives**, showcasing its commitment to **green energy, battery recycling, and eco-friendly logistics**.
- Marketing campaigns will reinforce the **impact of race-developed EV technologies** on **future consumer electric vehicles**, positioning the series as a **development ground for next generation automotive solutions**.
- Sustainable racing infrastructure (e.g., **renewable energy-powered paddocks, zero-emission logistics, and eco-conscious fan initiatives**) will be highlighted as part of the brand narrative.

Digital-First Engagement Strategy

- The championship will leverage **social media, esports, live streaming, and interactive content** to **engage younger, tech-savvy audiences**.
- **Behind-the-scenes access, team profiles, and real-time race data integration** will enhance storytelling and deepen fan engagement.
- AR (Augmented Reality) and VR (Virtual Reality) experiences will allow fans to immerse themselves in the **tactical and technological complexity** of electric endurance racing.

Branding Strategy: Creating a Unique Motorsport Identity

For **The Automobili La'Bergitla Endurance Series** to stand out among established motorsport categories, a distinct **visual identity, messaging approach, and cultural positioning** must be developed.

Defining the Championship's Visual Identity

- A sleek, **high-tech design language** incorporating **bold, futuristic typography, electric blue and neon-accented colour schemes**, and digital-inspired branding will differentiate the series.
- **Uniform branding across all race events, marketing materials, and digital platforms** will create a strong and consistent identity.

Developing an Emotional Brand Connection with Fans

- The championship will emphasize **human stories**, from **drivers and engineers** pushing the limits of EV racing to **the fans contributing to a sustainable racing future**.
- Highlighting **underdog teams, strategic battles, and technological breakthroughs** will create compelling narratives that resonate with a broad audience.

Aligning with Global Motorsport Heritage

- The **Le Mans name** carries **over a century of motorsport prestige**, and the series will embrace this legacy while positioning itself as the **next evolution of endurance racing**.
- Partnerships with **historic endurance racing teams and manufacturers** will reinforce credibility and legacy appeal.

Sponsorship & Commercial Partnerships

Targeting Sustainable & High-Tech Brands

- Sponsorship efforts will prioritize **automotive manufacturers, energy companies, battery technology leaders, and sustainability-driven corporations**.
- **Tech giants, AI developers, and semiconductor firms** will be engaged to showcase the role of **cutting-edge software and energy management solutions** in electric racing.
- **Renewable energy providers, EV charging networks, and environmental organizations** will be approached to **reinforce the series' sustainability credentials**.

Exclusive Automotive and EV Partnerships

- The championship will seek **exclusive sponsorship deals with leading EV manufacturers**, positioning the series as a **platform for testing and marketing next-generation electric vehicle innovations**.
- **Battery suppliers, energy storage companies, and advanced materials manufacturers** will have opportunities to showcase their technologies on a global stage.

Multi-Tiered Sponsorship Structure

- **Title Sponsor:** One exclusive brand will hold **naming rights** for the championship.
- **Official Suppliers:** Partner brands will provide **race technology, logistics, and sustainability solutions** (e.g., energy storage, AI race analytics, ultra-fast charging infrastructure).
- **Team & Driver Sponsors:** Individual teams and drivers will have **branding opportunities**, creating multiple sponsorship entry points.
- **Sustainable Initiatives & CSR Partners:** Corporate Social Responsibility (CSR) programs focused on **green energy, recycling, and emissions reduction** will be integrated into sponsorship packages.

Brand Activation & Experiential Sponsorship Opportunities

- Sponsors will have access to **fan interaction zones, EV test drive experiences, and behind the-scenes race technology showcases** at each event.
- **Augmented reality (AR) sponsorship activations**, allowing fans to interact with race technology, vehicle energy data, and pit stop simulations.
- **VIP hospitality & corporate engagement programs**, offering sponsors unique networking opportunities at high-profile racing venues.

Global Audience Engagement & Media Rights

To **maximize viewership and fan engagement**, the championship will adopt a **multi-platform broadcasting strategy** combining **live television, digital streaming, and social media content**.

Streaming & Digital First Approach

- The series will feature **live race streaming, on-demand content, and race analytics on global OTT (Over-the-Top) streaming platforms**.
- Short-form, **digestible race content** optimised for social media (e.g., Instagram Reels, TikTok, YouTube Shorts) will **target younger motorsport fans**.

Strategic Media Partnerships

- Global broadcast agreements will be secured with **major sports networks** to maximize TV exposure.
- Exclusive race insights, **real-time data overlays, and in-depth race breakdowns** will be integrated into broadcasts to differentiate the **electric endurance racing experience**.

Esports and Virtual Racing Integration

- A parallel **The Automobili La'Bergitla Endurance Series Esports Series** will engage gaming audiences, allowing fans to experience **simulated EV endurance racing with real-world physics and strategy elements**.
- **Team-run esports divisions** will create a **direct bridge between virtual and real-world racing**, attracting younger demographics into endurance motorsport.

Establishing a New Era in Motorsport Marketing

By implementing an **aggressive digital strategy, sustainability-focused branding, and strong commercial partnerships**, **The Automobili La'Bergitla Endurance Series** will secure its place as a **pioneering force in electric endurance racing**.

- **Positioning the series as the world's premier all-electric endurance championship.**
- **Leveraging sustainability as a core value to attract eco-conscious fans and sponsors.**
- **Using technology-driven storytelling and digital-first engagement strategies.**
- **Building a dynamic sponsorship ecosystem that aligns with cutting-edge automotive and green energy industries.**

With **global media reach, immersive fan experiences, and elite-level competition**, the series will **redefine motorsport for the electric age**—delivering **thrilling, high-tech endurance racing while leading the transition toward a sustainable motorsport future**.

10.1 Positioning the Series as a Cutting-Edge Motorsport Category

The introduction of an **all-electric endurance racing series** represents a **ground-breaking shift in motorsport**, blending **sustainability, high-performance competition, and advanced energy management strategies**. To establish its place in the global motorsport landscape, the championship must be positioned as a **leading-edge racing series that pushes the boundaries of electric vehicle (EV) technology while delivering thrilling, strategic, and competitive endurance racing**.

This section outlines the **core positioning strategies** that will define the championship's **identity, technological appeal, and sustainability-driven mission**.

1. The Future of Endurance Racing

This series will be promoted as the **next-generation evolution of endurance motorsport**, emphasizing its role in shaping the future of high-performance racing.

Key Differentiators from Traditional Endurance Racing:

- **Zero-Emission Competition:** The first endurance racing series to eliminate carbon emissions while maintaining the same strategic intensity as classic endurance events.

- **High-Speed, Long-Distance Racing:** Unlike Formula E, which focuses on short sprint races, this series will replicate the challenge of **multi-hour and 24-hour endurance racing**, proving that electric powertrains can compete in extreme conditions
- **Advanced Energy Strategy:** Unlike internal combustion engine (ICE) endurance racing, where fuel efficiency is managed through flow rates, this series introduces **real-time energy regeneration, battery swapping strategy, and hybridised supercapacitor deployment** as key elements of competitive racing.

Positioning Against Existing Motorsport Series:

- **Electric Alternative to Le Mans & WEC:** The series will be positioned as the **fully electric counterpart** to **the FIA World Endurance Championship (WEC) and the 24 Hours of Le Mans**, capitalizing on Le Mans' **prestige and history of innovation**.
- **The High-Performance Endurance Alternative to Formula E:** While Formula E represents **urban street racing with limited race durations**, this series will prove that electric motorsport can **match the scale and intensity of long-distance racing**.
- **A Platform for Future Automotive Technology:** Endurance racing has historically served as a **development ground for road car technology**, and this series will reinforce that legacy by advancing **battery performance, aerodynamics, and energy recovery systems** applicable to consumer EVs.

2. A Technology Innovation Platform

The series will serve as a **global proving ground for cutting-edge electric powertrains, battery swap systems, regenerative energy solutions, and AI-assisted race strategies**.

Key Technological Differentiators:

- **Ultra-Fast Battery Swapping:** Unlike traditional EV racing, which relies solely on charging, this series **eliminates downtime with rapid, pit-stop-style battery swaps**, mirroring refuelling strategies in traditional endurance racing.
- **Dual Supercapacitor Energy Buffers:** These systems **enhance energy recovery and power deployment**, setting a new benchmark in electric racing energy management.
- **Regenerative Shock Absorbers:** An industry-first implementation of **energy recovery from vehicle suspension**, proving that endurance racing can **maximize efficiency from every aspect of vehicle dynamics**.
- **AI-Optimised Energy Strategy:** Machine learning-driven race strategies will **analyse energy usage, tire degradation, and driver performance in real time**, assisting teams in maximizing efficiency over long stints.

Real-World Automotive Applications:

- **Battery Technology Development:** Lessons learned from **high-performance, long-duration electric racing** will translate directly to improvements in **consumer EV range, fast-charging solutions, and battery longevity**.
- **Energy Management Breakthroughs:** The deployment of **AI-driven regenerative braking strategies and smart power allocation systems** will shape the **next generation of electric powertrain efficiency** for road cars.
- **Aerodynamic Efficiency & Sustainability:** By prioritizing **low-drag, high-downforce designs**, manufacturers will develop **lighter, more energy-efficient EVs** that can extend range without sacrificing performance.

By establishing the championship as the **ultimate innovation lab for electric racing technology**, the series will attract **automotive manufacturers, energy companies, and technology leaders** looking to develop the next frontier of EV performance.

3. A Global Sustainability Movement

As governments, businesses, and consumers shift toward **clean energy and sustainability**, motorsport must evolve to reflect this transformation. **The Automobili La'Bergitla Endurance Series** will lead this change by demonstrating that **sustainability and high-performance racing can coexist**.

Sustainability as a Core Brand Pillar:

- **Zero-Carbon Racing:** The championship will **eliminate fossil fuel dependency** by ensuring that all race operations run on **renewable energy sources**, such as **solar, wind, and hydrogen-generated power**.
- **Circular Battery Economy:** The series will implement a **battery lifecycle management program**, ensuring that race-used battery packs are either **recycled, repurposed for consumer EVs, or reused in secondary energy applications**.
- **Eco-Friendly Logistics:** By optimizing **race transport, charging infrastructure, and event management**, the championship will maintain **low-carbon operations** throughout its global calendar.
- **Engaging a Sustainability-Focused Audience:** Modern motorsport fans demand **coconscious initiatives**, and this series will provide a **compelling, climate-positive motorsport experience** that appeals to environmentally aware viewers and sponsors.

Aligning with Global Climate & Energy Goals:

- The series will position itself as a **pioneer in sustainable motorsport**, aligning with **EU Green Deal policies, the UN's Sustainable Development Goals, and international emissions reduction targets**.
- Major **global brands focused on green technology, electric mobility, and carbon neutrality** will find a **perfect sponsorship platform** in a zero-emission racing series.

4. A New Level of Competition

The Automobili La'Bergitla Endurance Series championship will emphasize a **unique blend of strategic energy management, pit stop execution, and high-speed endurance racing**. Unlike traditional motorsport, which focuses purely on fuel conservation, this series introduces new competitive variables:

Key Competitive Differentiators:

- **Energy Management as a Core Skill:** Drivers will **actively manage their energy deployment**, using **regenerative braking, supercapacitors, and optimal battery swap timing** to gain a competitive advantage.

- **More Dynamic Pit Stop Strategies:** With **battery swaps, energy replenishment strategies, and tire changes occurring simultaneously**, the race will introduce a new layer of **pit lane decision-making and real-time adjustments**.
- **Class-Based Racing for Maximum Strategy Variability:** The series will feature multiple categories, including:
  - **Hypercar Class (500 kW power output)** – The top-tier category featuring the fastest electric endurance prototypes.
  - **LMP2-E Class (350-400 kW power output)** – A competitive feeder class ensuring close racing while maintaining a power differential from Hypercars.
  - **GT-E Class (varied power based on Balance of Performance)** – The electric evolution of GT racing, ensuring recognizable, production-based EV racing machines.

Bringing Endurance Racing Strategy into the Electric Era:

- Unlike sprint-based electric racing formats, this series will showcase **long-term race craft, tire preservation, and hybridised defensive/offensive driving techniques**.
- The **lack of mechanical fuel consumption changes** introduces a **new form of competitive parity**, requiring teams to **strategically manage energy resources** throughout a race.

By ensuring that the **racing remains unpredictable, strategic, and high-stakes**, the series will appeal to **endurance racing purists and electric vehicle enthusiasts alike**.

Establishing the Championship as a Flagship Electric Racing Series

To establish itself as a **leading-edge motorsport category**, **The Automobili La'Bergitla Endurance Series** will position itself as:

- **The premier global electric endurance racing championship.**
- **A cutting-edge innovation platform for EV and battery technology.**
- **A sustainability-driven motorsport series that aligns with global climate goals.**
- **A high-intensity, strategy-focused competition that delivers thrilling endurance racing.**

By combining **technology, sustainability, and competitive excellence**, this championship will **set the benchmark for the future of electric endurance racing**, ensuring that it stands alongside **Le Mans, the FIA WEC, and other premier motorsport events** as a revolutionary force in **the next era of racing history**.

10.2 Proposed Slogans and Brand Identity

A **distinctive and impactful brand identity** is crucial to establishing **The Automobili La'Bergitla Endurance Series** as a **pioneering motorsport series**. The branding must reflect the championship's

cutting-edge technology, electrified endurance spirit, and high-performance innovation, ensuring strong recognition among fans, manufacturers, and commercial partners.

1. Core Slogan: "Can't Rush Greatness"

The series will adopt a **powerful and memorable slogan** that encapsulates its core values of **meticulous engineering, strategic excellence, and the relentless pursuit of perfection in endurance racing**.

Primary Slogan:

- **"Can't Rush Greatness"** – Represents the precision, strategy, and innovation that define the championship. **Supporting Variations:**

- **"You Can't Rush Greatness"** – Used in promotional content, emphasizing the **engineering and dedication** behind each racing machine.
- **"We Can't Rush Greatness"** – Reinforces the **collective effort** of teams, drivers, and engineers in pushing the limits of EV endurance racing.
- **"Racing Toward the Future"** – Highlights the series' role as the **vanguard of electric motorsport innovation**.
- **"Where Speed Meets Sustainability"** – Communicates the balance between **high-performance racing and environmental responsibility**.

Application in Marketing:

- Integrated into **race broadcasts, promotional campaigns, merchandise, and digital content** to create a **cohesive and instantly recognizable brand message**.
- Featured prominently in **team uniforms, car liveries, and official event branding**.

2. Visual Branding: Defining the Championship's Aesthetic Identity

The **visual identity** of **The Automobili La'Bergitla Endurance Series** must convey:

- **Innovation and high-performance technology**
- **The electrified nature of the racing series**
- **Endurance, strategy, and cutting-edge design**

Logo Design Elements:

- **Sleek and futuristic typography** – A **modern, bold, and clean font** that reflects **advanced technology** and **precision engineering**.
- **Aerodynamic and digital aesthetics** – A **logo incorporating subtle speed lines or energy waves** to emphasize **motion and performance**.
- **Electric bolt or energy circuit integration** – Symbolizing the **electrification of endurance racing**.

Colour Palette:
The official **colour scheme** will emphasize **electric power, sustainability, and high-tech performance**:

- **Electric Blues & Neon Accents** – Representing **clean energy, speed, and cutting-edge technology**.
- **Metallic Shades (Silver, Black, Carbon Fibre)** – Communicating **premium performance and high-tech engineering**.
- **Sustainability-Inspired Greens** – Reinforcing the **series' commitment to eco-friendly motorsport solutions**.

Signature Typography:

- **High-tech, geometric sans-serif fonts** will be used for **official branding, sponsorship placements, and team materials**.
- The typography will reflect **precision, innovation, and a futuristic racing identity**.

Race Car Livery & Design Language:
The **official series livery design** will incorporate:

- **Dynamic energy flow patterns** – Symbolizing **electric power transfer and regenerative energy recovery**.
- **Striking contrast between bold, bright accents and deep, high-performance base colours**.
- **Subtle nods to Le Mans heritage** – Honouring the **iconic endurance racing lineage** while pushing the future of EV performance.

3. Branding Integration Across Digital & Physical Platforms

To **maximize audience engagement and commercial appeal**, the brand identity will be consistently applied across:

- **Race Cars & Team Uniforms** – Featuring the **official series colours, typography, and slogan placement**.
- **Broadcast & Digital Content** – Using **custom overlays, graphic elements, and energy inspired animations** to enhance **live race coverage**.
- **Merchandising & Fan Engagement** – Offering **branded apparel, collectibles, and digital NFTs** that reinforce the **futuristic, technology-driven racing identity**.
- **Marketing Partnerships & Sponsorship Branding** – Ensuring that **sponsors' logos are seamlessly integrated into the futuristic branding of the championship**.

Establishing a Powerful & Recognizable Motorsport Brand

The Automobili La'Bergitla Endurance Series branding will be a **fusion of electrified innovation, endurance strategy, and sustainability**, distinguishing it as **the premier electric endurance racing championship**.

By **leveraging a unique slogan, futuristic visual identity, and technology-driven aesthetics**, the series will stand out in the global motorsport landscape, attracting:

- **Automotive manufacturers looking to showcase EV innovation**
- **Sustainability-focused sponsors aiming to align with cutting-edge technology**
- **Fans and audiences eager for the next evolution of high-performance endurance racing**

Through **compelling storytelling, striking visuals, and a commitment to redefining motorsport**, **The Automobili La'Bergitla Endurance Series** will establish itself as the **benchmark for the future of electric endurance racing**.

10.3 Media Strategy and Fan Engagement

Maximizing media exposure and fostering **global fan engagement** is essential to establishing **The Automobili La'Bergitla Endurance Series** as a premier electric endurance racing championship. A **multi-platform approach** leveraging **live broadcasting, digital content, esports, and immersive fan experiences** will ensure **widespread reach and sustained engagement** across diverse audience demographics.

1. Live Broadcasting and Streaming: Expanding Global Reach

A **comprehensive live race coverage strategy** will ensure **high-quality broadcasting across traditional and digital platforms**, maximizing accessibility for global audiences.

TV Broadcast Partnerships:

- Secure agreements with **major sports networks** (e.g., **Sky Sports, Eurosport, ESPN, Fox Sports, NBC Sports**) to provide **live race coverage, pre-race analysis, and post-race breakdowns**.
- Expand coverage to **emerging motorsport markets**, ensuring **regional-language broadcasts** to engage a diverse international fanbase.
- Feature **dedicated behind-the-scenes content** on partner networks to enhance storytelling and build anticipation for race weekends.

Digital Streaming Platform:
Develop a **direct-to-consumer streaming service**, offering:

- **Live races** with customizable viewing angles (onboard cameras, pit lane feeds, telemetry overlays).
- **Exclusive team radio access** for deeper race insights.
- **Behind-the-scenes documentaries** covering teams, technology, and strategy.
  - Collaborate with major **online streaming platforms (Twitch, YouTube, Amazon Prime, Netflix Sports)** for broader exposure.

Social Media Live Feeds & Real-Time Race Updates:

- **Twitter/X and Facebook Live:** Instant updates, major race highlights, and live Q&A sessions.
- **Instagram & TikTok Live: Exclusive driver interactions, pit stop coverage, and energy deployment insights.**

- **YouTube Live & Interactive Race Companion:** Fans can follow along with **real-time leaderboard data and telemetry overlays.**

2. Social Media and Digital Content: Creating an Always-Connected Fanbase

A **dynamic digital presence** will engage fans through interactive content, gamification, and immersive storytelling.

Interactive Race Week Content:

- **Daily team updates, driver interviews, and technical breakdowns** provide in-depth analysis of race strategy.
- **Live data visualizations** illustrating real-time **energy recovery, battery swaps, and regenerative braking performance.**
- **Polls, prediction games, and fan challenges** increase engagement before and during race weekends.

Short-Form Video Clips & Viral Highlights:

Instant replay highlights of key overtakes, energy deployment tactics, and strategic pit stops shared on:

- **TikTok, Instagram Reels, YouTube Shorts, and Twitter/X.**
  - **AI-generated clips and race summaries** for quick, digestible content.
  - **Race weekend documentary-style shorts** highlighting key moments and dramatic battles.

Esports & Virtual Racing Integration:

- **Official esports racing league** where fans can race against professionals in simulated **The Automobili La'Bergitla Endurance Series events.**
- **Virtual Time Attack Leaderboards:** Fans can set lap times on virtual versions of race tracks using racing simulators like **iRacing, Gran Turismo, and Assetto Corsa.**
- **Pro vs. Fan Challenges:** Select fans compete against professional drivers in **live-streamed esports showdowns.**

Augmented Reality (AR) and Virtual Experiences:

- **Race Telemetry AR Overlays:** Fans can use their phones to **view live speed, battery charge levels, and driver stats** in real time.
- **Virtual Paddock Access:** AR-powered paddock tours offer **exclusive behind-the-scenes insights into team garages and race strategies.**
- **Holographic Race Visuals:** Large-scale AR activations at fan zones allow fans to **view energy deployment models and see how regenerative braking affects race strategy.**

3. On-Site Fan Experience: Immersing Fans in the Future of Motorsport

To **bridge the gap between digital and physical engagement**, The Automobili La'Bergitla Endurance Series will introduce **interactive fan zones, premium hospitality, and immersive experiences**.

Fan Zones & Technology Hubs:

- **Interactive EV Racing Tech Exhibits** – Fans can experience **battery swap simulations, regenerative braking demos, and high-voltage powertrain showcases.**
- **Sim Racing Pods** – Attendees can **test their skills in professional racing simulators** with leaderboards and prizes.
- **Driver Meet & Greet Sessions** – Fans get access to **autograph signings, panel discussions, and exclusive fan Q&As.**

VIP Electric Paddock Club:

- **Exclusive behind-the-scenes access** to team garages, pit lane action, and real-time race strategy discussions.
- **Premium hospitality with sustainability-focused menus** featuring locally sourced food and EV-powered catering services.
- **Special networking sessions** for **automotive executives, sponsors, and investors** to explore future motorsport innovations.

Sustainable & Digital Merchandise:

- **Eco-friendly race gear** made from **recycled materials and sustainable textiles.**
- **Collectible Digital NFTs** – Limited-edition race memorabilia in **digital form**, offering exclusive perks and VIP access.
- **AR-Enabled Merchandise** – Apparel and posters that **come to life through AR filters**, displaying holographic race stats and behind-the-scenes content.

Engaging Fans & Future-Proofing Motorsport Coverage

The Automobili La'Bergitla Endurance Series will **set new standards in motorsport media and fan engagement** by:

- **Blending traditional broadcasting with cutting-edge digital content** for a seamless global viewing experience.
- **Leveraging esports and interactive technologies** to bring fans closer to the action.
- **Offering immersive on-site experiences** that showcase the future of electric racing.
- **Creating a strong and sustainable brand identity** that appeals to motorsport enthusiasts, tech innovators, and environmental advocates alike.

With a **next-generation engagement strategy**, the series will **redefine how motorsport connects with fans**, ensuring **thrilling, accessible, and high-tech racing entertainment** for the electric era.

10.4 Attracting Sponsors and Investors

To ensure **financial sustainability and long-term growth**, The Automobili La'Bergitla Endurance Series must appeal to **forward-thinking sponsors and investors** who align with its vision of high-performance **electric endurance racing, sustainable innovation, and cutting-edge technology**.

This championship presents a **unique commercial opportunity** for brands seeking **global exposure in the EV revolution**, providing an **elite motorsport platform** to showcase advanced energy solutions, smart mobility, and sustainable development.

Key Sponsor Categories

1. Technology and Automotive Brands

The transition to all-electric endurance racing presents **a major marketing and R&D opportunity** for **automotive, energy storage, and AI-driven technology companies**. Target partners include:

- **Electric Vehicle (EV) Manufacturers:** Tesla, Porsche, BMW i, Rimac, Audi e-tron, Lotus EV, Mercedes EQ.
- **Battery and Energy Storage Leaders:** Panasonic, CATL, LG Energy Solution, Solid Power.
- **Charging Infrastructure Providers:** ABB, Shell Recharge, Electrify America, Ionity, ChargePoint.
- **Advanced AI & Software Developers:** Google AI, NVIDIA, Microsoft Azure, Qualcomm, AWS.
- **Smart Mobility & Autonomous Tech:** Waymo, Mobileye, Tesla Full Self-Driving (FSD), Bosch.

Value Proposition: These brands can use **The Automobili La'Bergitla Endurance Series** as a **live testbed** for next-gen **battery tech, AI-assisted racing, and autonomous race systems** under extreme performance conditions.

2. Sustainability and Renewable Energy Firms

The series aligns with **global climate goals**, making it an ideal partner for **sustainability-driven companies** in renewable energy, carbon-neutral solutions, and eco-friendly materials.

- **Solar & Wind Energy Companies:** Tesla Energy, Vestas, Ørsted, NextEra Energy.
- **Sustainable Lubricants & Fluids:** Castrol e-Fluids, Shell EV Fluids, Motul EV.
- **Circular Economy & Recycling Initiatives:** Umicore (battery recycling), Redwood Materials, BASF EV Materials.
- **Carbon Offset & ESG (Environmental, Social, Governance) Initiatives:** ClimatePartner, Verra, The Gold Standard.

Value Proposition: These companies can **showcase their commitment to green innovation** while leveraging the series to **promote electrification, sustainability, and carbon-neutral racing initiatives**.

3. Consumer Brands and Lifestyle Partners

Engaging **mainstream consumer brands** expands the **reach and cultural relevance** of the championship. These include:

- **Sportswear & Apparel Brands:** Nike, Adidas, Puma, Under Armour (sustainable performance gear).
- **Beverage & Energy Drinks:** Red Bull, Monster, Gatorade, sustainable brands like Oatly or Beyond Meat.
- **Technology & Entertainment Companies:** Apple, Sony PlayStation, Netflix, Hulu (documentary-style content production).
- **Luxury & Watch Brands:** TAG Heuer, Rolex, Hublot, Richard Mille (official timing partners).

Value Proposition: These companies gain **high-visibility branding** in a **premium motorsport category**, positioning themselves at the **intersection of speed, technology, and sustainability**.

4. Financial and Investment Firms

- **ESG & Impact Investment Funds:** BlackRock, Vanguard, JPMorgan Sustainable Investing.
- **Fintech & Blockchain Partnerships:** Visa, Mastercard, Ripple, Web3 brands for digital sponsorships.
- **Traditional Motorsports Financial Backers:** HSBC, UBS, and corporate banking sponsors looking to enter the EV space.

Value Proposition: The championship presents **high-value ESG sponsorship opportunities** for financial institutions backing **clean energy, impact investing, and next-gen sustainable motorsport ventures**.

Sponsorship Activation and Value Proposition

1. Exclusive Branding Opportunities

- **Naming Rights** – Title sponsorships for **races, teams, and championship trophies** (e.g., "ABB The Automobili La'Bergitla Endurance Series").
- **Official Sustainability Partner** – Green technology brands can sponsor **carbon-neutral race initiatives**.
- **Official Energy Partner** – Battery manufacturers and charging networks can be integrated as **exclusive power suppliers** for the series.

2. Innovative Advertising Models

- **Dynamic Digital Branding on Car Liveries** – E-ink display panels **enable real-time sponsor rotation** (used in Formula E Gen3).
- **Augmented Reality (AR) Sponsorships** – Virtual sponsor activations via **interactive pit lane AR experiences** for fans.
- **EV Tech Partner Showcases** – Teams work directly with **tech sponsors** to **integrate AI assisted racing**, **cloud telemetry**, and **machine learning strategies** into competition.

3. Sustainable Partnership Showcase

- **Carbon-Neutral Sponsorships** – Brands can showcase their **net-zero commitments** through on-track branding, pit zone activations, and fan engagement.

- **Technology Demos** – Sponsors can **demonstrate cutting-edge energy storage, regenerative braking, and AI race control solutions** in real time.
- **Sustainable Event Operations** – Race weekends will be **100% powered by renewable energy**, reducing the carbon footprint.

4. Tech Demonstration Platforms

- **Energy Storage & Grid Tech Testing** – The championship serves as a **real-world testbed** for **next-gen energy storage solutions**.
- **AI-Powered Race Strategy Trials** – Machine-learning algorithms from AI sponsors help teams **optimize energy efficiency & driver telemetry data**.
- **Smart Mobility R&D Partnerships** – Autonomous driving firms can integrate **self-driving technologies for pit lane automation** and **automated vehicle-to-grid (V2G) infrastructure**.

Analysis of Existing Sponsors in Motorsport

Understanding **current sponsorship trends** in motorsport provides **valuable insights** for **attracting partners**.

Formula 1 (F1):

- **Luxury & Consumer Brands:** McDonald's, Lego, Mattel's Hot Wheels, Louis Vuitton, Moët Hennessy, TAG Heuer (ft.com).
- **Tech & AI Integration:** Amazon Web Services (AWS) provides F1's cloud-based race strategy analytics.

Formula E:

- **EV & Sustainability Sponsors:** ABB, Jaguar, Envision Racing, Castrol, Michelin (en.wikipedia.org).
- **Renewable Energy Partners:** Supports net-zero carbon initiatives via **hydrogen fuel cell generators** in pit areas.

Le Mans 24 Hours:

- **Automotive Giants:** McLaren, Toyota, Peugeot, Ferrari.
- **Tech & High-Performance Partners:** United Autosports, Goodyear Racing, and Mobil 1 (unitedautosports.com).

Abu Dhabi Grand Prix:

- **Aviation & Energy Sponsorships:** Etihad Airways, ADNOC, Mubadala
- **Real Estate & Development Sponsors:** Aldar, providing **luxury race experiences** (yasmarinacircuit.com).

Silverstone Grand Prix:

- **Automotive, Financial & Consumer Goods Sponsors:** HSBC, Santander, Pirelli, DHL.

INDYCAR & NASCAR:

- **Tech & Telecom Partnerships:** Verizon 5G, Cisco, and Intel are integrating **real-time AI powered race analytics** in these series.

By **analysing these sponsorship trends**, The Automobili La'Bergitla Endurance Series can **target partners** that align with **sustainability, performance innovation, and global branding**.

Creating a Global Motorsport Phenomenon

Through **strategic marketing, branding, and high-value sponsorships**, The Automobili La'Bergitla Endurance Series can **redefine endurance racing** for the **electric era**. By securing **technology innovators, sustainability-driven corporations, and consumer lifestyle brands**, the championship can establish itself as **a premier motorsport event**.

- **Global Sponsorship Appeal** – Targeting **elite EV, AI, fintech, and consumer brands** to drive engagement.
- **Immersive Partner Activations** – Blending **dynamic branding, AR sponsorships, and interactive marketing**.
- **Financial Sustainability** – Ensuring **long-term commercial success** through diverse revenue streams.

With **innovative advertising models, sustainable branding initiatives, and a technology-driven identity**, the series will **attract world-class partners** and **establish itself as a dominant force in electric endurance racing**.

11. Conclusion

Electric endurance racing is not merely an evolution of motorsport—it is a revolution. By embracing cutting-edge **battery technology, regenerative energy recovery, and AI-driven race strategy**, The Automobili La'Bergitla Endurance Series is set to establish **a new benchmark in performance, efficiency, and sustainability**.

This championship is more than just a racing series; it is a **technology incubator** that will accelerate advancements in **high-density energy storage, ultra-fast charging, and intelligent powertrain systems**. These innovations will have **real-world applications**, influencing the next generation of **electric road cars, smart mobility solutions, and renewable energy integration**.

Key Takeaways: Why This Championship Matters

- **Pioneering Endurance Motorsport for the Electric Era** – The series proves that **EV technology** is capable of sustaining **24-hour endurance races**, matching and even exceeding the performance of traditional combustion-powered competitors.
- **A Strategic Battleground for Efficiency** – Unlike sprint-based electric racing, **The Automobili La'Bergitla Endurance Series** rewards **energy management, aerodynamics, and tactical power deployment**, making it a true **test of engineering and strategy**.
- **Revolutionizing Pit Stop Dynamics** – With the **introduction of battery swapping, regenerative energy recovery, and automated energy replenishment systems**, the race fundamentally changes how teams approach **stint planning and pit strategy**.
- **A Global Platform for Technology & Sustainability** – The championship is **a proving ground** for the **most advanced electric powertrains, supercapacitors, and AI-assisted racing software**, driving **faster adoption of EV technology** in mainstream mobility.
- **Commercially & Environmentally Sustainable** – The integration of **net-zero carbon operations, renewable energy infrastructure, and sustainable partnerships** ensures that this series aligns with **global climate goals**, reinforcing motorsport's role in **accelerating clean energy transitions**.

11.1 The Future of Electric Endurance Racing

Electric endurance racing is at the forefront of **motorsport evolution**, presenting a unique combination of **high-performance electrification, advanced energy strategies, and multi-class endurance challenges**. With **battery swapping technology**, regenerative energy recovery, and smart power management, this series **mirrors the strategic depth of traditional endurance racing while embracing the future of sustainable performance**.

As the series progresses, several **key factors** will shape its **growth, competitiveness, and global appeal**:

1. Increased Manufacturer Participation

With the **global transition to electric mobility**, endurance racing will become a **critical testing ground** for automakers developing next-generation EV technology. **Participation from legacy brands, emerging EV specialists, and independent innovators** will drive intense competition and rapid technological advancement.

- **Legacy Automakers** – Brands like Porsche, Toyota, Audi, and BMW, which already have endurance racing heritage, will leverage the series to develop their electric vehicle platforms.
- **EV Specialists** – Companies like Tesla, Rimac, and Lucid Motors could enter the championship to showcase high-performance electric technology in extreme conditions.
- **New Entrants & Privateer Teams** – The series' balanced regulations and standardised energy systems will enable **independent manufacturers and racing teams** to compete on a **level playing field**.

2. Global Expansion & Iconic Racing Destinations

To establish itself as a **world-class endurance championship**, the series will **expand globally**, integrating **legendary race circuits** and **urban street courses** that highlight the versatility and excitement of electric endurance racing.

- **Classic Circuits:** Expect venues such as **Le Mans, Nürburgring, Spa-Francorchamps, Fuji Speedway, and Daytona** to feature in the race calendar, maintaining the heritage of endurance racing.
- **New & Urban Races:** City circuits in **New York, Tokyo, Dubai, and London** could be added to showcase **high-speed electric endurance racing in metropolitan settings**, engaging a broader audience.
- **Sustainable Event Planning:** Races will **align with sustainable motorsport initiatives**, ensuring reduced carbon footprints through **renewable energy infrastructure, energy efficient logistics, and net-zero emissions policies**.

3. Regulatory Evolution & Technical Advancements

As the championship progresses, technical regulations will adapt to maintain fairness while allowing **open innovation** in **powertrain efficiency, aerodynamics, and energy recovery systems**.

- **Balanced Performance Regulations** – A **dynamic Balance of Performance (BoP)** will be continuously refined to maintain competitive parity while rewarding engineering ingenuity.
- **Battery & Powertrain Development** – Future iterations of the series could introduce **higher density solid-state batteries, AI-assisted race strategies, and modular energy storage advancements**.
- **Sustainability Targets** – Expect further regulations on **eco-friendly materials, carbon-neutral logistics, and sustainable tire solutions**, ensuring that the series sets a **global benchmark for sustainable motorsport**.

4. Next-Generation Fan Engagement & Digital Integration

The future of **electric endurance racing** will be defined not only by **on-track action** but also by **digital fan engagement** and **interactive experiences**.

- **Live Race Data & Interactive Broadcasts** – Advanced **telemetry dashboards**, real-time **energy deployment analysis**, and **AI-driven race predictions** will enhance viewer engagement.
- **Esports & Virtual Racing Leagues** – **Sim-racing championships** mirroring real-world endurance races will allow fans to compete alongside professional drivers in **hyper-realistic digital simulations**.
- **Augmented Reality (AR) & Second-Screen Experiences** – AR-enhanced race visuals and **360degree virtual pit tours** will immerse fans in the **technical and strategic elements** of endurance racing.
- **NFT & Digital Collectibles** – Limited-edition **digital race passes, driver cards, and historical race moments** could be introduced, engaging a new generation of motorsport enthusiasts.

A Pioneering Chapter in Motorsport

The future of electric endurance racing **is not just about replacing combustion engines with electric powertrains—it is about revolutionizing how endurance racing is approached, experienced, and advanced**.

- **Manufacturers** will race to **develop the most efficient powertrains**, pushing the limits of battery **technology, aerodynamics, and regenerative energy**.
- **Fans** will experience racing in a way that is **more interactive, immersive, and data-driven** than ever before.
- **Sustainability leaders** will witness a motorsport series that **redefines endurance racing as an environmentally responsible, high-performance global competition**.

By **continuously refining its technology, expanding to global circuits, and pioneering digital fan engagement**, **The Automobili La'Bergitla Endurance Series Championship** is set to **become one of the most compelling and forward-thinking racing series in motorsport history**.

The future **is electric, strategic, and faster than ever**—and this championship will lead the charge.

11.2 Transferring Motorsport Technology to Consumer EVs

Endurance racing has long been a **proving ground for automotive innovation**, with technological advancements developed for competition eventually shaping the **future of road cars**. The introduction of **all-electric endurance racing** accelerates this cycle, pushing the boundaries of **battery performance, aerodynamics, regenerative energy systems, and lightweight materials**.

The innovations driven by **The Automobili La'Bergitla Endurance Series** will **directly influence** the next generation of **consumer EVs**, improving their **efficiency, range, performance, and sustainability**.

1. Battery Efficiency and Longevity

- **Fast-Charging Capabilities:** The high-power charging solutions developed for racing—such as **800V+ architectures and ultra-fast energy replenishment systems**—will lead to quicker charging times for everyday EVs, making them more practical for consumers.
- **High-Density Energy Storage:** Advances in **solid-state battery chemistry** and **modular battery design** from endurance racing will improve **energy density**, allowing for **lighter, longer-lasting** EV batteries.
- **Thermal Management Systems:** Motorsport-driven **liquid cooling, phase-change materials (PCM), and predictive temperature regulation** will prevent overheating, increasing battery lifespan in road cars.

Real-World Impact:

Consumer EVs will **charge faster**, last longer, and maintain **higher efficiency in extreme conditions**.

2. Energy Recovery Systems

- **Regenerative Braking Optimization:** The high-output **motor-generators** developed for electric endurance racing will refine **braking efficiency**, **extending range** without sacrificing performance.
- **Suspension-Based Energy Harvesting:** Racing-developed **electromagnetic and piezoelectric suspension systems** will contribute to **micro-energy recovery**, improving vehicle efficiency over long distances.
- **Bidirectional Energy Flow:** The implementation of **vehicle-to-grid (V2G) technology** will allow future consumer EVs to **store and return energy to the grid**, enhancing sustainability and cost efficiency.

Real-World Impact:

Future EVs will **recover and reuse energy more efficiently**, leading to **increased range** and **lower energy consumption**.

3. Advanced Aerodynamics for Maximum Efficiency

- **Low-Drag Designs:** Motorsport aerodynamics will inspire **slippery, ultra-efficient** EV bodywork that minimizes air resistance while maintaining high stability.
- **Active Aero Integration:** Adaptive **drag-reduction systems (DRS), deployable air deflectors, and cooling vents** will be adapted from racing to **improve real-world EV efficiency**.
- **Optimised Underbody & Diffuser Technology:** Inspired by race car **venturi tunnels and underfloor aero**, road-going EVs will incorporate **smooth underbody panels** to maximize efficiency.

Real-World Impact:

Road EVs will **achieve higher range without increasing battery size**, thanks to **low-drag, race developed aerodynamics**.

4. Lightweight Materials and Chassis Design

- **Carbon Fibre & Composite Innovations:** Racing will drive advancements in **ultra-lightweight materials** that **reduce EV mass** without compromising **structural integrity**.
- **Multi-Material Chassis Construction:** The combination of **carbon composites, aluminium alloys, and advanced polymers** will improve **crash safety while maintaining strength and rigidity**.
- **Additive Manufacturing & 3D-Printed Components:** Motorsports' use of **3D-printed structural parts** will lead to **stronger, lighter, and more efficient production methods** for consumer EVs.

Real-World Impact:

Lighter EVs will require **less energy to operate**, improving **efficiency, handling, and acceleration**.

5. AI & Vehicle Autonomy Integration

- **Machine Learning-Based Power Management:** Race-derived **AI algorithms** will **predict and optimize energy usage**, improving efficiency in **real-world driving conditions**
- **Automated Driving Enhancements:** Endurance race technology will accelerate **autonomous features**, including **AI-assisted cornering, real-time energy deployment, and smart braking systems**.
- **Telemetry & Predictive Maintenance: Cloud-based diagnostics**, learned from motorsport data analysis, will help **detect potential failures** before they occur in consumer EVs.

Real-World Impact:

Future EVs will feature **smarter energy use, predictive self-maintenance, and advanced autonomous driving systems**, improving **safety, range, and driving experience**.

Motorsport as the Future of Consumer EV Development

The innovations driven by **The Automobili La'Bergitla Endurance Series** will play a **pivotal role** in shaping the **next generation of electric road cars**. **High-speed endurance racing forces automakers to push the limits of EV performance, efficiency, and durability**, creating technologies that will benefit everyday consumers.

- **Faster charging, higher energy density, and improved regenerative braking** will make EVs **more practical and sustainable**.
- **Aerodynamic advancements and lightweight materials** will **increase range** and **performance efficiency**.

- **AI-driven energy management** will optimize real-world EV usage, making **electric mobility smarter and more adaptive**.

By serving as an **open innovation laboratory**, electric endurance racing will **fast-track** cutting-edge **battery technology, energy recovery systems, and intelligent vehicle systems** into **mainstream automotive production**.

The future of performance, sustainability, and efficiency begins on the racetrack—and soon, it will be in every electric vehicle on the road.

11.3 Sustainability Through Performance Innovation

Sustainability is a **core pillar** of electric endurance racing, ensuring that cutting-edge **technological advancements** contribute to a greener future **without compromising performance**. The Automobili La'Bergitla Endurance Series is dedicated to reducing environmental impact while **setting new standards** for sustainability in motorsport.

This commitment extends across **vehicle design, race operations, logistics, and long-term energy strategies**, ensuring that every aspect of the series contributes to a **net-zero carbon future** while maintaining the **thrill and intensity of endurance racing**.

1. Renewable Energy-Powered Charging

The transition to **all-electric endurance racing** creates an opportunity to **redefine energy use in motorsport**. Rather than relying on traditional fossil-fuel-powered grids, the series will implement **renewable energy solutions** for charging infrastructure, ensuring a **carbon-neutral footprint**.

- **Solar and Wind Energy Integration:** Race tracks and pit facilities will incorporate **solar farms and wind turbines** to generate sustainable power.
- **Energy Storage Solutions:** High-capacity **battery buffers and supercapacitor storage units** will ensure consistent **clean energy supply** throughout race weekends.
- **Hydrogen Fuel Cells for Off-Grid Charging:** In remote locations, **hydrogen-powered generators** will supplement energy needs, ensuring race infrastructure operates without fossil fuels.
- **Sustainable Power Management:** Smart energy grids will balance **power distribution**, ensuring minimal wastage and optimal efficiency.

Real-World Impact:

By integrating **renewable energy sources**, the series **eliminates reliance on carbon-intensive electricity** and provides a **model for sustainable EV infrastructure worldwide**.

2. Sustainable Materials in Vehicle Construction

Endurance racing has traditionally been a **testbed for lightweight materials**, and electric racing presents a chance to pioneer **eco-friendly alternatives** without sacrificing **strength, aerodynamics, or performance**.

- **Bio-Based Composites:** Replacing traditional carbon fibre with **natural fibre-reinforced polymers**, such as **flax and hemp composites**, which reduce CO_2 emissions during production.
- **Recycled Carbon Fibre:** Utilizing **repurposed materials** from decommissioned race cars and aerospace applications to **minimize raw material waste**.
- **3D-Printed Lightweight Structures:** Advanced **additive manufacturing** will enable precision-built components using **minimal material waste**.
- **Low-Impact Paint & Coatings:** Eco-friendly **water-based paints** and **aerodynamic surface treatments** that reduce drag and enhance efficiency.

Real-World Impact:

These **innovations will directly transfer** into consumer EV manufacturing, **reducing reliance on carbon-heavy materials** and promoting **sustainable production methods**.

3. Closed-Loop Battery Systems and Circular Economy

Battery waste is a major challenge in **EV sustainability**, and the racing series will implement a **circular economy approach** to maximize the lifespan and reusability of battery packs.

- **Battery Reuse & Second-Life Applications:** End-of-life race batteries will be repurposed for **energy storage applications**, such as **grid-balancing storage or renewable energy buffering**.
- **Advanced Recycling Technologies:** The series will partner with **battery recycling specialists** to extract and reuse **valuable minerals** like lithium, cobalt, and nickel.
- **Regenerative Charging & Smart Grid Integration:** Recovered race energy will be **fed back into sustainable charging stations**, reducing the overall demand on the electrical grid.

Real-World Impact:

By **closing the loop** on battery production, the series will help **reduce electronic waste, conserve rare materials, and create a blueprint for EV battery sustainability**.

4. Eco-Friendly Logistics and Carbon-Neutral Operations

A truly **sustainable motorsport** must address **not just the cars, but the entire race ecosystem**. Logistics, team travel, and infrastructure will be optimised for **minimal environmental impact**.

- **Electric and Hydrogen-Powered Transport:** All **team support vehicles, transporters, and trackside logistics** will transition to **zero-emission fleets**.

- **Sustainable Shipping & Freight Solutions:** Collaboration with **carbon-neutral shipping** companies will ensure race equipment transport has **minimal environmental impact**.
- **Green Paddock Operations:** Race paddocks will be powered by **off-grid renewable energy**, with teams required to implement **waste-reduction strategies**.
- **Sustainable Fan Travel & Engagement:** Spectators will be encouraged to use **EV charging hubs, public transport, or carbon-offset programs** to **reduce event emissions**.

Real-World Impact:

The implementation of **sustainable logistics solutions** will serve as a model for **global motorsport series** and **influence the automotive supply chain**.

5. Environmental Offsets and Green Initiatives

While the series is committed to achieving **net-zero emissions**, unavoidable impacts will be mitigated through **carbon offset programs** and **sustainability partnerships**.

- **Reforestation & Conservation Projects:** A portion of the **race revenue will be invested** in tree-planting and land restoration efforts to **offset remaining emissions**.
- **Clean Energy Investment:** The championship will support **renewable energy start-ups** focused on EV infrastructure expansion.
- **Zero-Waste Race Weekends:** A commitment to **100% recyclable packaging, sustainable catering, and compostable materials** across all race events.

Real-World Impact:

By actively **offsetting its environmental footprint**, the series will lead the way in **sustainable motorsport practices**, setting an example for **other championships** to follow.

Racing Towards a Sustainable Future

Electric endurance racing is **more than a competition**—it is a **platform for global sustainability leadership**. Through **performance-driven innovation, eco-conscious engineering, and responsible event management**, the series will redefine how motorsport contributes to a cleaner, greener future.

- **100% renewable energy-powered operations** eliminate carbon dependency.
- **Lightweight, sustainable materials** set new standards for vehicle manufacturing.
- **Battery reuse and circular economy models** maximize energy efficiency and lifespan.
- **Green logistics and eco-friendly event planning** ensure sustainability across all race aspects.

By merging **high-performance motorsport with sustainability**, The Automobili La'Bergitla Endurance Series proves that **speed, endurance, and environmental responsibility can coexist without compromise**.

The future of endurance racing is electric, sustainable, and ready to revolutionize the world of motorsport.

Final Thoughts

The transition to **electric endurance racing** is more than just an **evolution of motorsport**—it is a complete redefinition of **performance, strategy, and sustainability**. By merging **state-of-the-art engineering, advanced energy management systems, and cutting-edge electric powertrains**, this series does not just replicate traditional endurance racing; it reinvents it.

At its core, endurance racing has always been about **pushing the limits**—of technology, human ability, and mechanical reliability. The shift to an **all-electric format** maintains this legacy while introducing new challenges: **battery management, regenerative energy utilization, and strategic pit stop execution**. This championship represents a **new era** where speed, efficiency, and sustainability converge in a way that has never been seen before.

Merging Innovation with Motorsport Excellence

Electric endurance racing will provide a **testing ground for next-generation automotive technologies**, allowing manufacturers to refine **battery efficiency, aerodynamics, and energy recovery systems** that will directly influence the development of future electric road cars. As seen in decades of **Le Mans innovation**, endurance racing accelerates breakthroughs that shape the future of mobility.

This series ensures that electric motorsport is **not just an alternative to traditional racing**, but a **pinnacle of performance and engineering excellence**. By focusing on **high-speed competition, strategic race execution, and technological advancement**, the championship will solidify its place as the most **dynamic and forward-thinking endurance series in the world**.

"Can't Rush Greatness": A New Motorsport Philosophy

The guiding principle of this championship, **"Can't Rush Greatness,"** is more than just a slogan—it is a **philosophy that defines the pursuit of perfection in electric endurance racing**. It reflects the reality that achieving **true greatness in motorsport innovation takes time, dedication, and relentless progress**.

- **It is about crafting the most efficient and advanced electric racing machines ever built.**
- **It is about refining race strategies that balance power, energy conservation, and pit stop execution.**
- **It is about proving to the world that electric endurance racing can be as thrilling, if not more so, than traditional motorsport.**

Through **cutting-edge technology, smart engineering, and a commitment to sustainability**, this series will become **a defining force in modern motorsport**.

Redefining the Future of Motorsport

Electric endurance racing is not simply an **experiment or niche category**—it is the **future of racing itself**. As regulations evolve and the automotive industry accelerates its shift towards **electrification**, this championship will remain at the forefront of **progress, competition, and sustainability**.

By delivering **high-intensity racing, energy-efficient technologies, and forward-thinking sustainability practices**, this series will:

- **Inspire the next generation of engineers, drivers, and racing enthusiasts.**
- **Provide manufacturers with a real-world testing ground for EV advancements.**
- **Demonstrate that motorsport can thrive in an era of environmental responsibility.**

The world is witnessing the dawn of a **new motorsport era**, where **performance and sustainability** are no longer at odds. With its **pioneering technology, strategic depth, and thrilling race craft**, this championship is set to **redefine endurance racing for the modern age**.

The future of motorsport has arrived—and it is faster, smarter, and more electrifying than ever.

All-Electric La'Bergitla Endurance Series – Technical and Sporting Regulations

Introduction

The **All-Electric La'Bergitla Endurance Series** represents the next stage in endurance racing, integrating **high performance electric propulsion** with cutting-edge **battery swapping technology and regenerative energy systems**. This championship is designed to ensure **competitive balance, sustainability, and technological advancement**, while maintaining the fundamental challenges of **strategy, efficiency, and durability** that define endurance racing.

This **rulebook** establishes the **technical and sporting regulations** for the all-electric prototype class, ensuring **safety, fairness, and a level playing field** while fostering **engineering innovation**. The framework is structured to support the **transition of existing teams and manufacturers** into the **electric endurance format**, providing **clear guidelines for battery technology, pit stop procedures, race operations, and energy recovery systems**.

Key Objectives of the Regulations

1. **Maintain the Integrity of Endurance Racing:** Preserve the fundamental endurance racing principles of **stint management, race strategy, and reliability** while introducing electric specific challenges.
2. **Encourage Innovation within a Standardised Framework:** Allow teams to develop **powertrains, aerodynamics, and energy recovery systems** while maintaining **a balanced competition structure** through controlled **battery specifications, energy allocation, and technical standards**.
3. **Ensure Safety and Sustainability:** Introduce **advanced safety protocols** for **high-voltage battery systems, energy storage, and pit stop operations**, while minimizing **environmental impact through sustainable technologies and clean energy solutions**.
4. **Provide a Clear Transition Path:** Support manufacturers and teams in **adapting to the electric endurance format** by setting **clear regulations** that align with existing endurance racing principles while **pushing the boundaries of electric vehicle (EV) performance**.

Scope of the Regulations

This **technical and sporting rulebook** applies to all teams, manufacturers, and competitors participating in the **All-Electric La'Bergitla Endurance Series Prototype Class**. The regulations cover:

- **Battery Technology & Swapping Systems:** Standardised **underside-mounted swappable battery packs** with **regulated capacity and weight limits**, ensuring equal energy allocation across teams.
- **Energy Recovery & Regeneration:** Implementation of **regenerative braking** and **hybrid electromagnetic/piezoelectric shock absorbers** to recover and store kinetic energy, enhancing **efficiency and race strategy**.
- **Pit Stop & Race Procedures:** Standardised **battery swap operations**, ensuring rapid, **efficient pit stops** while maintaining fair **race strategy execution**.

- **Technical Standards & Compliance:** Regulations governing **powertrain design, aerodynamics, and high-voltage safety**, ensuring **technical parity** while allowing **manufacturer innovation**.
- **Sporting Regulations & Race Management:** Guidelines for **qualifying formats, stint lengths, driver regulations, and penalties** to ensure a **fair, competitive, and thrilling endurance race**.

These regulations will serve as the foundation for the **transition to a fully electric endurance racing format**, ensuring that the **legend of Le Mans** continues while embracing **the next generation of motorsport innovation**.

1. Battery Voltage and Pack Size

The **battery system** serves as the core energy source for the **All-Electric La'Bergitla Endurance Series**, balancing **power output, efficiency, and race endurance**. To ensure **competitive parity, reliability, and safety**, all cars must conform to the following **battery voltage and pack size regulations**:

1.1 Standardised Voltage

- All race vehicles must utilize a **high-voltage battery system** operating at a **nominal 800V architecture**, optimised for high-performance endurance racing.
- A **tolerance range of 750V–850V** is permitted to accommodate varying battery conditions, thermal fluctuations, and energy recovery efficiency.
- The high-voltage system must be **fully insulated and protected**, ensuring **safe operation** under extreme race conditions.

1.2 Pack Energy Capacity

- Each vehicle will be equipped with a **standardised battery pack**, ensuring **performance consistency** across all teams.
- The **usable energy capacity is set at approximately 100 kWh (±5%)**, balancing **energy density, weight, and longevity** for endurance racing.
- The pack must be **engineered for rapid swaps**, allowing for seamless pit stop operations **without performance compromise**.

1.3 Uniform Specification

- To **ensure fair competition**, all teams must use an **approved, homologated battery pack** with **identical energy storage capabilities**.
- The **dimensions, weight, and structural integrity** of the battery pack will be standardised, preventing performance variations based on custom energy storage solutions.

- The uniform specification ensures **consistent race strategies** across teams, with success depending on **efficiency, energy management, and driver skill** rather than battery optimization.

1.4 Battery Pack Design & Safety

- The battery must be **integrated safely within the car's chassis**, meeting **FIA crash safety regulations** for **impact resistance, fire prevention, and high-voltage insulation**.
- Battery enclosures must feature **high-strength composite materials (CFRP or aluminium alloy)** to withstand structural stresses, ensuring **maximum durability under endurance conditions**.
- **Automatic disconnect mechanisms** must be in place to **shut down high-voltage power** in the event of a collision, overheating, or electrical failure.
- Each pack must include **built-in thermal management**, utilizing **liquid cooling, phase-change materials, or thermoelectric elements** to regulate battery temperatures and maintain consistent performance.
- The **Battery Management System (BMS)** must provide **real-time telemetry** to monitor **voltage, current, state-of-charge (SoC), and temperature**, with **instant alerts** for anomalies.

1.5 Voltage and Capacity Updates

- To keep pace with **technological advancements**, periodic **battery updates** may be introduced, ensuring the series remains at the forefront of **electric endurance racing innovation**.
- All updates must be **applied equally** to all teams to maintain **fair competition** and avoid performance imbalances.
- Future battery advancements, such as **solid-state technology or next-generation lithium-based chemistries**, may be integrated **with approval from the FIA technical committee** to enhance **energy density, safety, and longevity**.

By implementing **standardised battery voltage and pack size regulations**, the **All-Electric La'Bergitla Endurance Series** ensures a **level playing field**, promoting **energy efficiency, strategic race management, and long-term sustainability in endurance motorsport**.

2. Battery Swap Pit Stop Regulations

The **battery swap procedure** is a fundamental element of **all-electric endurance racing**, replacing traditional **fuelling stops** while ensuring a **fast, efficient, and safe** energy replenishment process. These regulations govern **swap execution, pit crew limitations, safety protocols, and energy management** during race operations.

2.1 Swap Procedure and Time

- Battery swaps serve as the primary **energy replenishment method**, mirroring the function of fuel stops in conventional endurance racing.
- Teams must execute swaps **within a target time of under 60 seconds**, ensuring minimal disruption to race strategy.
- The battery **must be fully removed and replaced**, with no partial recharges permitted during pit stops.
- Pit Lane procedures will be **monitored in real-time**, and failure to meet swap timing or safety standards may result in penalties.

2.2 Pit Crew and Automation

- A **maximum of five crew members** may work on the vehicle during a battery swap, including mechanics handling the battery system and safety personnel.
- Teams **may use semi-automated or mechanised systems** to facilitate battery handling and insertion, but fully autonomous robotic swaps are not permitted.
- Crew members must be **trained and certified in high-voltage systems** to ensure proper handling of energy storage components.
- Only **approved equipment** may be used for the battery exchange process, ensuring **structural integrity, electrical insulation, and efficiency**.

2.3 No Concurrent Mechanical Work

- To maintain **safety and procedural efficiency**, **no mechanical repairs or modifications** may be performed on the car **while a battery swap is in progress**.
- Permitted activities **during a battery swap** include:
  - **Driver changes** ○ **Windshield cleaning**
- **Data uploads and race strategy adjustments** ○ If a team needs to perform **repairs or adjustments**, these must be **conducted separately** from the battery swap procedure.

2.4 Allowed Number of Batteries Per Race

- Each car is permitted a **maximum of three battery packs** over the duration of the 24-hour race.
- Once a team has used all three allocated packs, they must **strategically manage energy use** to complete the race without exceeding their assigned battery quota.

- This limitation **introduces energy conservation strategies**, ensuring teams must balance **performance, efficiency, and pit stop timing**.
- Battery allocation will be **monitored electronically**, and exceeding the maximum allowance may lead to penalties.

2.5 Charging Between Stints

- **Removed battery packs** will be **immediately placed into high-power charging stations** located within the pit garages.
- Charging will be conducted using **standardised 600–800 kW fast chargers**, capable of replenishing **a full charge within 10–15 minutes**.
- Battery packs must be **actively cooled** during charging to **prevent overheating and ensure optimal performance** for subsequent stints.
- Each team's battery rotation strategy will be critical in **ensuring fully charged packs are available for each swap** while maintaining compliance with the **three-pack limit**.

2.6 Swap Safety Protocols

All battery swaps must adhere to **strict FIA high-voltage electrical safety standards**, including:

- **Mandatory use of insulated gloves and fire-resistant suits** for pit crew members handling battery packs.
- **Automatic high-voltage shutoff mechanisms** before battery removal.
- **Dedicated emergency kill switches** to disable power systems in case of malfunctions.
- **Grounded work areas** to prevent electrostatic discharge and minimize risk of electrical faults.
  - Battery safety monitoring will be conducted **before and after swaps**, ensuring that **damaged or compromised battery packs** are removed from circulation. o Pit garages will be equipped with **battery containment stations**, providing a **safe zone for inspecting overheated or damaged batteries** without disrupting race operations.

Maximizing Efficiency, Safety, and Strategy

By implementing a **structured and regulated battery swap system**, the **All-Electric La'Bergitla Endurance Series** ensures that pit stops remain **fast, efficient, and safe** while introducing **new strategic elements** into endurance racing. With **battery limits, high-power charging infrastructure, and crew safety protocols**, teams must carefully manage **energy use, pit stop timing, and battery conservation** to achieve **race-winning performance**.

3. Race Operations and Energy Use Regulations

The **All-Electric La'Bergitla Endurance Series** introduces a new paradigm in race operations by integrating high-performance electric powertrains, strategic energy management, and battery swap-based pit stops. The following regulations govern power deployment, stint lengths, and overall energy usage, ensuring competitive fairness and a level playing field.

3.1 Maximum Power Output

- All competing vehicles are limited to a **maximum combined output of 500 kW (~670 hp)** at any given time.
- This power cap applies **regardless of drivetrain configuration**, whether single-motor, dual motor, or all-wheel drive (AWD) systems.
- Teams may **adjust power delivery strategies** within this limit to optimize efficiency and performance across stints.
- Power restrictions ensure that races remain **competitive and balanced** while promoting efficient energy usage.

3.2 Power Deployment and Control

- Teams may optimize **power curves and energy deployment strategies** while remaining within the **500-kW regulatory cap**.
- Different driving modes may be utilised, such as:
  - **Full Power Mode** – Deployed in critical race moments, such as overtakes or final laps.
  - **Efficiency Mode** – Optimised for endurance stints, prioritizing regenerative braking and energy conservation.
  - **Regenerative Recovery Mode** – Maximizes energy recapture under braking and suspension loads to extend range.
- Energy deployment will be **continuously monitored via telemetry**, ensuring compliance with regulatory limitations.
- The use of **traction control, torque vectoring, and electronic differential tuning** within legal limits is permitted to optimize power delivery.

3.3 Energy Management and Stint Length

- Each car is expected to complete **10-14 laps per full battery charge** at Le Mans, depending on energy efficiency and driving strategy.
- Teams must balance **performance and energy conservation** to extend stints while maintaining competitive lap times.
- Regenerative braking and **suspension energy recovery systems** play a crucial role in **extending usable range** per charge.

- High-efficiency teams may stretch stints longer by leveraging **braking zones, lifting, and coasting techniques, and intelligent power distribution**.

3.4 Pit Stop Strategy

Teams will **strategize battery swaps similarly to fuel stops in traditional endurance racing**, factoring in:

- **Optimal stint length** based on energy consumption and race conditions.
- **Synchronization of battery swaps with tire changes and driver rotations** to minimize downtime.
- **Real-time telemetry adjustments** to optimize energy deployment across each stint.
- Swaps will occur in designated pit lanes under controlled safety protocols.
- The choice between **longer stints with conservative power deployment** vs. **shorter, high-performance stints with more frequent swaps** will introduce a new dimension of strategy.

3.5 Energy Usage Limits

- Unlike Formula E, which enforces per-lap energy caps, the **All-Electric La'Bergitla Endurance Series** will not impose a fixed limit per lap.
- Instead, total **energy consumption is naturally regulated by the battery swap system** and available recharge rates.
- Each car may use up to **three battery packs** over the full 24-hour race, requiring teams to **optimize energy efficiency** to stay competitive.
- Teams must make **tactical decisions regarding aggressive vs. conservative energy usage** to maximize race performance.

3.6 Driving Regulations

Standard **FIA endurance driving rules** apply, ensuring compliance with safety and sporting regulations:

- **Maximum Driving Time per Driver:** No driver may exceed **four consecutive hours** in a single stint, and no more than **13 hours total** within the 24-hour race.
- **Minimum Driver Rest Periods:** Drivers must take mandatory **rest breaks** between stints to prevent fatigue.
- **Driver Changes:** Must occur **at least once every six hours**, ensuring all team members contribute to the race effort.
- **Stint Strategy:** Teams may strategically adjust **driver rotations, energy management, and swap timing** based on race conditions.

- **Race Incidents & Safety Procedures:** Standard yellow flag, full-course yellow (FCY), and safety car protocols remain in place.

A New Era of Endurance Racing Strategy

By integrating **battery swap logistics, power management, and energy recovery**, the **All-Electric La'Bergitla Endurance Series** introduces a new strategic layer to endurance racing. Teams must carefully balance **energy efficiency, pit stop timing, and driver performance** to execute a **winning race strategy**. These regulations ensure **exciting, competitive, and sustainable motorsport**, setting the foundation for the future of electric endurance racing.

4. Regenerative Energy Recovery Systems

Regenerative energy recovery is a cornerstone of **All-Electric La'Bergitla Endurance Series** regulations, allowing teams to extend efficiency and enhance race strategy. By harnessing braking and suspension energy, cars can reclaim lost energy and reduce overall battery consumption. These systems must operate within defined regulatory limits to ensure fair competition.

4.1 Regenerative Braking

Regenerative braking serves as the primary method of energy recovery, converting kinetic energy into electrical energy during deceleration.

Regulations and Implementation:

- **Motor-Generators on All Driven Axles:** All vehicles must use electric motor-generators to capture and store energy from braking. Both **front and rear axles** may be utilised for optimal recovery.
- **Brake-by-Wire Integration:** Teams must use an electronic brake-by-wire system to blend regenerative and mechanical braking efficiently, maintaining stability while maximizing energy recovery.
- **Recovery Efficiency Limits:** The efficiency of energy recapture is naturally governed by **battery acceptance rates** and system limitations.
- **Dynamic Power Allocation:** Teams can redistribute recovered energy to **traction batteries or supercapacitors**, allowing flexible deployment strategies.
- **Thermal Load Management:** Excessive regenerative braking must be managed to prevent **motor overheating and brake system degradation** over long stints.

4.2 Hybrid Electromagnetic/Piezoelectric Suspension Regeneration

To complement braking regeneration, teams may integrate **shock absorber energy recovery systems** that convert mechanical suspension movement into electrical energy.

Key Features:

- **Electromagnetic Dampers:** Special dampers house **linear generators** that generate electricity as the suspension compresses and rebounds.
- **Piezoelectric Energy Harvesting:** Piezoelectric materials embedded in the shock absorbers convert vibrational energy into electrical charge.
- **Track-Dependent Efficiency:** Suspension-based regeneration is highly dependent on track roughness and curb usage. On smooth circuits like **Le Mans**, teams can expect a moderate but steady energy yield.
- **Direct Storage in Supercapacitors:** Due to its transient nature, most suspension-recovered energy is stored in **supercapacitors** for instant deployment rather than the main battery.

4.3 Energy Recovery Limits and Usage

While there is no fixed limit on **how much energy can be recovered**, teams must operate within natural constraints and regulatory oversight:

- **Battery Charge Acceptance Rate:** The ability to store regenerated energy is constrained by the battery's charge intake rate and overall energy flow balance.
- **Deployment Integration:** Recovered energy must be **directly reintegrated** into the vehicle's **traction power system** or **auxiliary functions**, ensuring efficient use.
- **Strategic Recovery Optimization:** Teams may tune recovery rates based on **braking zones, track conditions, and driving styles** to maximize efficiency while maintaining drivability.

4.4 Boost from Regeneration

While regenerative energy recovery improves efficiency, teams cannot exceed the **500-kW maximum deployment limit**:

- **Regenerated Energy Deployment:** Energy recaptured through braking and suspension recovery may be used **at any point** during a stint but must stay within the **regulated power cap**.
- **Overtake and Acceleration Strategy:** Teams may store recovered energy in supercapacitors for **short bursts of power**, providing a strategic advantage in overtaking situations.
- **Energy Flow Balance:** FIA telemetry will track the **energy input-output balance**, ensuring that teams **do not exceed stored energy allowances** or manipulate recovery systems.

4.5 Monitoring and Telemetry Compliance

To ensure fair play, the FIA will **continuously monitor** regenerative systems and enforce compliance:

- **Live Energy Flow Monitoring:** FIA-approved telemetry will track **power input from regenerative braking and suspension systems**, comparing it to deployment data.
- **Software Validation:** Teams must submit **ECU (Electronic Control Unit) data** for verification, ensuring that no unauthorised energy storage or release occurs.

- **Automatic Penalties for Violations:** If any car exceeds its allowed energy storage or uses regenerative energy in an unsanctioned manner, **time penalties or disqualification** may apply.
- **Anti-Bypass Measures:** Energy flow must remain **within specified routes** (battery → motor → drivetrain), preventing unauthorised boosts or unfair advantages.

The Role of Regenerative Systems in Endurance Racing

Regenerative braking and suspension energy recovery **enhance efficiency, extend stint lengths, and reduce battery swap frequency**. These systems will play a pivotal role in race strategy, allowing teams to balance performance with energy conservation. By enforcing strict monitoring and compliance measures, the FIA ensures that all teams benefit fairly from regeneration without bypassing technical regulations.

The integration of cutting-edge **energy recovery** systems in the **All-Electric La'Bergitla Endurance Series** marks a revolutionary shift in endurance racing, pushing the limits of **efficiency, performance, and sustainability** while maintaining the spirit of competition.

5. Technical Car Design Regulations

5.1 Drivetrain and Motors

The **All-Electric La'Bergitla Endurance Series** prototype regulations permit teams to develop custom drivetrains within defined performance constraints. This allows flexibility in design while ensuring fairness, safety, and competition integrity.

5.1.1 Powertrain Configuration

Teams have the freedom to develop **either Rear-Wheel Drive (RWD) or All-Wheel Drive (AWD) configurations**. The drivetrain layout impacts energy efficiency, handling characteristics, and regenerative braking potential.

Regulations for Powertrain Layouts:

- **AWD Configurations:** May utilize up to **four** electric motors, with separate units driving the front and rear axles.
- **RWD Configurations:** Allowed with up to **two** motors exclusively on the rear axle, reducing weight and complexity.
- **Torque Vectoring:** Teams may implement **torque vectoring** within the power limit, improving cornering performance by dynamically adjusting power distribution across the wheels.

- **Regenerative Braking Influence:** AWD systems benefit from front and rear axle energy recovery, whereas RWD cars rely primarily on **rear motor regeneration**.

5.1.2 Maximum Power and Torque Regulations

To maintain **performance parity**, all vehicles are subject to strict power and torque limitations:

- **Maximum Power Output:** 500 kW (~670 hp) combined, irrespective of motor count or configuration.
- **Torque Limitations:** Torque is indirectly constrained by the **500-kW power cap**, but teams may optimize power delivery through software mapping.
- **Power Curves and Energy Deployment:** Power mapping strategies are permitted, allowing teams to optimize acceleration, efficiency, and tire wear throughout a stint.
- **Overboost Restrictions:** Temporary power surges beyond 500 kW (e.g., via energy recaptured from regenerative braking) are strictly prohibited.

The **power cap ensures that performance differentials arise from efficiency, aerodynamics, and strategy** rather than raw power output.

5.1.3 Inverters and Control Electronics

Each team may **develop proprietary motor controllers and inverters**, provided they adhere to FIA safety and standardization requirements.

Inverter and Electronics Requirements:

- **Motor Controllers:** Custom inverters and software-controlled power delivery systems are permitted to maximize efficiency and motor response.
- **Thermal Management:** Teams must implement **active cooling** for inverters to prevent overheating during prolonged high-load conditions.
- **Standardised Safety Protocols:** Inverters must comply with **FIA electrical insulation and failsafe measures**, ensuring safe operation under extreme conditions.
- **Telemetry and FIA Monitoring:** All electronic control systems will be monitored in real time to prevent software-based power exploitation or illegal performance modifications.

By allowing teams to refine their **inverter technology**, the series encourages **efficiency improvements** without compromising fairness.

5.1.4 Gearbox and Transmission Options

Electric vehicles traditionally use **single-speed transmissions**, but the regulations allow for **multispeed gearboxes** to encourage powertrain innovation.

Transmission Regulations:

- **Single-Speed Gearbox:** The most common option, offering **simplicity, reliability, and efficiency** by directly linking motors to the drive wheels.
- **Multi-Speed Gearbox:** Allowed but must be **electronically controlled** to prevent sudden power surges.
- **Regenerative Compatibility:** Gearbox designs must integrate seamlessly with **regenerative braking systems**, ensuring smooth energy recovery.
- **Durability Requirements:** Any transmission components must be designed to **last the full 24hour race**, balancing weight, efficiency, and reliability.

Teams opting for **multi-speed transmissions** may gain advantages in energy efficiency and acceleration, but they must weigh these benefits against **increased complexity, weight, and potential reliability concerns**.

Balance of Power, Strategy, and Innovation

The drivetrain and motor regulations ensure that competition is based on **engineering ingenuity, race strategy, and power efficiency** rather than unregulated performance advantages. By capping power at **500 kW**, allowing AWD or RWD layouts, and permitting proprietary control electronics, the **All-Electric La'Bergitla Endurance Series** provides teams with a competitive yet regulated environment that encourages **technological progress and sustainability**.

The combination of **customizable power delivery, advanced inverter designs, and optimised gearboxes** will drive the evolution of electric endurance racing, pushing the limits of **efficiency, handling, and energy management** over the gruelling 24-hour race.

5.2 Battery and Energy Storage

The **All-Electric La'Bergitla Endurance Series** prototype class mandates a **standardised battery system** to ensure performance parity, safety, and reliability across all competing teams. While teams have flexibility in energy management and deployment strategies, the core battery and energy storage components are regulated.

5.2.1 Standard Battery Pack Specifications

To maintain fairness and allow competitive endurance racing, all cars must use an **approved spec battery pack** with the following specifications:

- **Capacity:** 100 kWh (±5%) usable energy storage.
- **Voltage: 800V nominal architecture**, with a permitted tolerance range of 750V–850V.
- **Charge Rate:** Supports **600–800 kW** DC fast charging and standardised swappable battery integration.
- **Weight and Safety Compliance:** Battery must meet **FIA safety standards**, including high-voltage shielding, impact-resistant casing, and thermal runaway protection.
- **Form Factor and Dimensions:** The battery pack's **shape and mounting points are standardised**, ensuring fair competition while allowing teams to integrate it efficiently within their chassis.

The **battery standardization ensures performance parity**, while energy deployment strategies remain a key area for competitive differentiation.

5.2.2 Battery Weight and Placement Regulations

To optimize **handling characteristics and crash safety**, battery placement is strictly regulated:

- **Chassis Integration:** The battery must be mounted **within a reinforced section of the chassis**, ensuring both weight distribution balance and structural integrity.
- **Underside Mounting:** Standardised **underside-mounted swappable battery pack** enables fast pit stop changes while maintaining a low centre of gravity.
- **Crash Protection:** The battery housing must be constructed from **carbon fibre-reinforced polymers (CFRP) and impact-resistant aluminium**, with fire-resistant barriers.
- **Thermal Management:** Integrated **liquid cooling systems** prevent overheating and ensure optimal performance across extended race stints.
- **Structural Load Distribution:** The battery pack must be positioned to **prevent excessive load transfer under acceleration, braking, and cornering**, ensuring predictable handling.

By **regulating weight distribution**, the series prevents teams from exploiting battery positioning for aerodynamic or handling advantages.

5.2.3 Minimum Weight Requirement

- **Total Minimum Car Weight: 1,300 kg** (including driver, fluids, and operational race components).
- **Battery Contribution:** The battery pack accounts for approximately **400–500 kg** of total vehicle weight.
- **Weight Parity Enforcement:** Teams may optimize lightweight materials for bodywork, but the car must **meet the 1,300 kg minimum weight** to ensure fair competition.

The weight regulations ensure that teams **cannot gain an advantage by using lighter or more energy-dense battery packs**, reinforcing strategic parity in race execution.

Balancing Energy Storage, Safety, and Performance

The standardised **100 kWh, 800V battery pack** guarantees a **level playing field** while allowing teams to innovate in **energy deployment and regenerative recovery**. The **minimum weight rule ensures competitive fairness**, while **regulated battery placement** maintains safety and vehicle balance.

By integrating **high-capacity, fast-swappable batteries** with advanced **thermal and crash protection systems**, the **All-Electric La'Bergitla Endurance Series** delivers a **technologically advanced, safe, and competitive endurance racing format**, setting a new benchmark for **electric motorsport innovation**.

5.3 Chassis and Aerodynamics

The **All-Electric La'Bergitla Endurance Series** prototype class mandates a balance between **safety, aerodynamics, and technical freedom**, ensuring that teams can innovate while adhering to performance regulations. The **chassis platform, aerodynamic parameters, and vehicle dimensions** are strictly regulated to maintain fair competition and high safety standards.

5.3.1 Chassis Platform and Structural Integrity

All competing cars must be built around an **FIA LMP-type crash structure**, ensuring **high-speed impact protection** and structural rigidity.

- **FIA Homologated Carbon Fibre Monocoque:** All cars must feature a **fully enclosed carbon fibre monocoque chassis**, designed to withstand multi-directional impacts.
- **High-Strength Impact Zones:** Sidepods, front and rear crash structures, and battery containment areas must meet **FIA impact absorption criteria**.
- **Battery Safety Housing:** The battery pack must be encased in **fire-resistant, impact absorbing materials** to prevent thermal runaway in the event of a crash.
- **Driver Safety Cell:** The cockpit must integrate **reinforced roll structures**, anti-intrusion panels, and fire-retardant materials for maximum driver protection.

This **unified chassis approach** ensures **structural integrity across all competitors**, maintaining safety while allowing for **individualised design and setup choices**.

5.3.2 Vehicle Dimensions and Specifications

To maintain aerodynamic parity and prevent extreme design variations, vehicles must conform to the following **size regulations**:

- **Maximum Length: 4,830 mm** (4.83 m)
- **Maximum Width: 2,000 mm** (2.00 m)
- **Maximum Height: 1,050 mm** (1.05 m)

- **Wheelbase Regulation:** Minimum and maximum wheelbase limits will be enforced to prevent excessive aerodynamic exploitation while allowing teams **some design freedom**.
- **Front and Rear Overhangs:** Teams may optimize nose and tail structures within regulated limits, ensuring balance between **aerodynamic efficiency and crash safety**.

These standardised dimensions **strike a balance between aerodynamic efficiency and race stability**, ensuring that **no single team gains an undue advantage through extreme bodywork variations**.

5.3.3 Aerodynamics and Drag Efficiency Regulations

Teams are allowed **some freedom** in designing aerodynamic components, but all designs must comply with performance balance regulations.

- **Aerodynamic Philosophy:**
  - Cars must maintain **high-efficiency aerodynamic performance**, prioritizing **low drag and high downforce**.
  - Aero surfaces must comply with **predefined drag and downforce efficiency targets**, ensuring **parity between different designs**. ○ The floor and underbody must conform to **regulated ground-effect principles**, preventing excessive aerodynamic stall sensitivity.
- **Allowed Aero Elements:**
  - **Front and Rear Wings:** Teams may design their own wing structures within **regulated size and shape parameters**.
  - **Diffuser and Venturi Tunnels:** Ground-effect aero must be **within FIA-set limits** to prevent excessive downforce generation.
  - **Sidepod and Cooling Duct Variations:** Teams may optimize cooling and air intake designs, provided they do not exceed **aero legality boxes**.
  - **Drag Efficiency Targets:** Computational Fluid Dynamics (CFD) and wind tunnel data will be used to ensure cars comply with **maximum drag coefficient limits**, preventing unfair straight-line speed advantages.

By regulating **aero performance without mandating a spec body**, teams are encouraged to **develop efficient, low-drag designs** while remaining within **performance parity constraints**.

5.3.4 Active Aerodynamics Regulations

Active aerodynamics are permitted **only in a limited capacity** to maintain competitive balance while allowing innovation.

Drag Reduction System (DRS-Like Feature):

- A **controlled rear wing adjustment system** may be activated under **specific conditions**, such as:
  - **Straight-line acceleration (predefined speed zones).**
  - **Overtaking scenarios (to reduce aerodynamic drag).**

- Activation parameters will be **FIA-controlled**, ensuring **no excessive deployment advantages**.
- **Active front flaps are prohibited** to prevent excessive mid-corner aero manipulation.

Brake Cooling Adjustments:

- Passive and **manually adjustable brake duct configurations** may be used to optimize cooling efficiency.
- Teams may incorporate **variable cooling inlets** to **improve thermal management** without generating excessive aerodynamic benefit.

This **active aero approach** ensures that **cars remain aerodynamically stable** while still allowing for **overtaking opportunities and improved straight-line efficiency**.

5.3.5 Wheels, Tires, and Rolling Resistance Regulations

- **Standardised Tire Supply:**
    - The series will use **spec tires supplied by an official tire partner**, ensuring **fair competition** while allowing **teams to fine-tune performance through setup adjustments**.
    - Tire dimensions and compounds will be optimised for **low rolling resistance while maintaining race durability**.
- **Wheel Regulations:**
    - **Standardised wheel diameter** to prevent excessive rolling resistance advantages.
    - Teams may adjust **wheel offset and rim ventilation** for **cooling optimization** but must remain **within specified dimensional limits**.

By implementing **controlled tire specifications**, the series ensures **fair competition**, while **giving teams flexibility in car setup and energy management strategies**.

The Balance Between Performance and Fair Competition

The **All-Electric La'Bergitla Endurance Series** chassis and aerodynamics regulations are designed to:

- **Prioritize driver safety** through **FIA-approved monocoques and crash structures**.
- **Ensure aerodynamic efficiency** while preventing extreme design variations that could lead to **performance imbalances**.

- **Allow innovation within strict guidelines**, giving teams freedom to optimize **cooling, energy management, and race performance**.
- **Standardize tires and wheel dimensions** to keep racing **competitive and balanced** across different teams.

By blending **design freedom with regulatory oversight**, the series ensures that endurance racing remains an **engineering-driven competition**, where the **best combination of efficiency, aerodynamics, and strategy wins**.

5.4 Additional Technical Provisions

To ensure safety, performance integrity, and regulatory compliance, the **All-Electric La'Bergitla Endurance Series** includes a set of additional technical provisions. These provisions govern **energy recovery, electrical safety, fire protection, telemetry, and vehicle alert systems**, ensuring that all vehicles meet the highest standards of endurance racing.

5.4.1 Hybrid Suspension Systems & Energy Recovery

The series allows for **regenerative suspension systems** that convert mechanical vibrations and suspension movement into electrical energy.

Regenerative Shock Absorbers:

- Teams may integrate **electromagnetic and piezoelectric shock absorbers** to harvest energy from suspension compression and rebound.
- Energy recovery is limited by **battery acceptance rates** and must comply with **FIA safety regulations**.

Energy Deployment from Suspension:

- Harvested energy may be **fed directly into the vehicle's supercapacitor buffer or battery**.
- **No direct power boost from suspension energy**—it must be stored and deployed within standard power limits (500 kW).

This hybrid suspension technology enhances **energy efficiency without affecting handling performance**, making it a **strategic advantage for endurance stints**.

5.4.2 Electrical Safety Standards

Given the high-voltage nature of electric endurance prototypes, **FIA-standardised electrical safety measures** are **mandatory** across all teams.

High-Voltage Containment:

- All cars must use **insulated, shielded, and fire-resistant high-voltage wiring**.
- **Color-coded and clearly labelled high-voltage components** to aid in emergency handling.

Automatic Power Shutdown Systems:

- Vehicles must **instantly disconnect from power sources** in the event of a severe crash.
- **Manual and automatic shutdown protocols** will ensure the safety of drivers, marshals, and pit crews.

High-Voltage Indicator Lights:

- **Externally visible LED warning indicators** must display battery status for safety personnel.
- **Green (safe), yellow (standby), and red (high-voltage active)** status indicators required on all vehicles.

These provisions **prevent electrical hazards** and ensure that teams operate **within a standardised safety framework**.

5.4.3 Fire Safety and Suppression Systems

Electric endurance racing requires **advanced fire safety measures**, given the risks associated with high-energy lithium-ion batteries.

FIA-Approved Fire Suppression Systems:

- **Onboard automatic fire extinguishing systems** must be capable of neutralizing **lithium-ion battery fires**.
- **Fire-retardant enclosures** around the battery pack prevent **thermal propagation** in the event of overheating.

Battery Venting and Thermal Runaway Protection:

- **Passive and active cooling systems** must manage thermal loads to prevent battery failures.
- **Emergency venting mechanisms** must safely expel gases in case of thermal runaway.

Pit Lane & Garage Fire Safety Standards:

- FIA-regulated **battery containment zones** for overheated or damaged battery packs.
- **Fire-resistant suits, gloves, and insulating tools** mandatory for all pit crew members handling batteries.

These safety protocols **mitigate fire risks**, ensuring that electric endurance racing remains **safe and sustainable**.

5.4.4 Telemetry and Data Monitoring

Continuous telemetry ensures **real-time performance analysis, compliance enforcement, and safety monitoring**.

Live Data Streaming to FIA and Teams:

- **Energy consumption, regenerative braking rates, and temperature data** must be transmitted in real time.

- **Live battery health analysis** to detect anomalies before failures occur.

Performance and Compliance Monitoring:

- **Power output limits (500 kW) and energy usage regulations** monitored to prevent rule violations.
- **Live BoP adjustments possible if significant imbalances arise between vehicle designs**.

This telemetry infrastructure enhances **team strategies and regulatory enforcement**, making the series **technologically advanced and transparent**.

5.4.5 External Noise and Safety Alert Systems

Unlike internal combustion engines, electric cars are nearly silent at low speeds, requiring **external sound alerts** for safety.

Mandatory External Sound System:

- Cars must emit **artificial sound** to alert **marshals, pit crews, and nearby vehicles**.
- **Variable pitch and volume settings** based on speed to ensure clear differentiation from ambient noise.

Dynamic Sound Signatures for Identification:

- Teams may customize **non-performance-enhancing sound profiles** within FIA-approved parameters.
- Ensures **each car has a distinct sound identity**, aiding driver awareness and spectator experience.

By incorporating external noise systems, the series enhances **on-track safety**, making **multi-class racing safer and more immersive**.

5.4.6 Endurance Lighting and Power Efficiency Regulations

Lighting and auxiliary systems play a crucial role in **night racing**, requiring efficient **low-power solutions**.

Standardised LED Lighting Systems:

- **Ultra-bright, low-energy LED headlights and taillights** required for night-time visibility.
- **Mandatory rain lights and hazard indicators** to improve safety in adverse conditions.

Intelligent Power Consumption Management:

- **Teams must optimize non-driving energy consumption**, ensuring that lighting, cooling, and communication systems do not **unnecessarily drain the battery**.
- **Optional solar panels** on pit equipment to reduce **team energy consumption footprint**.

These lighting and efficiency standards ensure that cars remain **highly visible and operational**, even under **24-hour race conditions**.

Ensuring Safety, Innovation, and Competitive Integrity

The **Additional Technical Provisions** ensure that **electric endurance racing remains competitive, safe, and efficient** by:

- Allowing **regenerative suspension** for extended range without **performance imbalance**.
- Enforcing **strict electrical safety measures** to protect **drivers, marshals, and pit crews**.
- Implementing **FIA-approved fire safety and battery containment protocols** to prevent thermal incidents.
- Providing **real-time telemetry monitoring**, ensuring compliance with **power and energy regulations**.
- Requiring **external noise alerts** to enhance **track safety** and improve the **spectator experience**.
- Standardizing **LED lighting systems** to ensure visibility and efficiency **throughout the 24-hour race**.

With these innovations, the **All-Electric La'Bergitla Endurance Series** creates a **thrilling and technologically advanced motorsport category**, showcasing the **future of endurance racing** while maintaining **the highest standards of safety and competition**.

6. Team and Vehicle Adaptation Guidelines

As endurance racing transitions to all-electric powertrains, teams must navigate new engineering and operational challenges. The **All-Electric La'Bergitla Endurance Series** ensures a structured adaptation process, allowing existing teams and manufacturers to develop competitive electric prototypes while maintaining fairness, technological diversity, and sporting integrity.

6.1 Transition of Existing Teams

The series encourages **current Hypercar, LMDh, and LMP2 teams** to transition into **electric endurance racing**, leveraging their expertise in aerodynamics, chassis engineering, and race strategy.

Manufacturer Entry Support:

- **Existing WEC teams and Hypercar manufacturers** are invited to develop **all-electric prototypes**, aligning with the future of endurance racing.
- **Technical workshops and regulatory guidance** will help teams adapt to **battery swapping, regenerative braking, and energy management strategies**.

Flexible Development Roadmap:

- Teams may **gradually phase in EV development**—participating initially with hybrid test mules before committing to full-electric race cars.
- A **multi-year roadmap** ensures a **smooth transition without financial strain**.

By integrating current teams, the series **maintains a high level of competition** while promoting **sustainability and technical innovation**.

6.2 Vehicle Conversion and Development

To **ease the transition**, existing **LMDh and LMP2 chassis** may be **modified for electric powertrains**, provided they meet regulatory safety and performance standards.

Chassis Adaptation:

- FIA-approved **LMP2 or LMDh chassis** may be **electrified**, allowing teams to leverage existing expertise.
- **Battery, motor, and inverter integration points standardised** to maintain safety and balance.

Powertrain Development Freedom:

- Teams may **design custom electric powertrains**, provided they **comply with energy and power output limits**.
- **Balance of Performance (BoP)** will ensure **parity between different design philosophies**.

This **conversion option minimizes costs** and **encourages manufacturer participation**, making it easier for teams to **enter the electric era of endurance racing**.

6.3 Manufacturer Support and Collaboration

To ensure a **competitive grid**, teams may **work with common battery, powertrain, and component suppliers** while maintaining brand identity and technical individuality.

Battery Standardization with Engineering Freedom:

- While **battery packs remain standardised (100 kWh, 800V spec)**, manufacturers may **develop proprietary cooling, inverters, and energy recovery solutions**.
- **Third-party suppliers** may offer modular energy storage solutions, ensuring **performance parity across teams**.

Supplier Collaboration:

- Automakers may **partner with technology firms** (e.g., battery developers, software companies) to enhance energy efficiency.
- Open-source **vehicle software interfaces** allow manufacturers to optimize **power delivery strategies**.

By enabling **cross-industry collaboration**, the series fosters **innovation while controlling costs**.

6.4 Competitiveness and Balance

To maintain **close racing**, the FIA will employ **Balance of Performance (BoP) adjustments** if significant **disparities arise between different powertrain concepts**.

BoP Parameters:

- **Adjustments to weight, energy deployment limits, or regen recovery caps** may be applied based on performance trends.
- Data-driven BoP ensures that teams **cannot gain excessive advantages through budget disparities**.

Strategic BoP Implementation:

- **Pre-season testing, race data, and simulations** will guide BoP regulations.
- **No mid-race BoP changes** to ensure teams maintain **consistent strategy execution**.

This approach **balances performance without restricting engineering creativity**.

6.5 Manufacturer Diversity and Engineering Philosophy

Teams are encouraged to develop **unique powertrain configurations** while remaining within **competitive limits**.

Different Drivetrain Approaches:

- Some teams may prioritize **energy efficiency (longer stints, fewer swaps)**.
- Others may focus on **outright speed (shorter stints, higher output, more aggressive energy deployment)**.

Diverse Engineering Strategies:

- Teams may explore **AWD vs. RWD configurations**, different **regenerative braking strategies**, and **unique aero solutions**.
- **Power delivery optimization, torque vectoring, and active energy management** will be key differentiators.

By **allowing multiple design paths**, the series encourages **diverse manufacturer involvement** while maintaining **sporting fairness**.

6.6 Reliability and Long-Term Serviceability

Managing **battery life, powertrain durability, and temperature control** will be **essential** in a **24-hour race format**.

Thermal Management:

- Teams must implement **effective battery cooling** to sustain peak performance over multiple stints.
- **Fast-charging cycles and deep discharges** must be **strategically managed** to extend battery longevity.

Long-Term Durability:

- Regulations ensure that **motors, inverters, and batteries** maintain **performance stability** throughout a race season.

- **Lifetime use limits** may be implemented to **prevent excessive component wear**.

Teams must **optimize energy deployment** while maintaining **mechanical and electrical reliability**.

6.7 Safety Car and Caution Period Considerations

Electric powertrains require **specific adjustments** during **Safety Car (SC) and Full Course Yellow (FCY) periods**.

Energy Conservation:

- Under SC/FCY, cars must **reduce power output** and operate in **low-consumption mode**.
- **No regenerative energy deployment** under SC conditions to **maintain fairness**.

Battery Cooling & Efficiency Adjustments:

- Teams may use **caution periods** to **actively manage battery cooling**.
- **Pit stop window strategies** may change based on **timing of SC deployments**.

This ensures that **races remain competitive even under caution conditions**.

6.8 Integration with Other Endurance Racing Classes

Electric prototypes will be **balanced alongside other endurance categories**, ensuring **multi-class racing remains strategic and fair**.

Hypercar & LMP2 Coexistence:

- Performance regulations ensure that **electric prototypes are competitive with existing Le Mans Hypercars (LMH/LMDh)**.
- **Clear class differentiation** prevents excessive speed disparities.

Traffic Management Considerations:

- **Blue-flag rules and energy deployment restrictions** ensure **safe overtaking and class separation**.
- Teams must strategize **energy recovery while managing multi-class race dynamics**.

This integration ensures that **electric endurance racing complements** existing Le Mans racing categories.

6.9 Future Developments and Regulation Evolution

The **electric endurance racing format** will **continuously evolve** alongside **battery, charging, and energy recovery advancements**.

Potential Future Enhancements:

- **Fast-charging technologies** may be introduced in future seasons.
- **Solid-state battery integration** could **increase energy density and improve safety**.
- **Enhanced pit lane automation** may further **optimize swap times and vehicle turnaround**.

Adapting to Industry Innovation:

- As **EV technology progresses**, regulations will be adjusted **to maintain relevance and competition**.
- **Sustainability goals** will drive the adoption of **renewable energy-powered race operations**.

By maintaining a **dynamic regulatory framework**, the series **remains at the cutting edge of motorsport innovation**.

A New Era for Endurance Racing

The transition to **electric endurance racing** presents an **unparalleled opportunity for teams, manufacturers, and technology developers**.

1. **Current Hypercar manufacturers can seamlessly integrate into the electric racing format.**
2. **Diverse engineering strategies ensure teams can pursue unique powertrain solutions while maintaining competitiveness.**
3. **Regulatory flexibility allows teams to optimize efficiency, performance, and energy deployment.**
4. **Integration with other endurance classes ensures balanced and strategic multi-class racing.**
5. **Future-focused regulations evolve with EV technology, ensuring long-term sustainability.**

The **All-Electric La'Bergitla Endurance Series is more than just a motorsport revolution—it's the future of endurance racing**, driving the **next generation of high-performance electric vehicles** while preserving the **historic spirit of Le Mans competition**.

Conclusion:

The transition to an **All-Electric La'Bergitla Endurance Series** marks a **ground-breaking evolution** in endurance racing, merging **cutting-edge EV technology with the strategic intensity of traditional motorsport**. By implementing a **balanced regulatory framework**, the series ensures **fairness, competition, and technological progress** while preserving the **spirit of endurance racing**.

Through **standardised battery systems, innovative energy recovery solutions, and regenerative technologies**, the championship provides a **level playing field for manufacturers** while fostering **engineering creativity**. Teams will **strategize around battery swaps, energy efficiency, and power deployment**, making endurance racing as much about **technical mastery as it is about driver skill and race craft**.

This transformation of **Le Mans endurance racing** has far-reaching implications beyond the track. The technological advancements developed in this high-pressure motorsport environment—such as **high-**

density energy storage, ultra-fast charging, regenerative braking, and lightweight aerodynamics—will directly influence the future of **consumer EV technology**. Motorsport has long served as a **testing ground for innovation**, and this shift to electric endurance racing will **accelerate the global transition toward more efficient, high-performance electric vehicles**.

However, pioneering the future of endurance racing does not happen overnight. **Greatness takes time, innovation, and perseverance.** The philosophy behind this championship is simple yet profound—**"Can't Rush Greatness."** Every breakthrough in **EV technology, energy efficiency, and race strategy** is built upon **relentless engineering, rigorous testing, and a commitment to excellence**. Just as **Le Mans has always been the ultimate test of endurance and resilience**, this new era of electric racing is about **pushing boundaries without cutting corners**.

By **embracing electrification** while **honouring the tradition of endurance racing**, the **All-Electric La'Bergitla Endurance Series** represents the **future of motorsport**—a future that is **fast, strategic, and sustainable**. This series will **push the boundaries of electric performance**, ensuring that **Le Mans continues to be the ultimate test of innovation, endurance, and human excellence**. The journey to revolutionizing endurance racing **cannot be rushed—but it will be worth it.**

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