

University of Wales Trinity Saint David
School of Engineering

Renewable Future of Motorcycle Motorsport

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Jason Stubbs (1902057)
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1. Introduction

This report is focused on presenting the FIM Board with a detailed analysis of the feasibility and benefits of shifting towards alternative energy carriers in motorsport. Specifically, we will explore whether the FIM should encourage circuits to invest in sustainable infrastructure and technologies that can help reduce the environmental impact of racing while improving performance and safety.

To support this, we will provide evidence from current and future legislation that highlights the need for the motorsport industry to adopt sustainable practices. We will also evaluate recent research and technological advancements in the automotive engineering industry, which could be influential in shaping the future of motorsport series.

One important consideration when evaluating a range of energy carriers is their effectiveness and operational efficiency. Therefore, we will critically analyse the pros and cons of different energy carriers currently available. This will involve a detailed examination of their technical specifications, fuel efficiency, and environmental impact. Additionally, we will explore the possibility of implementing energy recovery systems that can help reduce waste and improve sustainability.

Given the unique challenges of motorcycle racing, it is important to examine how the technology being developed in the automotive engineering industry can be adapted for motorcycle racing purposes. This could include looking at how innovations in electric and hybrid powertrains can enhance the performance of racing vehicles while reducing their environmental impact.

Finally, we will advise the FIM Board on what direction they should encourage circuits to head towards in terms of supporting infrastructure, health and safety considerations, and other relevant factors. This will include a discussion on how the FIM can work with circuits to create policies and guidelines that promote sustainable practices and technologies.

Overall, this technical report will provide the FIM Board with a comprehensive analysis of the benefits and feasibility of adopting alternative energy carriers in motorsport. Through this report, we hope to help the FIM make informed decisions that promote sustainable practices, enhance performance, and improve safety in motorsport racing.

2. Current Energy Carriers Overview

i. Fossil fuels

Fossil fuels are a finite resource by nature, given that they take millions of years to replenish. Fossil fuels were first used to create power and energy in the 1880s. This was mostly the use of coal to power factories and trains (Brown, 2019). Now 81% of the power in the US comes from coal and natural gas. And these fuels account for 75% of the emissions we have produced in the last 20 years (National Geographic Society, 2022). Also, current data suggests that crude oil may run out by 2052, natural gas by 2060 and coal by 2090 (Kuo, 2019).

ii. EV energy Storage

The most common form of electric storage is within batteries. Commonly this is lead acid batteries which are commonly used to start your car. But due the weight of the lead and the poor power density of lead acid batteries, they tend to not be the best solution for EV only vehicles. For this reason, lighter more power dense Lithium based batteries are now used in EV vehicles. And although EV vehicles have become popular in recent years, they are not a modern concept. The first EV vehicle being a carriage built by Thomas Davenport in 1835. This was before fossil fuels. The problem this Thomas' invention was the lack of reliable battery technology (Abdul 2022). Although currently Lithium mining is not sustainable. This is due to the process of rinsing the salt from the lithium leeches excessive salt and heavy metals into surrounding areas. Making the water unsuitable for humans and wildlife. Although this is an issue that could resolved with implementation of equipment for filtering out these harmful deposits (Williams, 2023).

iii. Hydrogen and E-fuels

Hydrogen power is a sustainable and renewable energy source. But is not without its complications. Hydrogen as a fuel is hard to store, especially for prolonged period. It's extremely explosive and therefore must be stored in thick re-enforced containers. As well as being energy intensive to separate from oxygen and to compress into containers to be distributed. Although hydrogen tanks are much faster to fill than batteries. As well as hydrogen power is not temperature dependant like battery power (BMW, 2019).

The current fan favourite are E-fuels, having just been given the green light from the EU allowing the sale of petrol and diesel E-fuel powered cars after 2035 (Winton, 2023). The basic principle of E-Fuel is using electricity to separate hydrogen from water through electrolysis. And capture carbon dioxide from the air to create petrol. Making the production of carbon dioxide from the exhaust net zero carbon (Porsche, 2022). Although this does not stop the production of Nitrogen oxide or carbon monoxide. Although by 2035 vehicles may have emissions systems that will stop the production of these gasses entirely.

3. Progress & Research Conducted by Automotive Industry

Currently there are many manufacturers spending money on research into alternative fuel solutions. such as Yamaha working in collaboration with Toyota to manufacture hydrogen powered ICE engines. And since they have created a 450BHP V8 hydrogen powered engine (Yamaha, 2022). Which has led to Toyota presenting a Hydrogen ICE concept car called the Corolla Cross H2 Concept (Sachek, 2022). But this is not a new concept. As BMW made a short run 100 of Hydrogen ICE powered production cars in 2006 called the hydrogen 7. But these cars were not available to consumers even though they were road legal (Saunders, 2006).

Obviously, there is which was Tesla at the forefront of making affordable production EV only cars. Powered by Lithium batteries charged with electricity. Which has led to many existing manufacturers to follow suit with the EV movement.

Toyota is the leader in hydrogen fuel cell vehicles. Having produced the Toyota Mirai since 2014. The current Mirai has a range of 400 miles and produces 172BHP from 5.6KG of compressed hydrogen. And Toyota continues to develop this technology. Although these vehicles generally weigh more than the equivalent ICE counterparts.

4. Pros and Cons of Different Energy Carriers When Applied to Motorcycle Racing

From here on we will focus specifically on motorcycles and racing. Above has been presented many of the current solutions to the Sustainability problem with fuels.

Currently motorcycle racing does not focus on sustainable practices. Other than Moto E in moto GP which are electric bikes powered by lithium batteries. From the above there are a few more sustainable options available for powering motorcycles. But some are more practical than others. For motorcycles the solution must be compact and light. But also, powerful. Current Ducati MotoGP bike for example has a dry weight of 157Kg and produces of 250Hp. Compared to Ducati's current MotoE bike specifications of a weight of 225Kg and 150Hp. This is quite a contrast.

Hydrogen fuel cell also has the same problem as the EV option. Hydrogen fuel cell vehicles are heavy and do not produce as much power for their extra weight when compared to EV and ICE. This leaves the options of hydrogen ICE, and E-fuel. So far there has been little movement on motorcycle manufacturers building a Hydrogen ICE concept. Other than from Kawasaki in 2020 whom presented a concept using the H2 powerplant to convert to hydrogen fuel. This would involve converting the engine to direct injection (Pervis, 2021). But since then, there has been no updates on that project. Which could suggest there are unforeseen difficulties which has led to delays, or a lack of money for the project. It is likely that packaging such a system is the main steppingstone for using hydrogen for motorcycle. However, E-fuel would require no changes to the motorcycles besides some remapping of the ECU potentially.

For motorcycle racing E-fuel would be the most convenient solution to introduce some sustainable practices into the sport. While not introducing excessive development costs to the teams. As well as the potential disruption to the popularity of the sport. One example of this is the viewership difference between formula E and formula 1. Of 330 million for formula E and 1.6 billion for formula 1 in 2019 (Sharma, 2019). And since the money in motorsport largely comes from viewership and sponsors then this is a consideration for the survival of motorsports. Since some sponsors may pull out if viewership dropped by 80%. As well as some sponsors supply equipment that is specific to ICE engines and therefor would not sponsor EV vehicles.

So, it is in the FIM's best interest to allow racing with ICE engines to continue but with the introduction of the use of E-fuels. As well as promoting other efficiency increasing technology. Such as Kinetic energy recovery systems (KERS).

5. Kinetic energy recovery systems

There are two main types of KERS systems. One works on electricity and the other is mechanical. Electric KERS work by using the vehicles motors to apply a load under braking to generate electricity during braking to send back to the battery. Tesla calls their KERS system Regenerative Braking System (RBS). They claim that this system can extend the range of the vehicle by 10%. While also extending the life of the brakes by 50% (Armstrong, 2023). And though that is excellent for road vehicles it is not so much of a concern for racing as races aren't long enough to require brakes to be replaced mid race. But 10% more efficiency could help the motorcycles be more efficient.

Unfortunately adding batteries and generators to the front wheel of a racing motorcycle could add excessive complication to the mechanics of the machines. And weight which can make crashing more dangerous. As well as the additional unsprung mass in the front wheel if the generator were fitted in the hub could create some unsteady characteristics to the handling. Not to mention the difficulty of packaging the whole assembly into a motorcycle frame while keeping the motorcycle compact and light.

The other kind of KERS system is mechanical. It works using a constant velocity transmission to spin a flywheel. This flywheel is connected to the drive system on cars and works in tandem with the brakes. Just like the electric version. And once the flywheel is up to speed it has potential energy that can be delivered at any time (Jones, 2014).

This system would be more realistic for use in conventional motorcycles. As they are a unit construction and could be more easily integrated into a motorcycle chassis. Although it would only be able to recover braking energy from the rear wheel of a motorcycle. There is also a side effect of the flywheel that could be beneficial in a motorcycle. That is the gyroscopic effect that it has, which could cancel out the gyroscopic effect of the wheels or engine components when its spinning and potentially allow the motorcycle to change direction faster during that time. As well as be used in the straights to help overtaking at high speed. Since most large capacity motorcycles are geometry accelerating limited below 100MPH anyway. As well as it may improve efficiency slightly if used correctly.

6. Conclusion

In conclusion, this technical report provides an analysis of the benefits and drawbacks of adopting alternative energy carriers in motorsport that the FIM govern. The report highlights the complexity of the situation that motorsport faces regarding sustainable practices. This report also evaluates recent research and technological advancements in the automotive engineering industry that could influence the future of motorsport and motorcycle racing.

The report analyses the pros and cons of different energy carriers currently available, including fossil fuels, EV energy storage, hydrogen, and e-fuels. Fossil fuels, a finite resource, have contributed significantly to emissions and are expected to run out in the next few decades. EV energy storage is commonly used in electric vehicles, but lithium mining is not sustainable. Hydrogen power is a renewable energy source, but hydrogen as a fuel is hard to store, and its production is energy intensive. E-fuels have been accepted by the EU to be a suitable long-term replacement for fossil fuels since they are in essence carbon neutral.

The report also highlights the progress and research conducted by the automotive industry into alternative fuel solutions. Manufacturers are spending money on research into alternative fuel solutions. Such as BMW with the hydrogen 7 production car. And more recently Yamaha working in collaboration with Toyota to manufacture hydrogen-powered ICE engines. With concept cars in the works. But unfortunately, the motorcycle industry is behind in this regard.

In conclusion, the report recommends that the FIM Board should encourage sustainable infrastructure and technologies that could help reduce the environmental impact of racing. While managing performance and safety to an acceptable level. The FIM should work with circuits to create policies and guidelines that promote sustainable practices and technologies, including the implementation of energy recovery systems that have the potential to increase efficiency while maintaining the appeal of the sport. The motorsport industry must adopt sustainable practices to ensure a future for motorsport racing while also contributing to a sustainable future for the planet.

7. Bibliography

- Brown, J (2019), When did humans first use fossil fuels?, knowledgeburrow.com, Available at: <https://knowledgeburrow.com/when-did-humans-first-use-fossil-fuels/>, Accessed: 01/04/2023.
- National Geographic Society (2022), What is a fossil fuel and what is being done to make fossil fuels more environmentally friendly?, education.nationalgeographic.org, Available at: <https://education.nationalgeographic.org/resource/fossil-fuels/>, Accessed: 01/04/2023.
- Kuo, G (2019), When Fossil Fuels Run Out, What Then?, mahb.stanford.edu, Available at: <https://mahb.stanford.edu/library-item/fossil-fuels-run/>, Accessed: 01/04/2023.
- Abdul (2022), The First Electric Cars: A Brief History, osvehicle.com, Available at: <https://www.osvehicle.com/the-first-electric-cars-a-brief-history/#:~:text=The%20first%20electric%20car%20was%20the%20EV1%2C%20which,vehicle%2C%20a%20small%20locomotive%2C%20in%201835%20or%201835.,> Accessed: 02/04/2023.
- Williams, A (2023), Is Lithium Mining Bad for the Environment? 6 Crucial Facts, citizensustainable.com, Available at: https://citizensustainable.com/lithium-mining/?utm_content=cmp-true, Accessed: 02/04/2023.
- BMW (2019), 6 questions about hydrogen fuel cell cars: you're just a click away from the answers, BMW.com, Available at: <https://www.bmw.com/en/innovation/how-hydrogen-fuel-cell-cars-work.html>, Accessed: 02/04/2023.
- Porsche (2022), eFuels to supplement electric mobility on the road to becoming CO2 neutral, media.porsche.com, Available at: <https://media.porsche.com/mediakit/innovation-sustainability-performance/en/innovation-sustainability-performance/synthetic-fuels>, Accessed: 02/04/2023.

- Winton, N (2023), Germany Wins European E-Fuels Concession; Nothing Much Changes, forbes.com, Available at: <https://www.forbes.com/sites/neilwinton/2023/03/30/germany-wins-european-e-fuels-concession-nothing-much-changes/?sh=775f663057f4>, Accessed: 02/04/2023.
- Yamaha (2022), Tapping the Potential Within 100% Hydrogen-Powered Engines, yamaha-motor.eu, Available at: <https://www.yamaha-motor.eu/gb/en/news/tapping-the-potential-within-100--hydrogen-powered-engines/>, Accessed: 02/04/2023.
- Sachek, R (2022), Toyota's Hydrogen Combustion Engine Has The Potential To Make EVs Obsolete, topspeed.com, Available at: <https://www.topspeed.com/toyotas-hydrogen-combustion-engine-has-the-potential-to-make-evs-obsolete/#:~:text=Toyota%27s%20new%20hydrogen-powered%20Corolla%20Cross%20H2%20Concept.%20So,%22ICE%22%29%20car%20called%20the%20Corolla%20Cross%20H2%20Concept.,> Accessed:02/04/2023.
- Saunders, M (2006), BMW Hydrogen 7 first drive, Autocar.co.uk, Available at: <https://www.autocar.co.uk/car-review/bmw/7-series/first-drives/bmw-hydrogen-7>, Accessed: 02/04/2023.
- Burt, M (2020), New Mirai hydrogen fuel cell electric vehicle – under the skin, mag.toyota.co.uk, Available at: <https://mag.toyota.co.uk/new-mirai-hydrogen-fuel-cell-electric-vehicle/>, Accessed: 02/04/2023.
- Ducati (2022), Desmosedici GP, ducati.com, Available at: <https://www.ducati.com/ww/en/racing/motogp/ducati-lenovo-team-bike-desmosedici-gp#:~:text=2022%20Ducati%20Lenovo%20Team%20%7C%20Desmosedici%20GP%2022,Transmission%20Ducati%20Seamless%20Transmission.%20Chain%20final%20drive.%20Carburation>, Accessed: 02/04/2023.
- Ducati (2023), Code-name: V21L, Ducati.com, Available at: <https://www.ducati.com/ww/en/company/innovation/moto-e/prototype>, Accessed: 02/04/2023.

- Pervis, B (2021), Kawasaki Reveals Hydrogen Bike Plans, cycleworld.com, Available at: <https://www.cycleworld.com/story/motorcycle-news/kawasaki-reveals-hydrogen-fueled-bike-plans/>, Accessed: 02/02/2023.
- Sharma, G (2019), Formula E Versus Formula 1: Microcosm Of The Tussle For Mobility's Future, Forbes.com, Available at: <https://www.forbes.com/sites/gauravsharma/2019/07/29/formula-e-versus-formula-1-microcosm-of-the-tussle-for-mobilitys-future/?sh=386ac2a43dfa>, Accessed: 02/04/2023.
- Armstrong, K (2023), How Tesla's Regenerative Braking Works, notateslaapp.com, Available at: <https://www.notateslaapp.com/news/1051/tesla-s-regenerative-braking-functions-benefits-and-history>, Accessed: 02/04/2023.
- Jones, M (2014), Why we need cars with KERS, topgear.com, Available at: <https://www.topgear.com/car-news/future-tech/why-we-need-cars-kers>, Accessed: 02/04/2023.