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Potential utilization of renewable fuels for general internal combustion cars in the 2026 f1 engine regulations

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Abstract

In the automotive sector, which produces over 60-70% of global pollution emissions, the world faces difficulties in making the switch from fossil fuels to environmentally friendly renewable energy sources. Technology has advanced significantly, and companies such as Toyota and FiA are working to improve competitiveness and attract more manufacturers to produce hybrid cars. Reducing environmental impact and greenhouse gas emissions is the goal of the Formula 1 project, which partners with ARAMCO, one of the world's largest mining companies. Using the methodology of reviewing literature on energy-efficient fuels and adapting to Formula 1 vehicle regulations, with a special emphasis on hybrid strategies, to achieve net zero emissions by 2050. Research on the use of synthetic materials in fuels such as ethanol, ethanol, butanole, dimethyl methacrylate (DMM), and oxymethylethyl (OME) 3-5 has shown promising results in reducing greenhouse gas emissions. The transition to renewable energy sources is essential to reduce global pollution.

1. INTRODUCTION

Currently the world is preoccupied with the transition of fossil energy to new renewable energy, the automotive world has not escaped the attention of environmentalists and energy experts, currently motor vehicles contribute 60-70% of pollution worldwide, so it is necessary to accelerate the energy transition to new renewable energy sources.

The development of electrification technology has been very intensively carried out since long ago, Japanese manufacturers, Toyota, have conducted in-depth research on electrification technology, since 1996 Toyota has launched their first hybrid model, the Toyota Prius with a significant savings value compared to its competitors. Since the last 10 years, many car manufacturers have conducted research on electrification technology for mass production vehicles to replace the less environmentally friendly internal combustion engine, the development and implementation are not only applied to mass production vehicles, but also to the realm of prestigious competitions such as Formula 1.

The engine for formula racing is very complicated, the system prepared for formula 1 racing carries hybrid technology or a mixture of gasoline engines with electric drives as a power enhancer, complicated technology, expensive design costs, and lack of correlation with the application of technology for mass production vehicles make many car manufacturers reluctant to jump directly into the land jet competition.

FiA and F1 are looking for ways to make the competition more exciting and can attract more manufacturers to develop their engines there, one way is by overhauling their hybrid engine regulations that are more friendly to manufacturers and more relate to hybrid vehicles sold in the market. Not only the development of hybrid technology, but F1 together with the world's largest oil producer, ARAMCO, made an environmentally friendly fuel whose raw material comes from household waste.

2. RESEARCH METHODS

The method used is the literature view, which analyses each study literature contained in Scopus, Google Scholar, and SciVar regarding fuel energy sources that replace fossil fuels, and discussion of F1 engine regulations that have undergone drastic changes so that the technology can be applied to mass production cars (Iskandar et al., 2023; Marsyaelina et al., 2022).

This literature analysis is a qualitative method, using a research approach that focuses on data analysis. Literature analysis was carried out by citing some literature through the UNNES Science House page, in May-June 2024. We have conducted a literature review to find out how convincing the manufacturer's new engine project in F1 is in supporting net zero carbon declared by the F1 organizers and net zero emission world 2050.

3. RESULTS AND DISCUSSION

Vehicle electrification is being intensified by the government through various programs to reduce exhaust emissions produced by motor vehicles. Electrification is not only oriented towards electric vehicles (BEV), but also hybrid vehicles (a mixture of battery drive and conventional combustion engine).

Currently, the government of the Republic of Indonesia has changed the tax regulations for motor vehicles sold under new circumstances from ATPM, vehicles with the lowest emission values get a light tax, as well as vehicles with high emission values.

The hybrid technology developed in the latest regulation eliminates the MGU-H component, which is considered less relevant to the application in mass production cars. The manufacturer developed the MGU-K component which is more relevant to the technology in mass production components due to the regeneration energy wasted from deceleration.

Regulations of Fuel and Regulations

Referring to the technical regulations released by the FiA with the approval of all factory teams in the Formula 1 event, the engine can only use fuel as much as 70-80kg / hour (Andersson & Börjesson, 2021) this is a 20-30% decrease compared to the 2014 regulation engine which requires 100kg / hour of fuel (Olson et al., 2023), the FiA has issued regulations governing the content of substances in fuel and lubricants used in the latest regulation engine, the regulations are mentioned in the table below:

Table 1. Properties of fuels used in F1 competition in the 2026 engine regulations

Property	Units	Min	Max
RON		95	102
Sensitivity (RON-MON)			15.0
LHV	Mj/kg	38.0	41.0
Density (at 15°C)	Kg/m³	720	785
Methanol	%v/v		3.0
Oxygen	wt%	6.70	7.10
Nitrogen	mg/kg		500
Benzene	wt%		1
DVPE	kPa	45	68
LEAD			5

Manganse	mg/l		2
Metals (excluding alkaline)			5
Oxidation Stability	Minutes	360	
Sulphur	mg/kg		10
Electrical Conductivity	pS/m	200	

The fuel content must be at a maximum boiling point of $>210^{o}$ C. Engine lubricants are also not spared by developers to ensure that they are environmentally friendly, here are the testing methods for engine lubricants.

Table 2. Lubricant properties and test methods used in the F1 2026 engine regulations

Property	Test Method
Saturates	ASTM D2007
Viscosity Index	ASTM D2270
Sulfur (one listed method)	ASTM D1552
	ASTM D2622
	ASTM D3120
	ASTM D4294
	ASTM D4927

New Renewable Fuels to Replace Fossil Fuels

The use of fossil fuels is currently increasingly restricted due to the amount of exhaust pollution, the European Union is currently developing neutral electro biofuels that will be used after 2035 (Karavalakis et al., 2013). CO hydrogenated fuels are becoming the favorite of researchers because they can integrate well with the fuel currently used by the general public (Fédération Internationale de l'Automobile, 2022).

A development team from a German aerospace research center has made research on the use of synthetic materials as the main composition in new renewable fuels to replace fossil fuel oil (Boretti, 2019). The development team conducted research into aviation fuel (JET A-1) and ground transportation fuel. JET A-1 combines synthetic oil from paraffin. Tests, conducted in accordance with ASTM D4054, concluded that the blend improved engine performance and reduced carbon exhaust levels significantly, but fell short of the ATAG standard of 50% exhaust reduction.

The team also developed a motor vehicle pollution treatment through observing the behavior of fuel blends mixed with oxygen, they prepared Methanol, Ethanol, Butanol (n- or i-), Dimethoxymethane (DMM), and Oxymethyleneethres (OME) 3-5.

Butanol blending has no effect, increasing CO gases due to lower combustion temperatures (OECD-FAO, 2019; Swedish Energy Agency, 2021), but HC gases can drop significantly when butanol is blended at 40% max. Blending 15-25% OME can reduce CO and HC exhaust gases significantly (Albrecht & Nguyen, 2020; Hannula, 2016; Hinderks & Wagner, 2020). Blending Butanol, OME, DMM, can reduce NOx gas significantly due to the large oxygen content in these three substances (Hannula, 2016; Hinderks & Wagner, 2020; International Energy Agency, 2019; Plötz et al., 2017).

Isobutanol utilization through renewable sources, namely biomass, is also a development program in the search for the next renewable fuel (Su et al., 2020). Isobutanol can also be obtained from a mixture of methanol and several other alcohols (such as ethanol) by the Guerbet reaction method. The cost of producing a titer of Isobutanol requires USD1.42/l; the cost has drastically decreased from USD2.24/l after a study by Roussos et al. (2019), while the cost of producing cellulosic ethanol is "only" USD0.73/l after a study by Lynd et al. (2017).

The addition of Isobutanol as an oxygenate can reduce the CO and PM values that come out of the engine combustion and improve fuel consumption significantly, the presence of alcohol in this mixture can reduce the explosion point so that NOx levels can be suppressed. Behind these advantages, blending Isobutanol with conventional gasoline can reduce the calorific value of the fuel itself, the power produced by the engine decreases especially at low temperature conditions (Iskandar et al., 2020, 2024; Karavalakis et al., 2014; Yang et al., 2016).

Combining Renewable Fuels with Hybrid Cars

The combination of using renewable fuels with a hybrid system that efficiently captures the wasted kinetic energy results in lower CO_2 exhaust than a fully electric car.

The test was conducted using a KIA Niro, KIA Niro has 3 types of electrified cars namely HEV, PHEV, and BEV (Kathrotia et al., 2018; Lee et al., 2009). E85 is 85% ethanol with 15% (fossil) gasoline, HVO is hydrotreated vegetable oil.

Table 3. Emission output of each energy source [4]

Energi	CO_2 g/l	CO_2 g/kWh
Gasoline (fosil)	2930	-
E85	1120	-
HVO	295	-
2020 EV	-	429
2050 EV	-	38

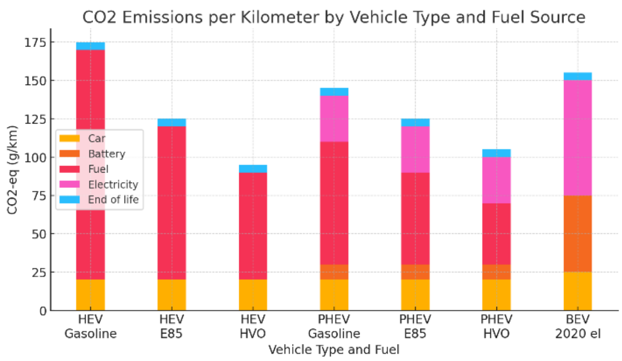

Figure 1. Emission cycle between HEV, PHEV, and BEV with EU-28 2020 electricity

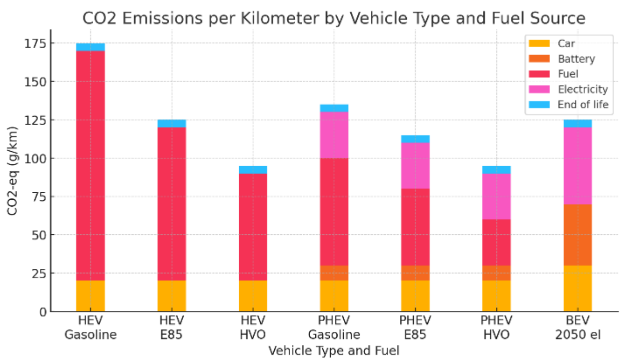

Figure 2. Emission cycle between HEV, PHEV, and BEV with EU-28 electricity 2050

Both figures above show that HEVs with HVO fuels have the highest CO2 gas reduction potential reaching 74% even compared to the 2050 electric technology.

A regulatory framework on renewable fuels has been developed by the European Renewable Energy Directive (REDII), which states that greenhouse gas savings should be above 65% for biofuels and 70% for other fuels starting from 2021 (Brosowski et al., 2016).

4. CONCLUSIONS

The conclusion of this literature review is that the fuel applied by the FiA technical team for F1 engine regulations is a synthetic fuel derived from household waste.

The majority of research that has been done is blending fossil fuels with biofuels extracted from nearby plants and biomass from agricultural waste. The results from testing such blended fuels can produce significantly lower greenhouse gas values than using 100% fossil fuels.

Research on synthetic fuels needs to be done to **test** the reliability of these fuels. The idea of synthetic fuels can also help reduce environmental concerns and waste.

The use of *hybrid* technology also helps reduce greenhouse gas pollution because the combustion engine does not turn on more than 60%, the energy obtained from the car's deceleration (rotation of the generator turbine to the battery and braking) can prevent the engine from turning back on because the energy from the battery is maintained at a certain level.

5. DECLARATION/STATEMENT

5.1. Author Contribution

Here is the role of the writer in the article we compiled. Putu Wisnu Darmayasa contributed to as chairman and searching for articles as research material, reviewing each article both whole articles and the results of studies from friends in order to get valid data. Compiling the whole article and editing. Fiqih Firman Syah contributed to searching for articles as research material, reviewing each article obtained and reporting to the chairman, compiling abstracts on articles. Wahyu Hidayat contributed to searching for articles as research material, reviewing each article obtained and reporting to the chairman, compiling problem topics that will be discussed in the article, providing input and suggestions to the chairman regarding data collection on the articles reviewed. Yudan Lutfy Fadillah contributed to searching for articles as research material, reviewing each article obtained and reporting to the chairman. Irlan Supralan contributed to searching for articles as research material, reviewing each article obtained and reporting to the chairman. Muhammad Irfan Rachman contributed to searching for articles as research material, reviewing each article obtained and reporting to the chairman.

5.2. Conflict of Interest

There is no conflict of interest in the preparation of this scientific article.

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