

ME-352 Applied Thermodynamics Lab

Energy Recovery System: MGU-K and MGU- H for F1 Cars

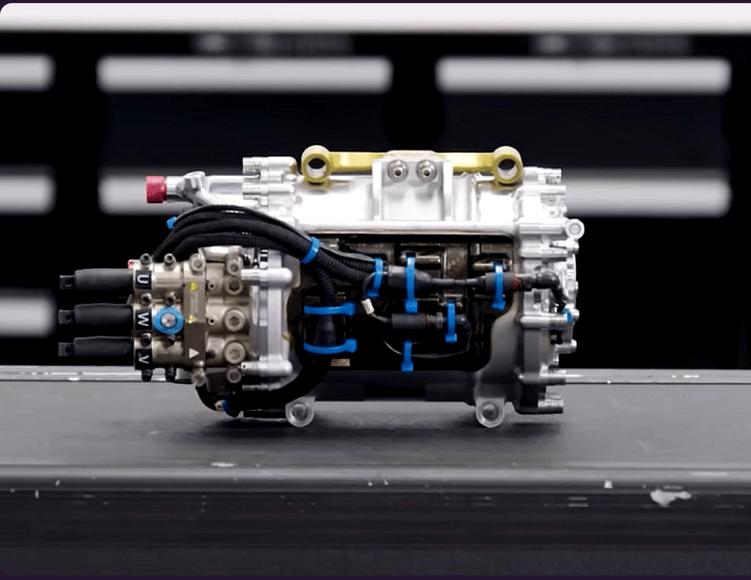
The Energy Recovery System (ERS) is a key component in modern-day Formula One. In this presentation, we'll explore how the MGU-K and MGU-H units work together to gain a competitive advantage on the race track.

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What is the MGU-K?



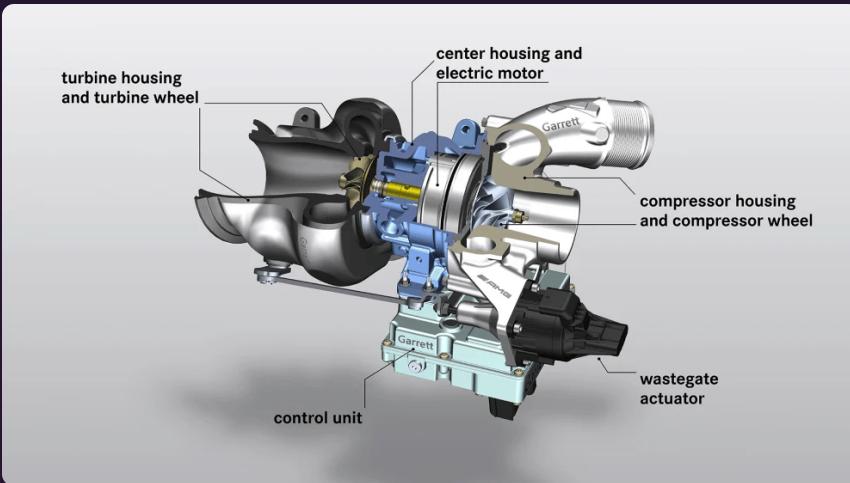
How it works?

The Motor Generator Unit - Kinetic (MGU-K) recovers the energy generated by braking and stores it in the battery. On the track, this energy can then be used to provide a power boost to propel the car forward.

The Benefits:

By deploying the stored energy at strategic points during the race, drivers can improve their lap times and gain a crucial advantage over their rivals. In a sport where every fraction of a second counts, the MGU-K is a game changer.

What is the MGU-H?



How it works?

The Motor Generator Unit - Heat (MGU-H) recovers the heat energy generated by the turbocharger, which is usually wasted in conventional engines. The MGU-H then converts this energy into electrical energy which can be stored in the battery.

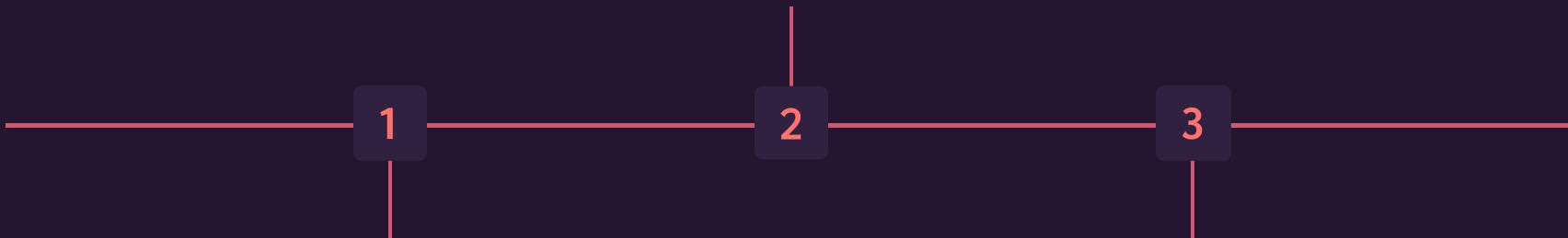
Performance Enhancement:

The stored energy can be used to enhance the performance of the MGU-K, or can be used to power the MGU-H itself - effectively making it a second engine. By making efficient use of waste energy, the MGU-H helps F1 cars achieve new levels of performance.

MGU-K and MGU-H: The Perfect Pair

Increased Efficiency

The deployment strategy of MGU-K and MGU-H can be customized to suit race tracks or various driving scenarios, allowing for greater efficiency compared to traditional engine systems.



Optimizing Performance

By working in tandem, the MGU-K and MGU-H can provide a non-stop energy recovery system, greatly improving overall performance of the car.

Success on the Track

As a pioneer in energy recovery systems, F1 teams using MGU-K and MGU-H have enjoyed great success on the track, with several teams winning multiple championships.

Key Figures and Benefits:

Power:

MGU-K can provide up to 160 horsepower and MGU-H can provide up to 50 horsepower.

Efficiency:

ERS systems can recover up to 80% of wasted energy, providing better fuel efficiency and less harmful emissions.

Advantage:

Cars equipped with ERS have a big advantage over those without the system in terms of speed and acceleration. Along with this we get significantly lower level of carbon emission per race distance.

Analysis methodology:

$$\eta = \frac{W_{out}}{Q_{in}}$$

$$W_{mgu} = 120 \text{ kW}$$

$$Q_{in} = m_f \cdot LVH$$

$$\begin{aligned}\eta &= \frac{W_{out}}{Q_{in}} \\ &= 0.0973 \\ &= 9.73\%\end{aligned}$$

For Carbon emission: Mass of carbon emitted = (mass of fuel) * 8.887 kg of CO₂

$$\eta_t = \frac{\text{actual work}}{\text{isentropic work}} = \frac{\dot{W}_a}{\dot{W}_s}$$

$$\eta_c = \frac{\text{isentropic work}}{\text{actual work}} = \frac{\dot{W}_s}{\dot{W}_a}$$

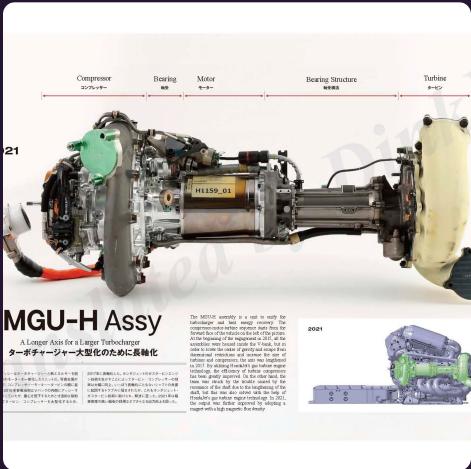
$$P_T = 32.3026 \text{ kW}$$

$$P_c = 16.76559 \text{ kW}$$

$$P_T - P_c \pm P_{MGU-H} = T\omega$$

$$\frac{P_{MGU-H}}{P_T} = 0.3916$$

MGU-K and MGU-H in Action:



Efficient Energy Recovery

MGU-K and MGU-H in action, working together to provide a non-stop energy recovery system.



Powerful Force

MGU-K provides an additional power boost to the engine, ensuring explosive acceleration.



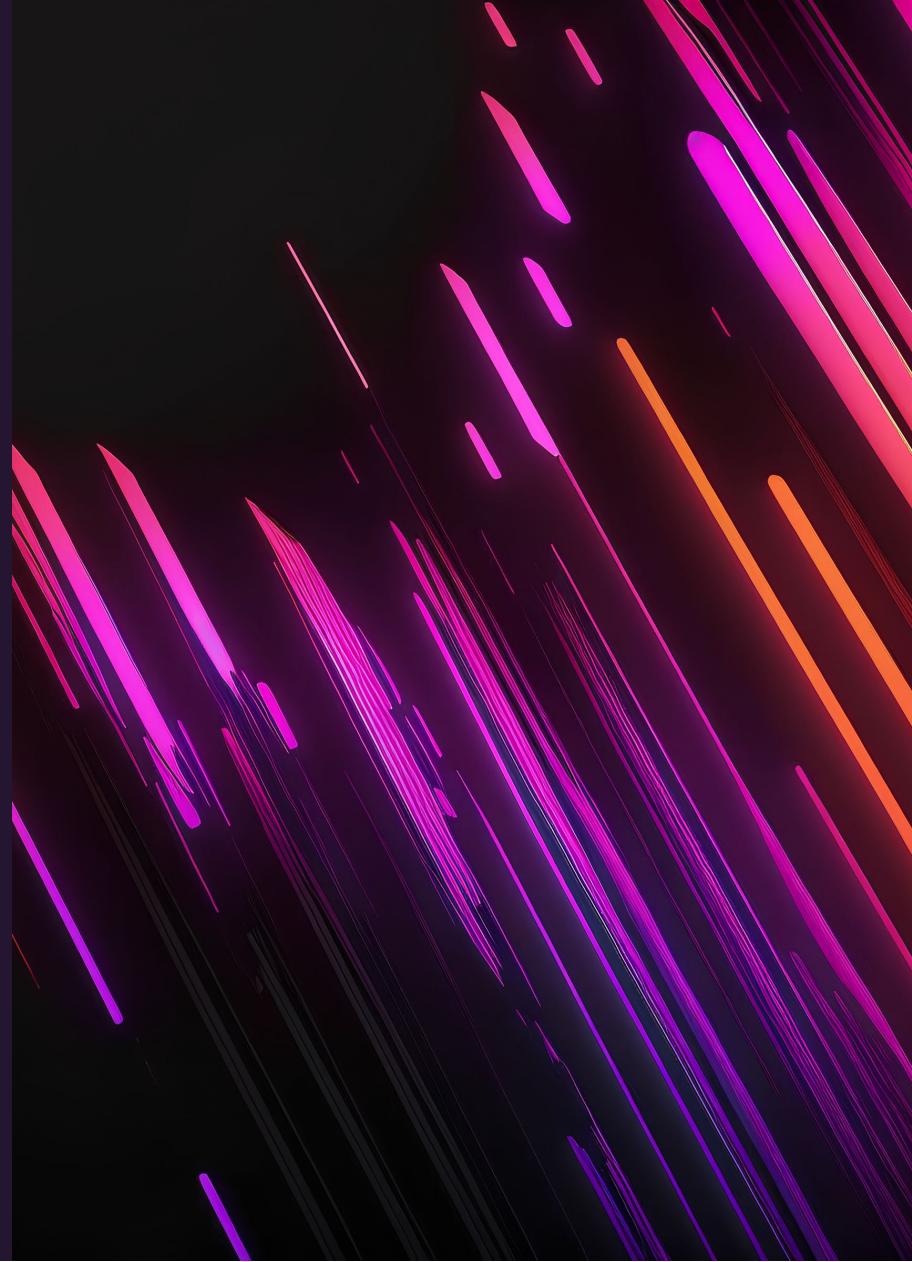
Maximum Speed

The stored energy can be used to power the MGU-K, allowing for more speed on the track.

The Future of ERS Technology:

With rapid advances in technology, we can expect to see more efficient and powerful ERS systems in the future. These innovations will further reduce waste and emissions while also pushing the limits of what F1 cars are capable of achieving.

Today, the MGU-K and MGU-H systems available are quite expensive and thus the future scope can be to develop comparatively cheaper MGU-K and MGU-H systems to allow them to be used more often.



Conclusion:

The results are as follows:-

- When the MGU-K is being used in F1 cars, the net efficiency of its engines increase by **9.73%**.
- The carbon emissions due to the introduction of MGU-K in F1 cars is quite a considerable amount of about **10%**.
- Introduction of MGU-H allows us to recover about 12.651W of exhaust energy and store it in the form of electrical energy which can be used to prevent **turbo-lag**. This is about 39.16% of total exhaust energy.

The use of MGU-K and MGU-H has revolutionized modern-day Formula One, allowing teams to gain a decisive edge on the track. As ERS technology continues to evolve at a rapid pace, we can expect to see even greater breakthroughs in the years to come.

References:

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