flybridsystems

Mechanical Hybrid Systems

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Introduction

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Flybrid Systems is a privately owned company developing kinetic energy recovery systems for motorsport and road vehicles

- Based in the Technology Park at Silverstone circuit
- Staffed by highly skilled and experienced engineers
- With a Formula One spec system built and tested
- Already working on road car applications

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The Flybrid System

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A high-speed flywheel based energy storage and recovery system

- A light weight composite flywheel spinning at very high speed
- The flywheel runs in a vacuum and is enclosed within a housing that provides containment in the event of failure
- The flywheel is connected to the vehicle by a Continuously Variable Transmission (CVT)
- Control of energy storage or recovery is managed by controlling the torque transferred through the CVT
- A clutch allows disengagement of the device and minimises losses when not in use

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F1 System Specification

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• Power	60 kW (restricted by regulation)
• Storage	400 kJ
• Weight	25 kg
• Efficiency	> 70% round trip mechanical
• Dynamic response	zero to full power in 50 ms
• Life	2,000 km between rebuilds
• Flywheel speed	64,500 RPM Max
• Flywheel weight	< 5 kg for 400 kJ
• Control system	Flybrid KCU with CAN link

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System layout for F1

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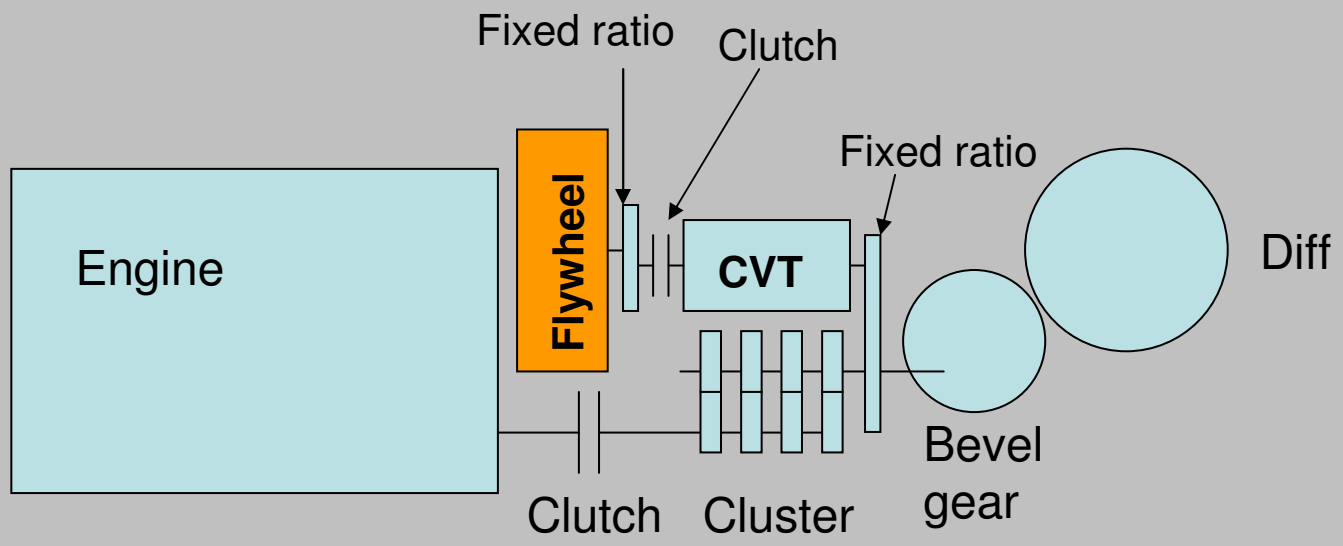

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Flybrid F1 System Working Envelope

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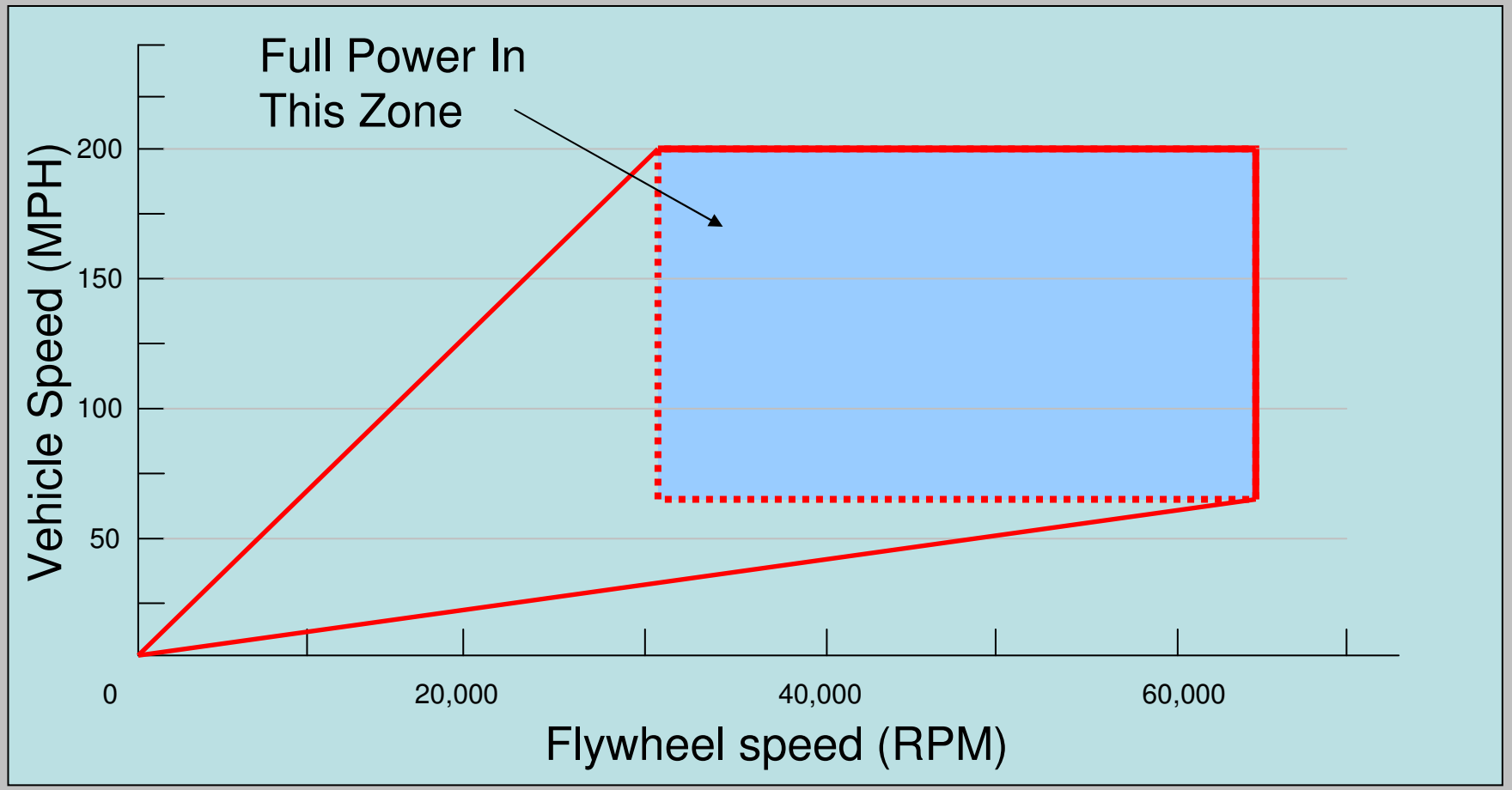

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Demonstration System

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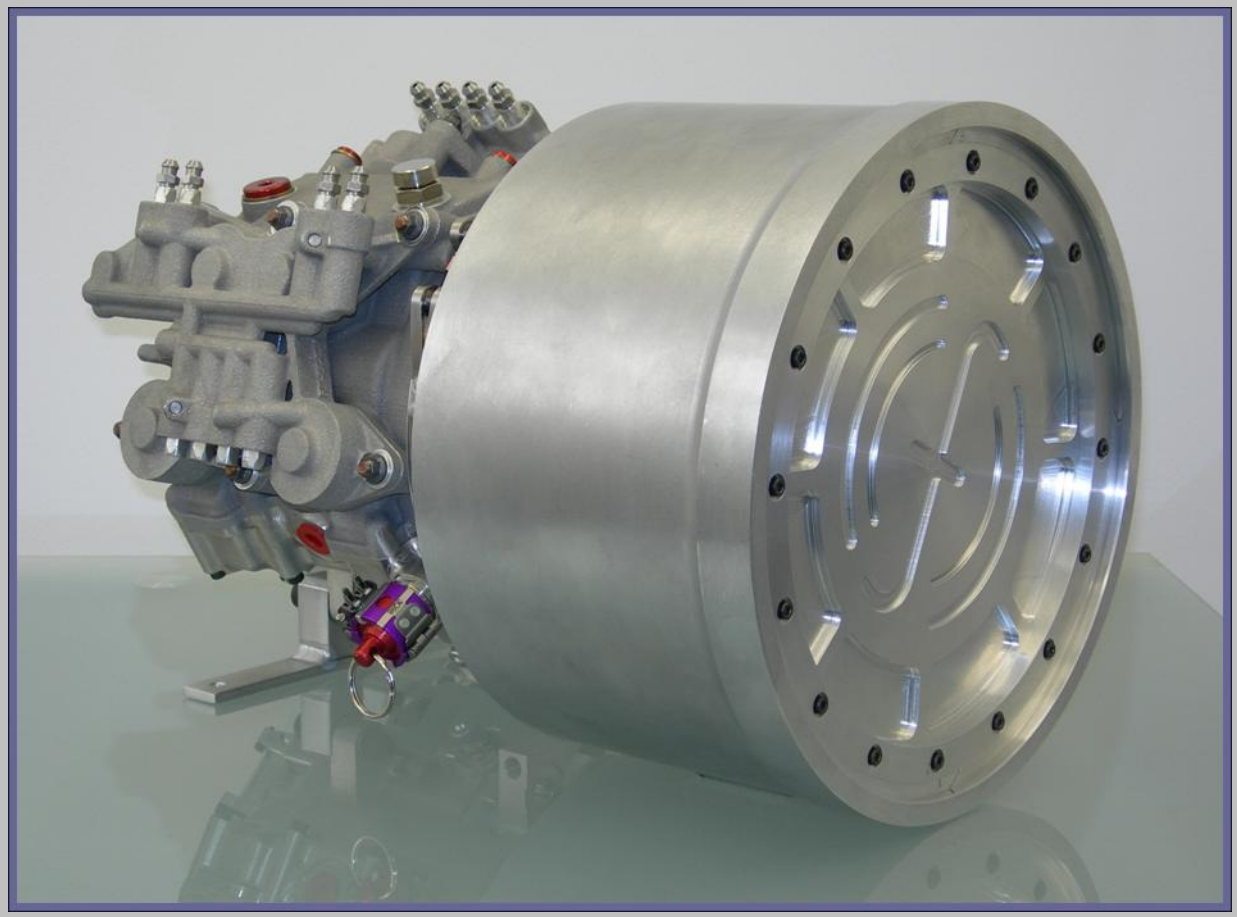

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Key Components

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CVT variator

Control system

Flywheel

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F1 System Testing

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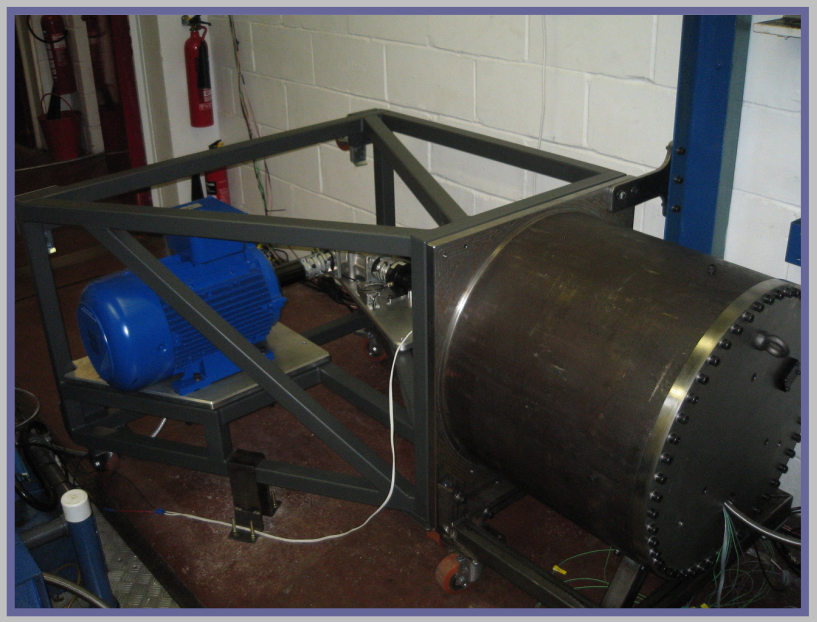
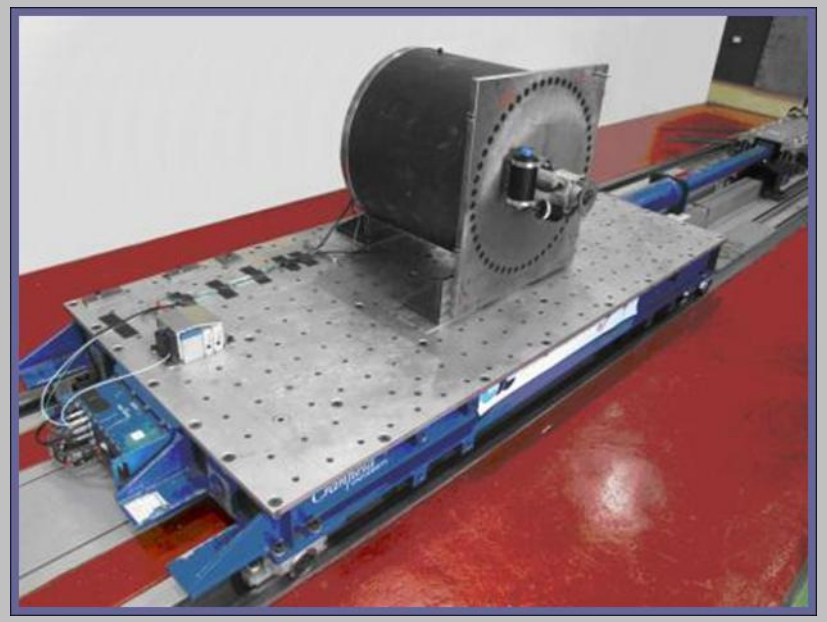
A full prototype KERS has been made and fully tested



Flywheel Spin Test



Flywheel Crash Test

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F1 System Testing

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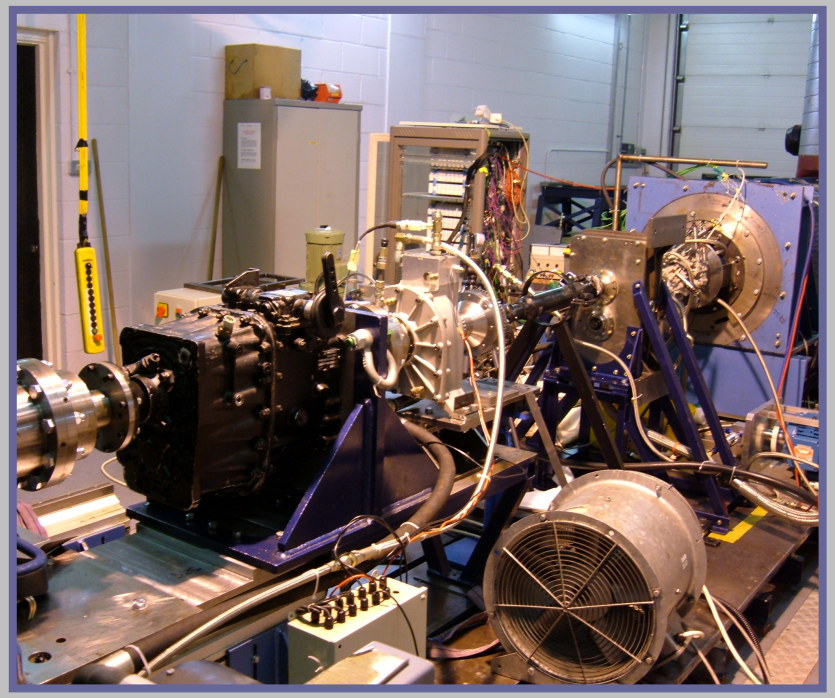
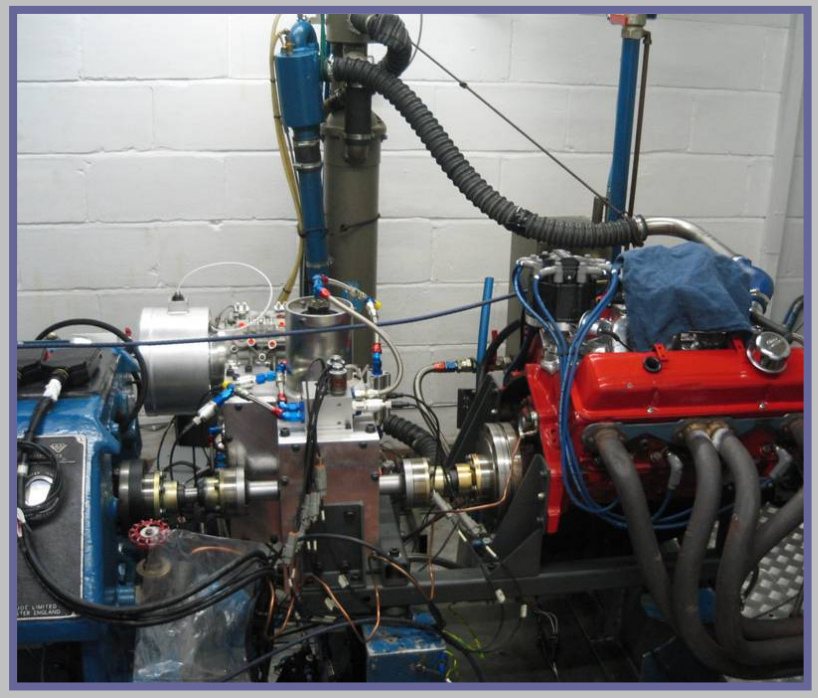


CVT Transmission Test



Full System Dyno Test

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Road Car Applications

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The system is absolutely relevant to road cars, buses, trucks and trains

- The change from a Formula One system to a road vehicle one is quite straightforward
- All the key components have a long fatigue life and the bearings are conservatively rated
- The CVT has already been ‘production approved’ by a large car maker
- The cost in volume can be accurately forecast

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Key Competitor Technology

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Electric Hybrid

Electric hybrid vehicles are increasing in popularity and they do offer fuel savings on certain drive cycles but they have received poor reviews for their real world economy

There are significant issues with the technology such as high installed weight, poor efficiency, performance degradation with life, availability of raw materials, end of life recycling and cost

These issues have so far restricted applications to high priced niche vehicles

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Technology Comparison

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	Flybrid System	Electric Hybrid
Round Trip Efficiency	74%	34%
Weight	35 kg	85 kg
Volume	20 litres	50 litres
Cost (200k units)	$2,000	$8,000

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Potential Fuel Savings

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Simulation of vehicles fitted with the Flybrid system shows:

- 18% saving for a 1.7 ton saloon car on the NEDC test cycle
- 35% saving for a 2.6 ton SUV on the US FTP drive cycle
- 45% fuel saving for a 17 ton bus on the London bus drive cycle

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Its All About The Cycle!

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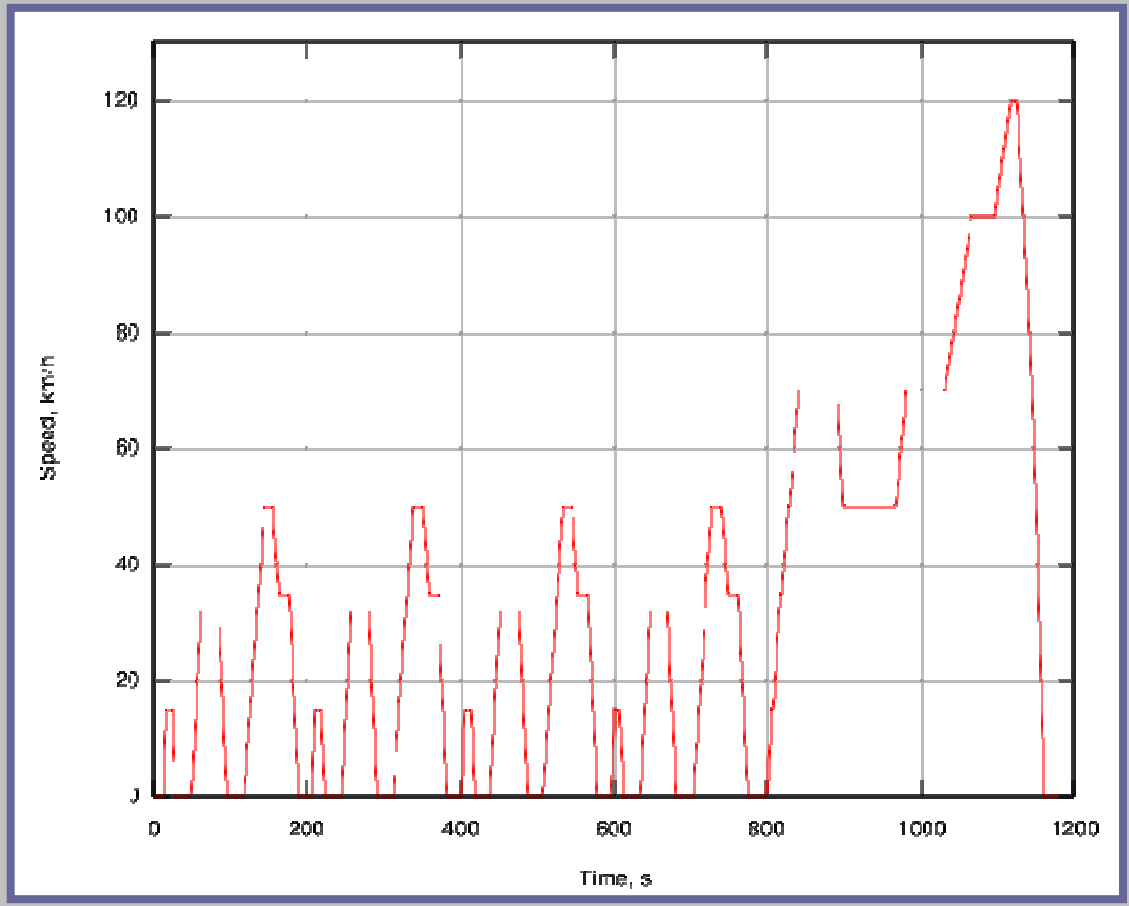
The NEDC test cycle features very gentle acceleration and deceleration

A low power hybrid solution with very little storage will get a good result on this cycle



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Real Drive Cycles

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Many real drive cycles are much more aggressive than NEDC

- It is reasonable to assume that all sports cars and most heavy cars will be driven this way
- Many commercial vehicles also have very aggressive drive cycles
- For these applications a powerful hybrid system is needed to capture the available energy and this is easily achieved with a mechanical system

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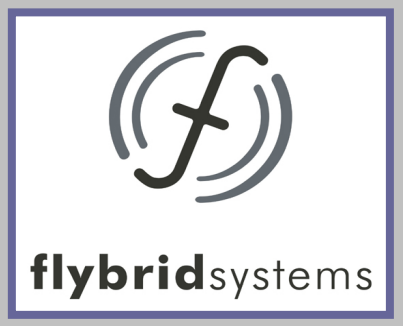
Mechanical Hybrids Offer A Truly Green Solution



- Made from abundant materials that are relatively easy to extract
- A long life with very low degradation means the vehicle maintains its low emissions over time
- The unit is serviceable with replacement bearings and seals
- At the end of life it is easy to recycle and the high quality materials will have a high scrap value

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Future Development

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There is huge potential for future development of this technology

- Operation strategies
- Alternative mechanical configurations including the choice of CVT or IVT can allow functionality like stop / start or driving the vehicle with the engine turned off
- Friction reduction for improved efficiency
- Traction fluid development for improved efficiency
- Higher flywheel speeds for more storage or lower weight

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Future Applications

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Kinetic energy recovery is a clear energy saver and should be used on all vehicle classes

- Deployment depends not only on the technical qualities of the solution but also on cost
- Mechanical KERS has a strong part to play and can be used on vehicles with a wide range of primary power sources
- Even electrically powered vehicles should use mechanical KERS because it is much more efficient and will extend both range and battery life

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