

2014 NEV Hong Kong

Directed Evolution of High-Energy Flywheels for Ground Vehicles 飞轮动力技术的研发现状及发展方向

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首席技术总监 Chris Ellis

Why Flywheel Energy Recovery? 为什么选择飞轮回收制动能量

- High Efficiency 高效
- High Specific Power 高功率
- Low Cost 低成本
- Safety 安全
- Life-of-the-vehicle 全寿命

Development Progress

商用车和工程机械应用前景和挑战 Comm Veh Opportunities

- 政策引导和强力推广，全国规模市场已经形成；
- 批量小，功率大，成本高；
- 节能效果显著。



Traction and Braking Energy Consumption

驱动和制动能量

2/10/4WD Vision

		EPA 75 Urban	Austr. Urban	ECE- 15	Japan 1015	New York City
Traction energy 驱动能量 (KJ)	Total	4000	6480	3478	1675	998
	Per km.	377	606	437	402	519
Braking energy 制动能量 (KJ)	Total	1934	4195	953	888	878
	Per km.	182	392	120	213	461
Percentage of braking energy to total traction energy (%)		48.3	64.7	27.5	53.0	88.8

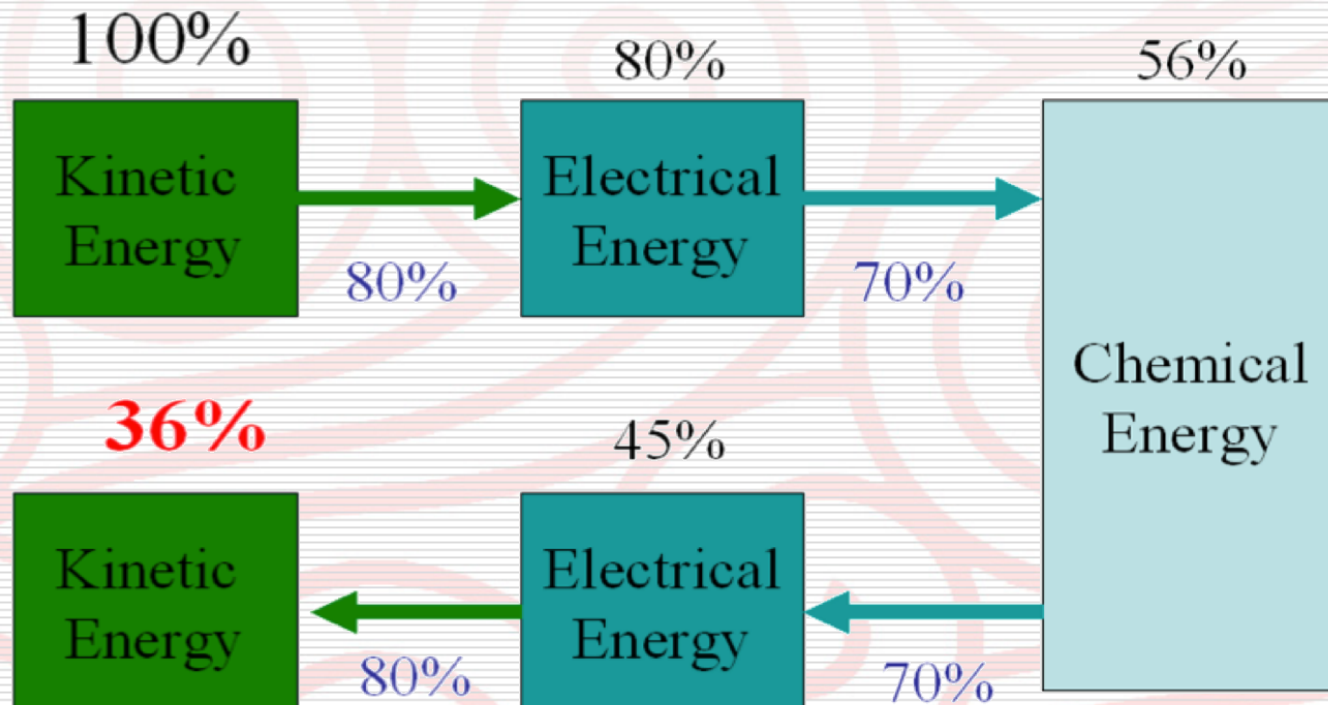
Effective regen braking is key for dramatic FE improvement

高效的制动能量利用是减少油耗的关键

Braking to a stop and back again 制动能量回收及再利用

A battery hybrid typically returns less than 35% of the vehicle's original kinetic energy

利用电池储能的混动系统仅可重新利用35%的制动动能

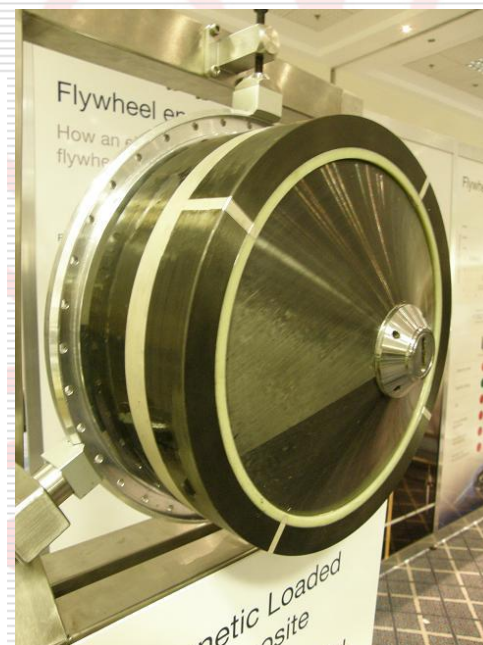
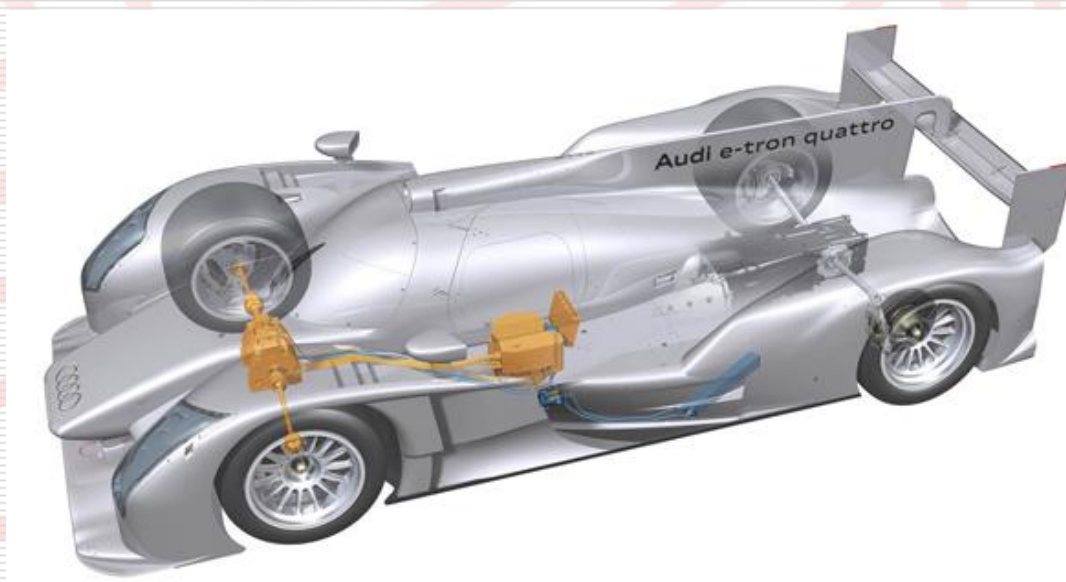


4
次
能
量
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换

Four energy transformations

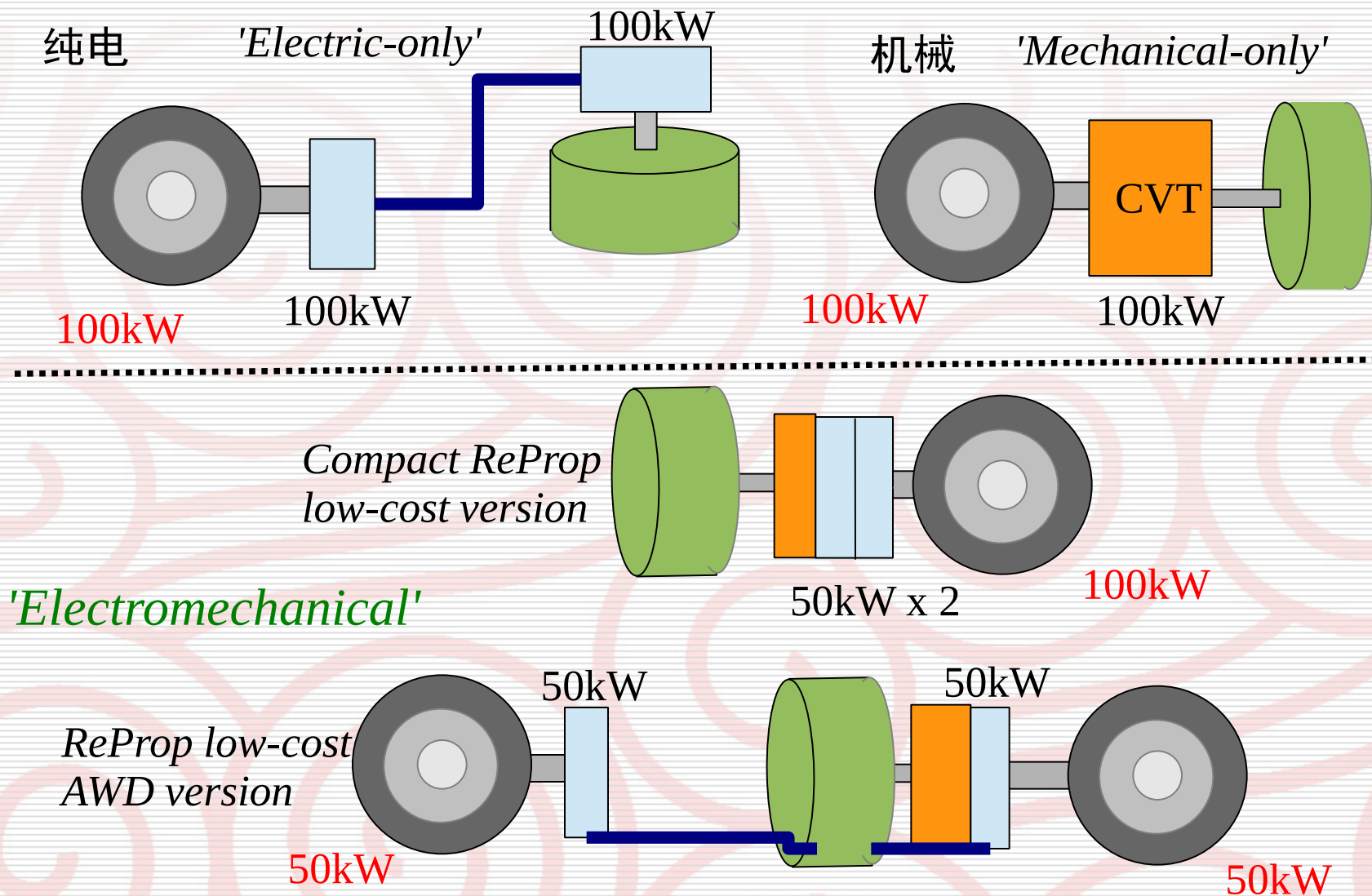
“储能式”飞轮混动系统 *Williams Flywheel*

- 2009年，世界F1赛车联合会颁布了在赛车中使用飞轮混动系统的新比赛规则
- 2012年24小时耐力赛在法国勒芒奥迪R18 e-tron quattro夺得第1、2名
- 采用了非常规的四轮驱动技术：后轮使用3.7L V6涡轮增压柴油发动机驱动，前轮则使用飞轮KERS电机驱动
- 这套动力的意义在于前轮的飞轮小型化能够带来高效的能量回收
- 英国威廉姆斯混合动力有限公司(WHP)开发



Flywheel ERS Evolution

飞轮能量回收系统的发展



Integrated Flywheel-assisted Surge Power Drive

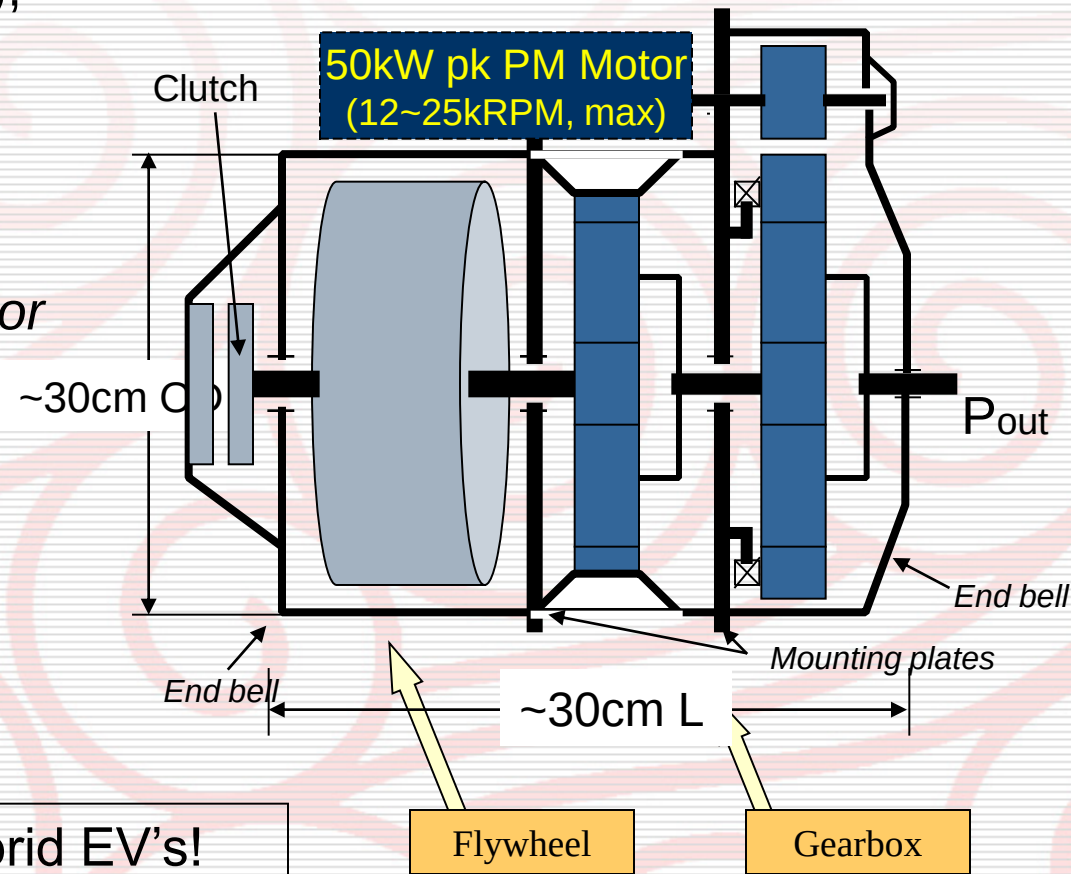
常州海科的“电动式”机电一体化飞轮助力驱动装置

Breakthrough approach to system integration w/ proven components

- Hi-speed IPM motor (~ 14krpm);
- Flywheel speed: ~15krpm;
- Batteries and controls housed separately.

Resulting in innovative and superior product concepts

- Scalable product line;
- Cost-effectiveness;
- Durability, reliability, life.



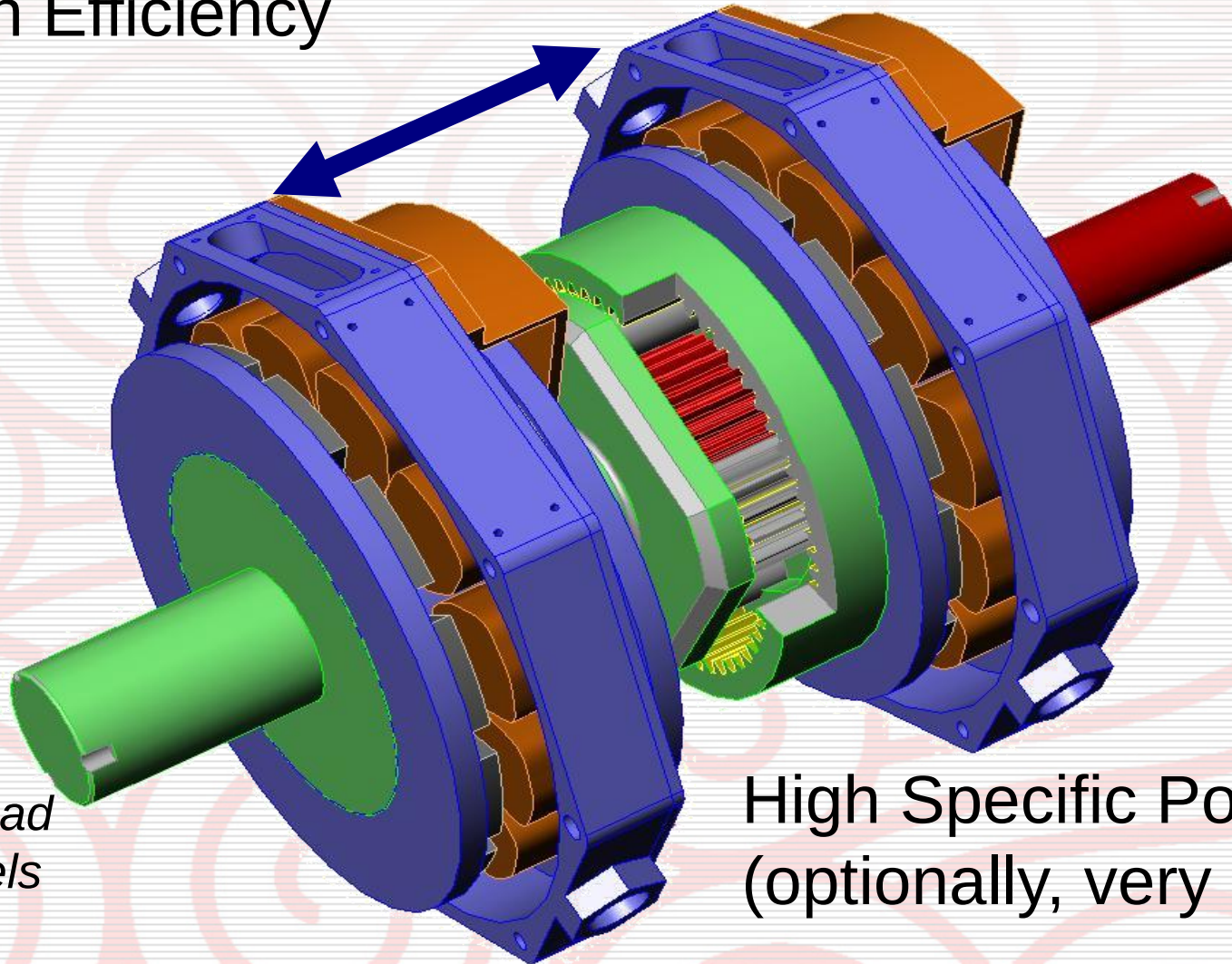
Hybrid approach to hybrid EV's!

Integrated Flywheel-assisted Surge Power System

常州海科的“电动式”机电一体化飞轮助力驱动装置

High Efficiency

To flywheel(s)



Low
Cost

To road
wheels

High Specific Power
(optionally, very high)



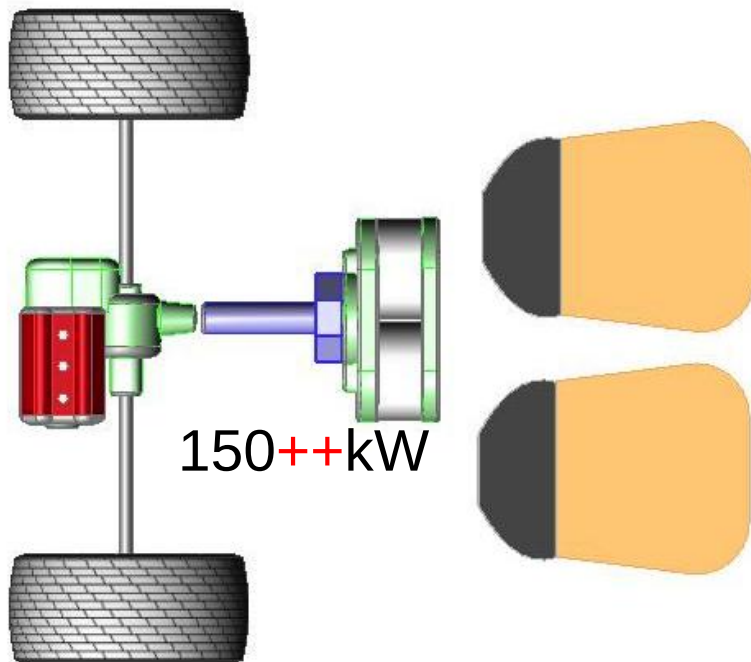
'Virtuous Supercar'

*Low
L/100*

150kW

150++kW

*Plug-in
optional*



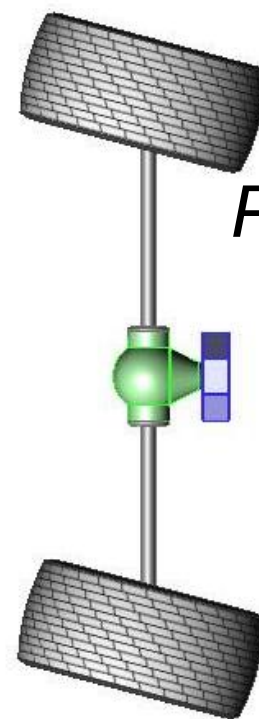
AWD

Full Regen

150kW

Low CdA

<1100kg





LE MANS 2014 LMP1 FUEL FLOW LIMITS - from Appendix B

'Releasable Energy' MJ/lap	<2	<4	<6	<8
Max Petrol Flow kg/hour	93.0	90.5	87.9	87.3

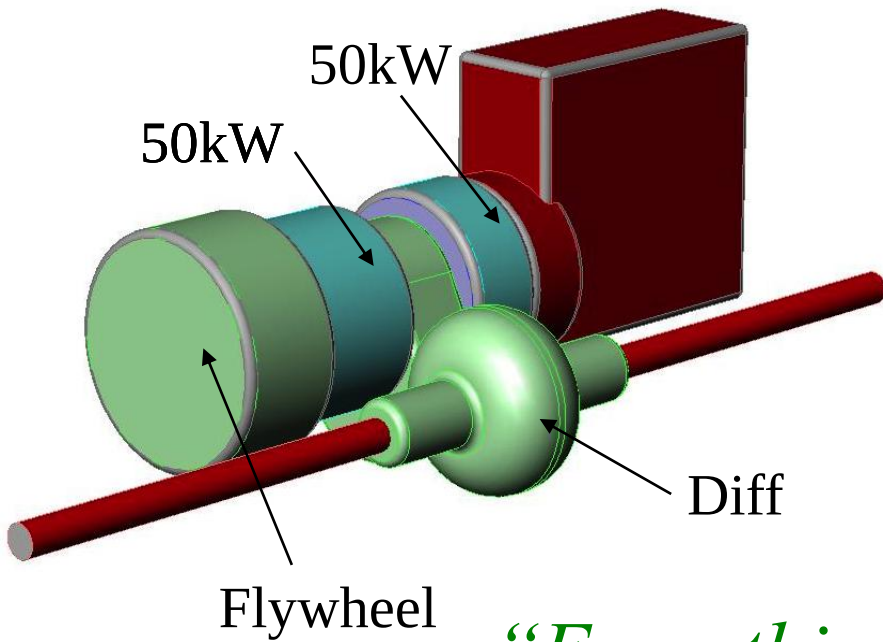
Non-hybrid LMP1-Ls are allowed 95.6 kg/hr, 9.5% more than a '<8'

'Punishing the virtuous'

It's a **French** thing – you wouldn't understand....

World motorsport is controlled from Paris....

Hybrid Family Car

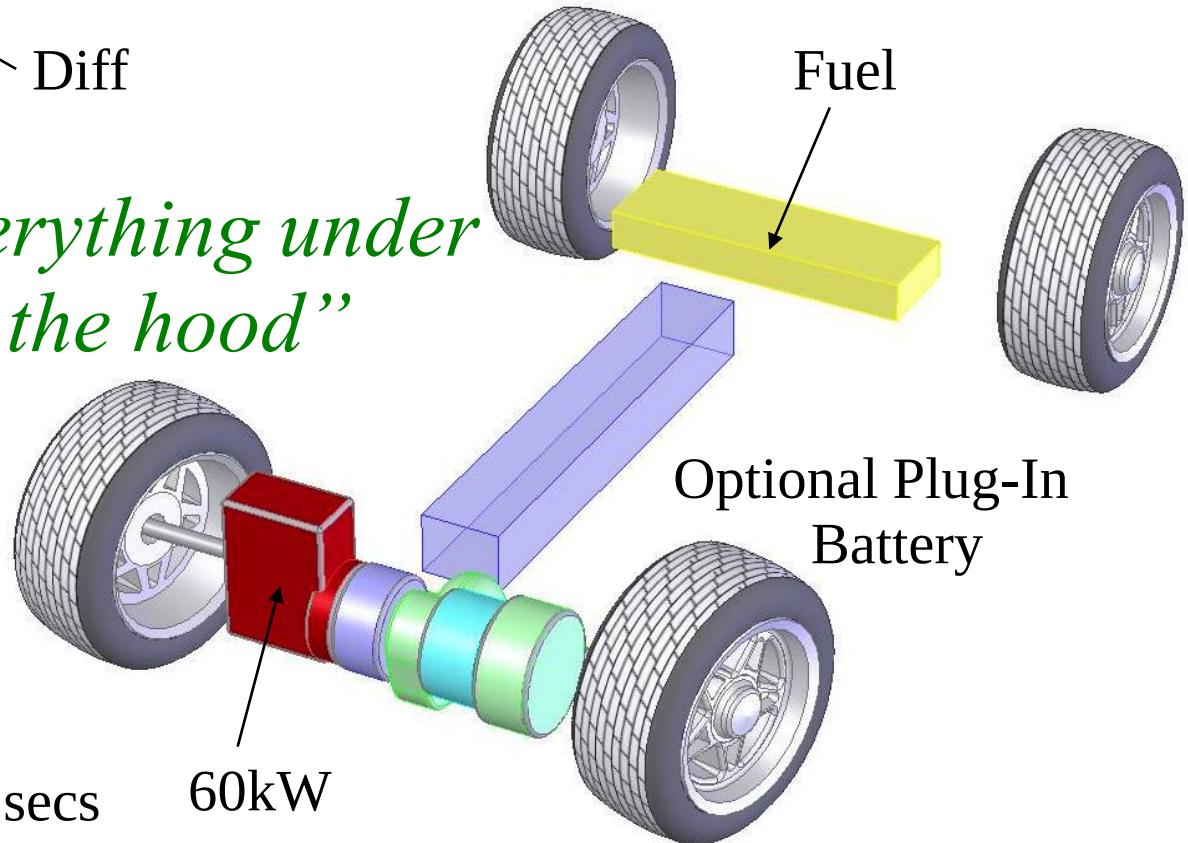


“Everything under the hood”

Engine off: 100kW

Engine on: 160kW

0 – 100: < 10 secs, < 8 secs



EM Flywheel Power Product Dev @ CHK

常州海科的产品开发进程

- PoC prototype 原理样机：2012.7.
- Test-rig prototype 台架样机：2012.12.
- Functional Proto. 功能样机：2013.9.
- *Market Launch* *市场投放：2014.8.*



Conclusions

- *Flywheel Power is emerging as the next-generation drive technology*
飞轮动力系统正被公认为新一代新能源汽车动力主流技术和产品。
- *EM flywheel power system is of superior performance, least development risk and lower cost for wide-range of applications.*
机电式飞轮动力系统 产品性价比高，技术风险小，应用范围广泛。
- *Compared to traditional Flywheel-based ESS, it is of light & compact package with minimal gyroscopic effect & safety hazard.*
• 比传统的飞轮储能系统更加精简，安全，有更小的陀螺效应。
 - *Flywheel speed: ~25krpm vs. 50-100krpm*
 - *Rigidity & Safety*
 - *Tolerant of high shock and vibration loads from road*

High efficiency, high specific power, low cost
高效，高功率，低成本

Thank You

谢谢!

Merci!