



Formula E – the evolution towards all wheel drive, or not?

Roger Griffiths EAWD'19 – Graz, Austria



Introduction

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Roger Griffiths

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Former Formula E Teams and Manufacturer's
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25year veteran of motor racing encompassing
F1, IndyCar, Le Mans Prototypes, and Touring
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Part of the Andretti Formula E team from the
beginning

Press PLAY!

What is Formula E?

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From a debut in the grounds of the Olympic Park in Beijing in 2014, FIA Formula E has grown into a global entertainment brand with motorsport at its heart.

11 teams and 22 drivers on the grid, 9 manufacturers on board – from Jaguar, Nissan, BMW, Audi to DS and Mahindra - Formula E serves as a competitive platform for global car manufacturers and mobility providers to test and develop road-relevant technologies.

Racing on the streets, the series acts as a catalyst, helping to refine the design of electric vehicles and improve the driving experience for everyday road car users

ABB FORMULA-E 2018/19 FIA FORMULA-E CHAMPIONSHIP SEASON 5 CALENDAR		
ROUND 1	AD DIRIYAH, SAUDI ARABIA*	15 TH DEC 2018
ROUND 2	MARRAKESH, MOROCCO	12 TH JAN 2019
ROUND 3	SANTIAGO, CHILE*	26 TH JAN 2019
ROUND 4	MEXICO CITY, MEXICO	16 TH FEB 2019
ROUND 5	HONG KONG, CHINA	10 TH MAR 2019
ROUND 6	SANYA, CHINA*	23 RD MAR 2019
ROUND 7	ROME, ITALY	13 TH APR 2019
ROUND 8	PARIS, FRANCE	27 TH APR 2019
ROUND 9	MONACO, MONACO	11 TH MAY 2019
ROUND 10	BERLIN, GERMANY	25 TH MAY 2019
ROUND 11	BERN, SWITZERLAND*	22 ND JUNE 2019
ROUND 12	NEW YORK CITY, USA	13 TH JULY 2019
ROUND 13	NEW YORK CITY, USA	14 TH JULY 2019

*Subject to circuit homologation

Building on five seasons of racing, the championship features 13 races in 12 of the world's most progressive cities covering five continents.

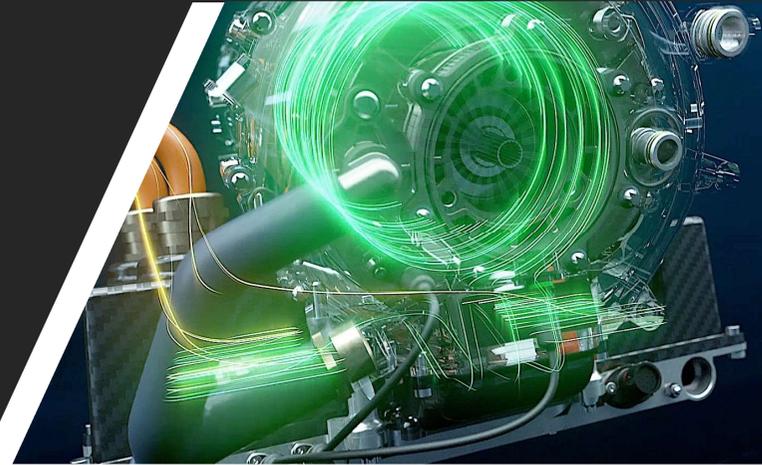
The powertrain technology behind Formula E – pushing the boundaries

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The current (Gen 2) Formula E Car

- 900kg all up weight including driver
- 250kW, (single or twin) Motor / Generator unit
- 52kWhr traction battery by McLaren
 - 890v, 500A output
 - 380kg
- SiC MOSFET Invertor
- Single speed transmission driving rear axle only
- Open control systems and software
- Brake by wire



Comparing to a Road car

BMW Racing eDrive01 vs. electric drive in the BMW i3:

Weight of drive	-50 percent
Performance of drive	+100 percent
Size of drive	-66 percent
Energy density of drive	+300 percent
Torque density of drive	+100 percent



TYRES All-weather tyres last the full race as there is no longer a car swap

The evolution toward AWD – brake regeneration

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In Season 1→4, heavy cars, low-downforce, two wheel drive, treaded all-weather tyres and sensitive brakes. Lap by lap manual brake bias adjustment as regenerative system performance varied with state of charge and battery temperature. All being managed on a bumpy low-grip street circuit with closely lined with walls. That's a lot of things to get right!

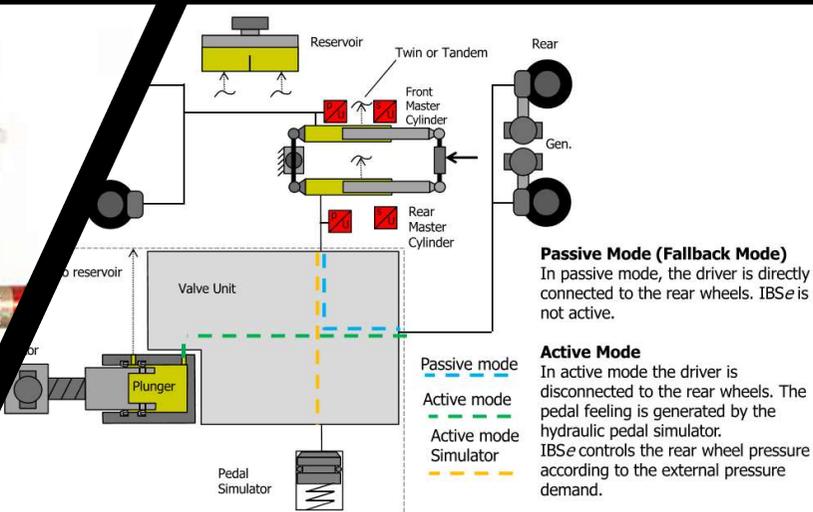
Driving mistakes are common up and down the grid adding to the unpredictability and excitement of FE races.



Glowing red brake discs and no regeneration capability from the front axle means approx. 50% of the braking energy wasted and not converted to electrical energy.

Gen 2 car; Brake regeneration – the next steps

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Active braking and regen systems are an integral part of electric road car technology – “It’s probably important to have it in order to show the technology for the road,” – so the use in FE makes sense. The problem is keeping the balance between entertaining racing and engineering-driven excellence that makes things predictable.



Motor racing is entertainment, isn't the driver the real star?

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BMW i Andretti driver Antonio Felix da Costa warned that “we have to find a way to make races really entertaining next year, the car will be easier to drive”.



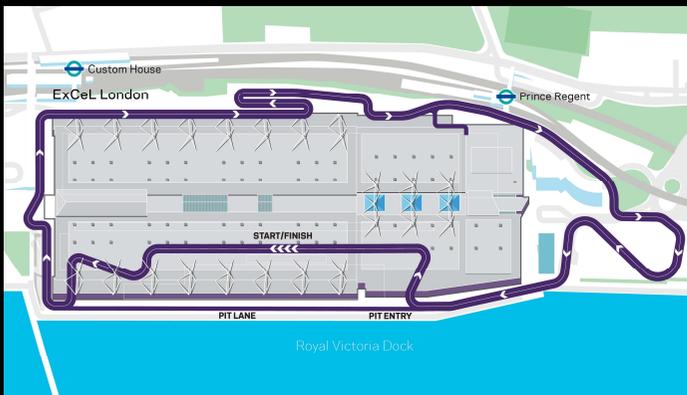
Formula E – Street racing is key

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A cornerstone of Formula E is racing on street circuits in the heart of the world’s great cities. Racing Formula E cars on a purpose-built circuit racing would dilute the message it promotes regarding sustainability and the environment. But street circuits do bring limitations regarding car performance related to the safety and circuit homologation aspects.

Will too much technology leading to too much speed mean the loss of some city circuits....?



“Formula E coming back to the UK extends beyond pure racing excitement, it’s also a strong message for London to tackle inner-city air pollution by promoting clean technologies and electric sustainable mobility” – Agag, Chairman, Formula E

What comes next, the third generation of Formula E

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	Gen 2 S5 Current	Gen 2 Update	Gen 3 S9 Base	Gen 3 S9 Alternate
Battery capacity	52 kWh	←	5? kWh	5? kWh
Max Power Qual	250 kW	←	350kW	350kW
Max Power Race	200kW	Potential Increase	300kW	300kW
Max Power FanBoost	250 kW	←	300 kW	300 kW
Attack mode	?	?	?	?
Other in race features			Fast Charging?	?
Max Power Regen	250 kW	←	250 kW	250kW
E Diff / 1 MGU per wheel / TRQ Vectoring	No	←	No	Open to discuss
Braking system	Active	←	Active	Active
Transmission	RWD	←	RWD	AWD
Car Design	Generation 2	Generation 2 plus update bodywork	New Design	New Design
Weight inc. driver	900kg	←	850kg	875kg

Possible front GU for front axle braking regen only



“For a start, the right approach for an electric racing car is to make it all-wheel drive, with electric motors connected to each wheel - not individually, as we want to control torque vectoring ability, but using a differential.” “It will make things less driver relevant, It’s part of the evolution, we have to find other ways to make the show better.” – de Grassi

The third generation of Formula E – AWD and where does this take us?

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JAGUAR



Mahindra



Mercedes-Benz



PORSCHE



Pros – the view of the OEM / Manufacturers

Stronger relevance to the road car direction – OEM justification for racing

Increase in the technical content

Likely increase in on track performance

More efficient use of braking systems

Cons – the view of the FIA / FEO

Highly likely to increase costs to develop and compete – does this mean fewer manufacturers?

Technology moves away from the realm of the “privateer” manufacturers

Do the cars become “too fast” for the city streets?

Less emphasis on the driver with more automated systems

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Thank you