



Opportunities in electric and autonomous flying

动力需要能量

Beijing 08-11-2017

For the expected success of e-flight and autonomous flying we have to solve the following issues:



- ✓ International certification rules electric propulsion – fly by wire and autonomous flying
- ✓ Service and maintenance practice for high voltage systems
- ✓ Air traffic management systems for increased traffic and density
- ✓ New safety concepts – what we call at Flight Design **“Vision Zero”**
- ✓ High Density (weight to power) electrical sources, which give an equivalent to current fuel based systems
- ✓and than evolutionairy airplane concepts considering the solution for above

Today we concentrate on Motion needs Energy and performance is not depending on the source of Energy

动力並不依赖于能量的来源



Fuel Station
燃料站



Hydrogen Station
氢气站



Electric Charging Station
充电站



An electrical car needs the same amount of energy than a similar car with a traditional engine

电动汽车需要的能量与传统汽油车相同



Tesla X
特斯拉 X



Mercedes GLE Coupe
奔驰 双门跑车

An electrical airplane needs the same amount of energy than a similar plane with an traditional engine



电动飞机需要的能量与传统汽油飞机相同

Electric aircraft

电动飞机



Airplane with a traditional engine

传统汽油发动机飞机



An electrical airplane needs significant less energy than a VTOL aircraft with same performance



电动飞机需求的能量比同性能垂直起降飞机或多轴直升机少很多

Electric aircraft
电动飞机



VTOL aircraft
垂直起降飞机



多轴直升机



An electrical engine is: 电动马达：



- ✓ Significant lighter means weighs 1/6 of the weight of a combustion engine
比内燃机明显的轻：只有约六分之一的重量 -



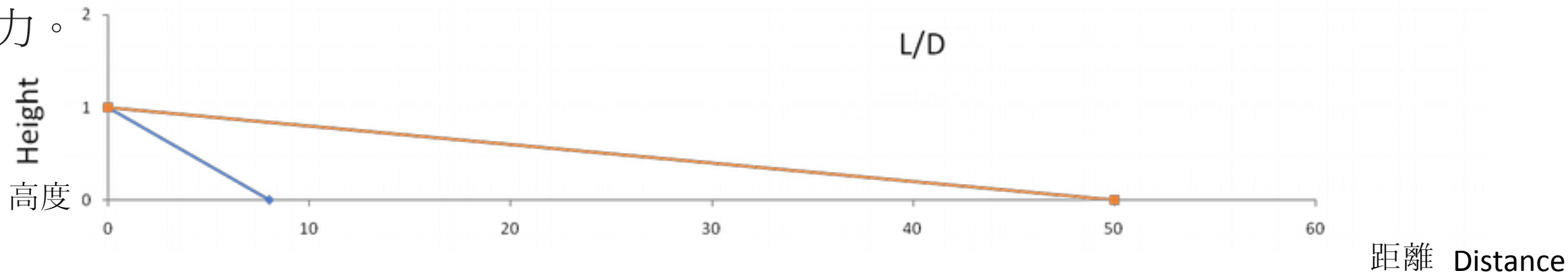
- ✓ Produces by itself “no emission” 电动马达不会产生“废气”
 - Gas engine produces & creates emission; 汽油发动机不但产生而且排放废气;
 - Electricity production does mostly create emission; 电力公司发电通常也产生废气
- ✓ Produces “no noise” 电动马达不会产生“噪音”

Fuel versus Electricity 燃料与电力



- ✓ A very good combustion engine produced maximum 4.000 wh/kg fuel = 0,24l / HP
一个很好的内燃机每千克汽油可产生至多 4,000 瓦时 = 每 0.24 公升产生一马力。
- ✓ A small 2 seat motor airplane consumes 50-60 kwh to cruise at 120 kts = 222 km/h
一架小型双座飞机需 50 ~ 60 千瓦 / 小时动力巡航 120 节 = 时速 222 公里的速度。
- ✓ Even the very good motor gliders Stemme S10 with an L/D rate of +50 at 107 km/h = 58 kts, consumes +40 kwh at 120 kts = 222 km/h.

即使是最好的电动滑翔机 Stemme S10 在飞行 58 节 = 时速 107 公里，在 L/D 效率比大于 50 时，在飞速 120 节 = 时速 222 公里时，也得消耗 40 千瓦 / 小时以上的动力。



We can save energy by: 省能源的诀窍

- ✓ Reduce cruise speed to the speed of L/D-max: e.g. 65 kts versus 120 kts today
降低到 L/D-max 的速度：例如： 65 节的速度对比 120 节的速度
- ✓ Increase the L/D rate to a motorgliders 25 versus 8 on conventional airplanes
增加一般飞机的 L/D 效率比，到有如电动滑翔机的 25 比 8 。
- ✓ Increase the thrust generated by propellers (rotors)
增加螺旋桨（转子）可产生的推力效率。

.....or have more amount of energy available

或是增加更多的可用能量

By Hybrid engines

混合发动机



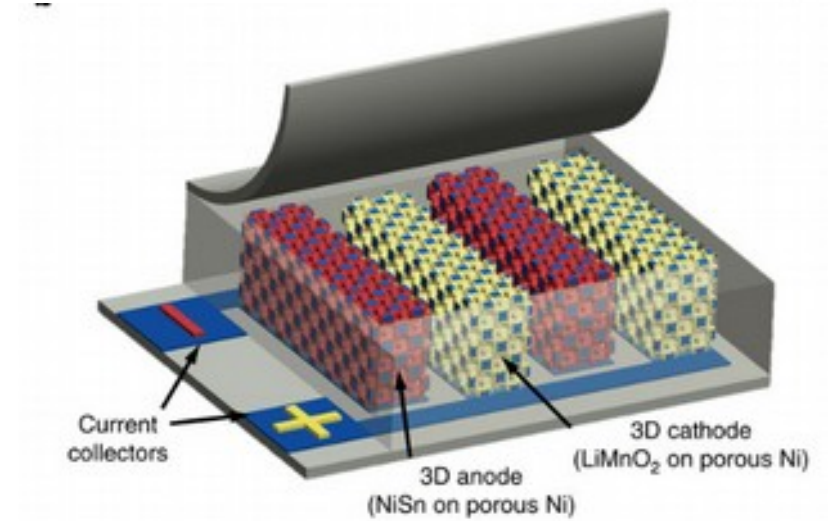
Improved Batteries 改良的电池



Lead batteries provide 40 wh/kg
铅酸电池每千克提供 40 瓦时



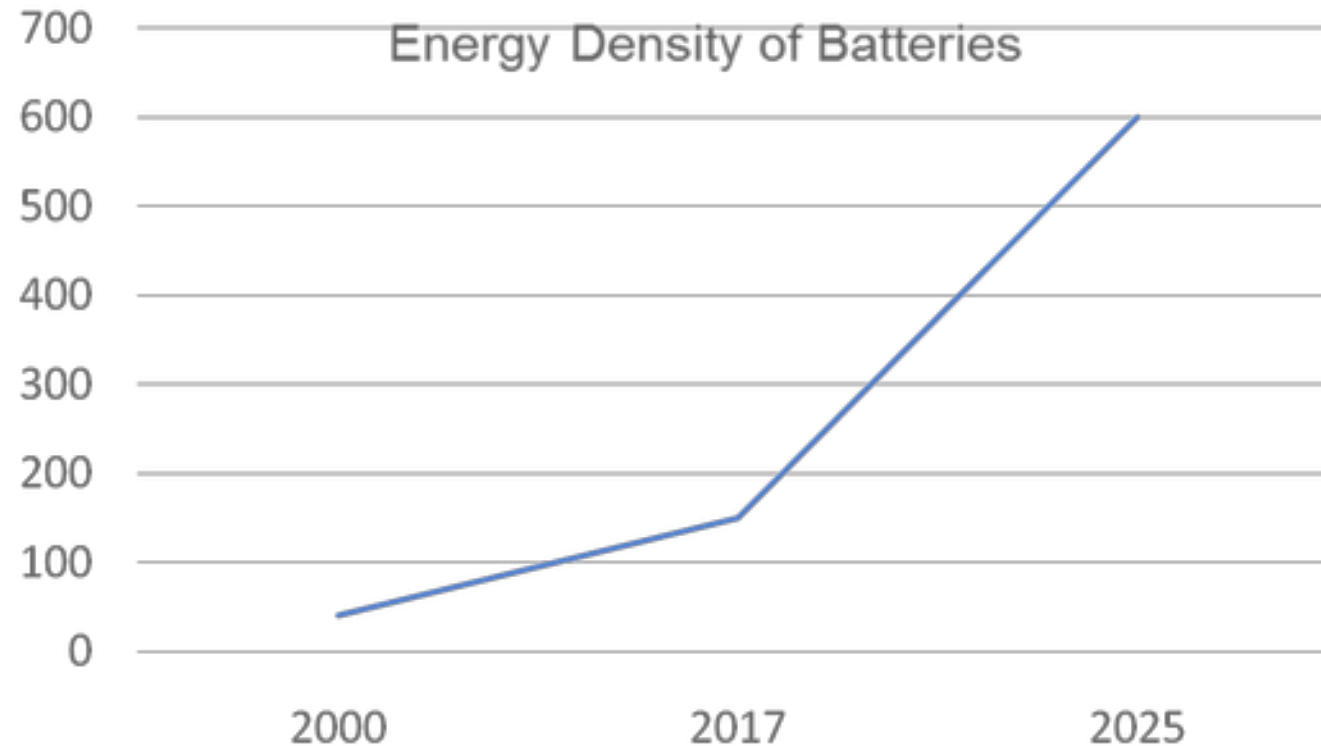
Modern li-ion batteries 150 - 200 wh/kg
最新锂离子电池每千克 150 ~ 200 瓦时



Future 3D lition batteries +600 wh/kg
未来 3D lition 电池每千克可储 600 瓦时

Energy Density of Batteries 电池能量的密度

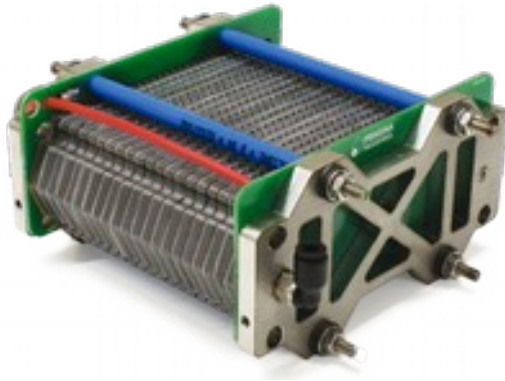
The next generation batteries with 600 wh/kg in the near future
未来下一代的电池，每千克可提供 600 瓦时的电力



Efficient Fuel Cells 高效的燃料電池

Efficient fuel cells with 1 kg of carbon hydrogen tank today provide
~15 kwh power at the propeller.

今天高效的燃料電池和碳氫氣儲存筒每千克可提供螺旋槳 15 千瓦 / 小時的電力。



Performance Comparision 性能比較表

	Fuel engine 81 kw	Electric- Engine 81 kw	Electric- Engine 81 kw	Electric- Engine 81 kw	Electric- Engine 81 kw	Electric- Engine 81 kw	E-Engine 81 kw + Fuel Cell (53%eff)
	Fuel	40wh/kg	150wh/kg	600wh/kg	900wh/kg	2.200wh/kg	Hydrogen kg
400 kwh = kg	100	10.000	2.667	667	444	182	25
Tank kg	integrated	integrated	integrated	integrated	integrated	integrated	330
Per kg	4 kwh	0,04 kwh	0,16 kwh	0,66 kwh	0,9 kwh	2,2 kwh	1,13 kwh
Stack/Converter	N/A	N/A	N/A	N/A	N/A	N/A	90
81 kw Engine installed – kg	100	15	15	15	15	15	15
Total weight kg	200	10.015	2.682	682	459	197	460
Fuel / others	1,0	50,1	13,4	3,4	2,3	1,0	2,3

**The future is electric and autonomous
Thanks for listening!**

**电就是未来的方向
感谢听讲！**

Thanks for listening!

感谢听讲



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