

How the UK will Embrace Battery Technology – One year on...

UKPDiM19, MTC Ansty
June 2019

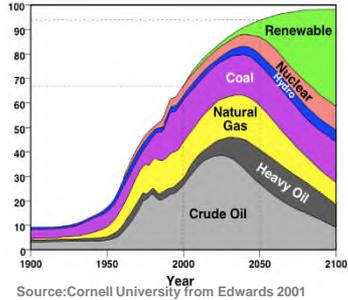
Prof. David Greenwood
Advanced Propulsion Systems
WMG, The University of Warwick



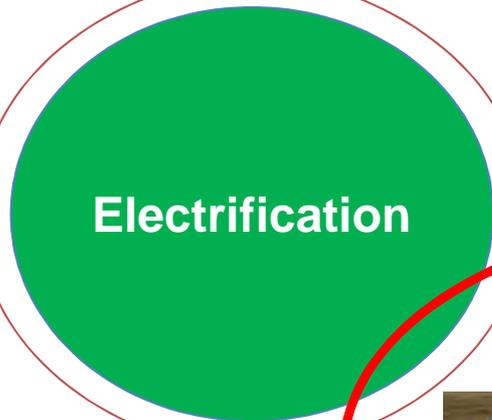
d.greenwood@warwick.ac.uk

Drivers for Electrification in Automotive

Energy Security



Climate Change & Air Quality



Industrial Opportunity



Consumer demand

Lots of new models due 2019/2020



Supply is constraining EV sales for most manufacturers



3 Months

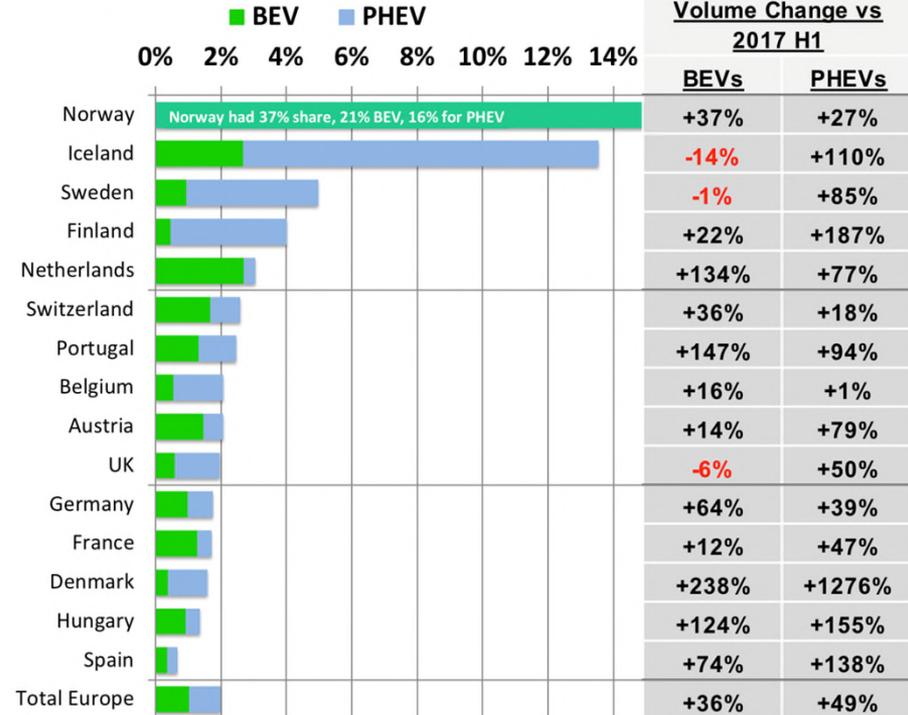
3 years

12 Months

EV and PHEV sales up – even against headwind of falling UK sales



Plug-in Shares and Composition 2018

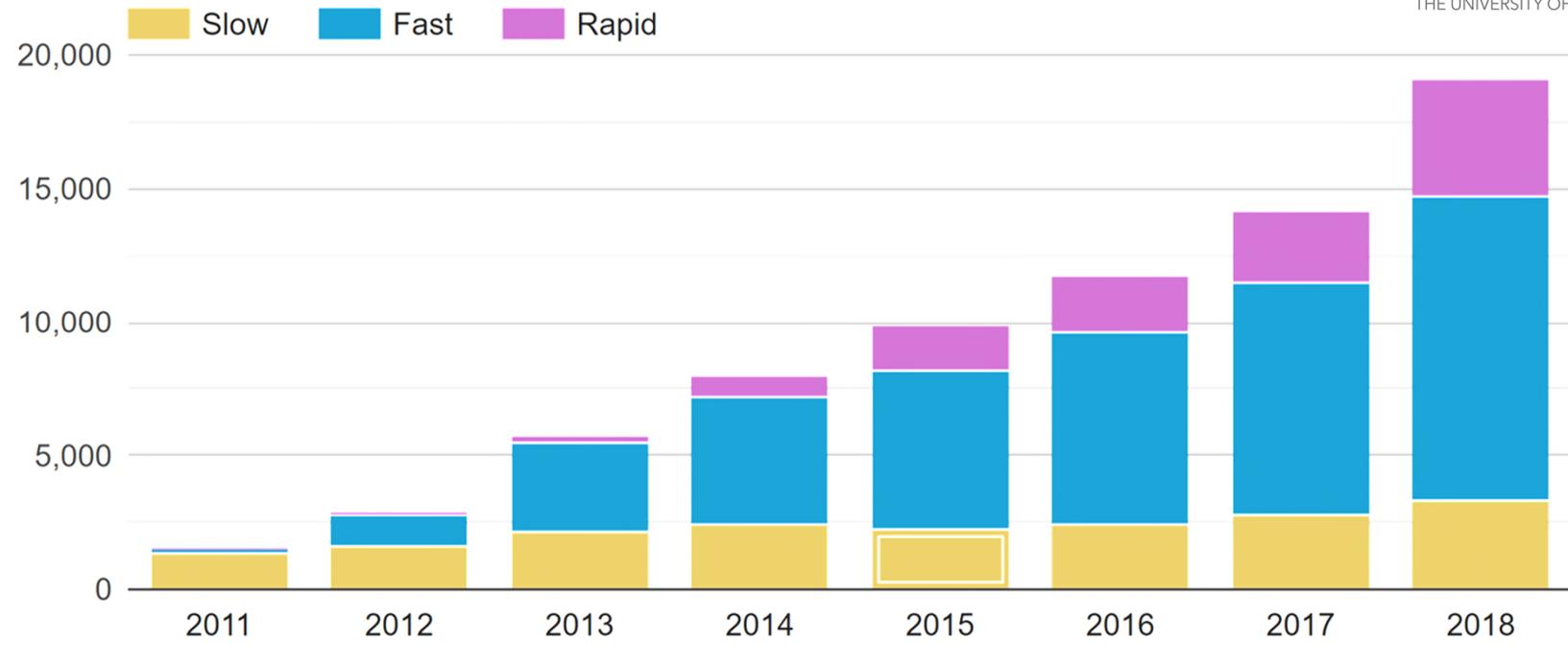


EV VOLUMES.COM

Volume Change vs 2017 H1

	BEVs	PHEVs
Norway	+37%	+27%
Iceland	-14%	+110%
Sweden	-1%	+85%
Finland	+22%	+187%
Netherlands	+134%	+77%
Switzerland	+36%	+18%
Portugal	+147%	+94%
Belgium	+16%	+1%
Austria	+14%	+79%
UK	-6%	+50%
Germany	+64%	+39%
France	+12%	+47%
Denmark	+238%	+1276%
Hungary	+124%	+155%
Spain	+74%	+138%
Total Europe	+36%	+49%

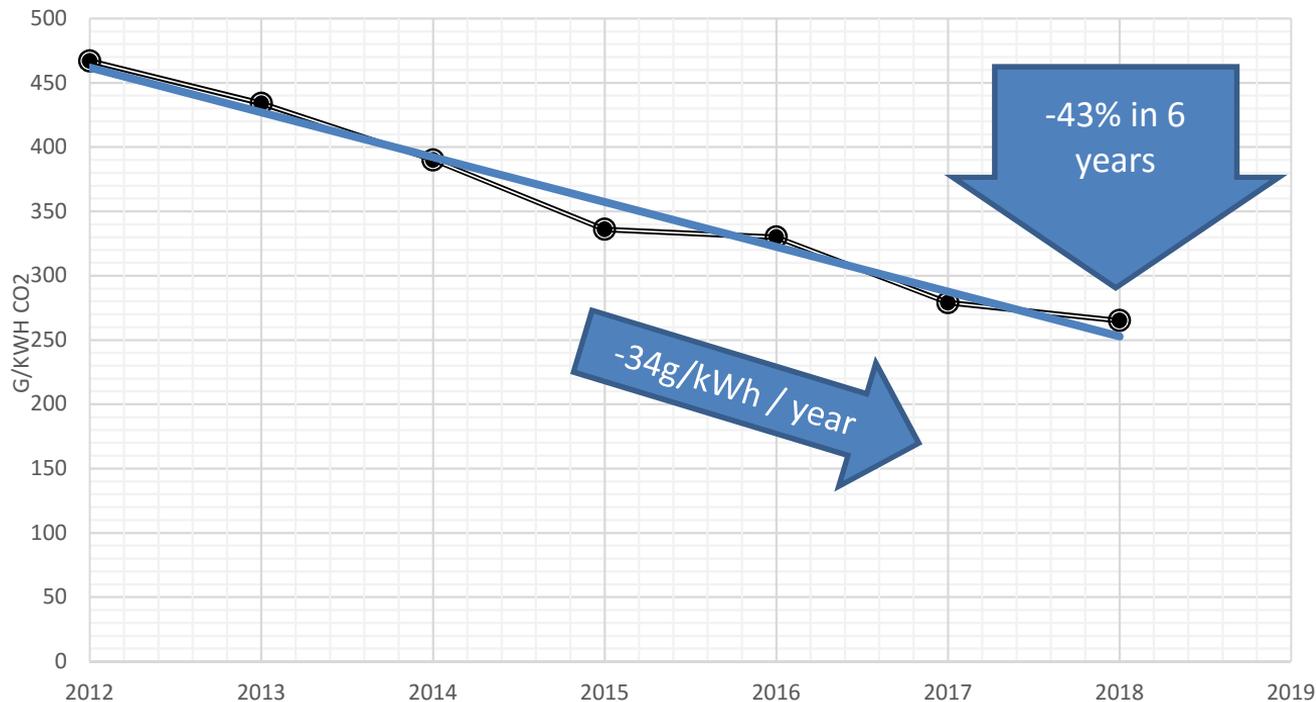
UK charging infrastructure is growing faster than EV/PHEV sales



Source: Zap-Map - <https://www.zap-map.com>

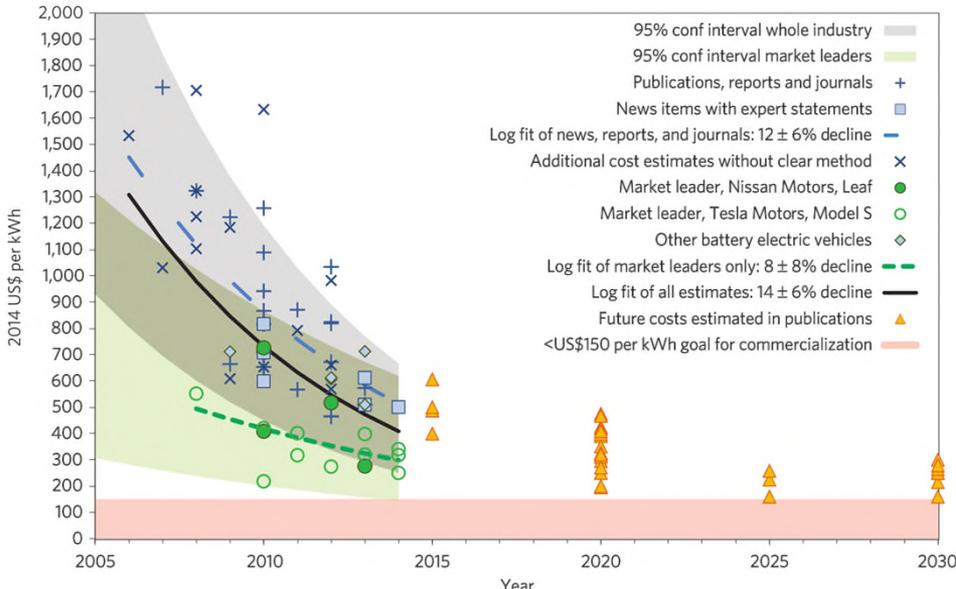
And the UK Grid is the fastest decarbonizing in the G20

UK Grid Carbon Intensity



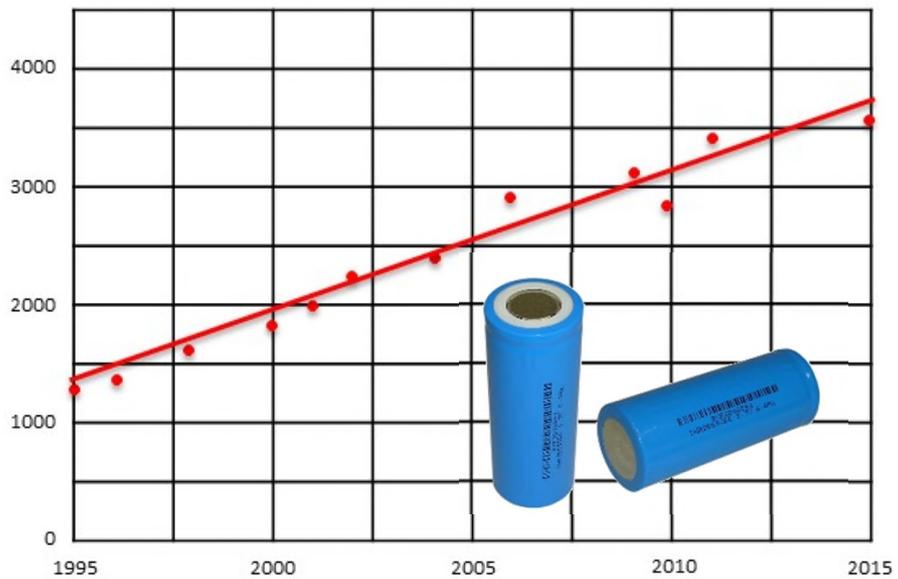
Lithium Ion batteries are improving rapidly

- ▶ Costs have fallen dramatically due to technology, production volume and market dynamics
- ▶ Pack cost fallen from \$1,000/kWh to <\$250/kWh in less than 8 years



Nykvist et al 2014

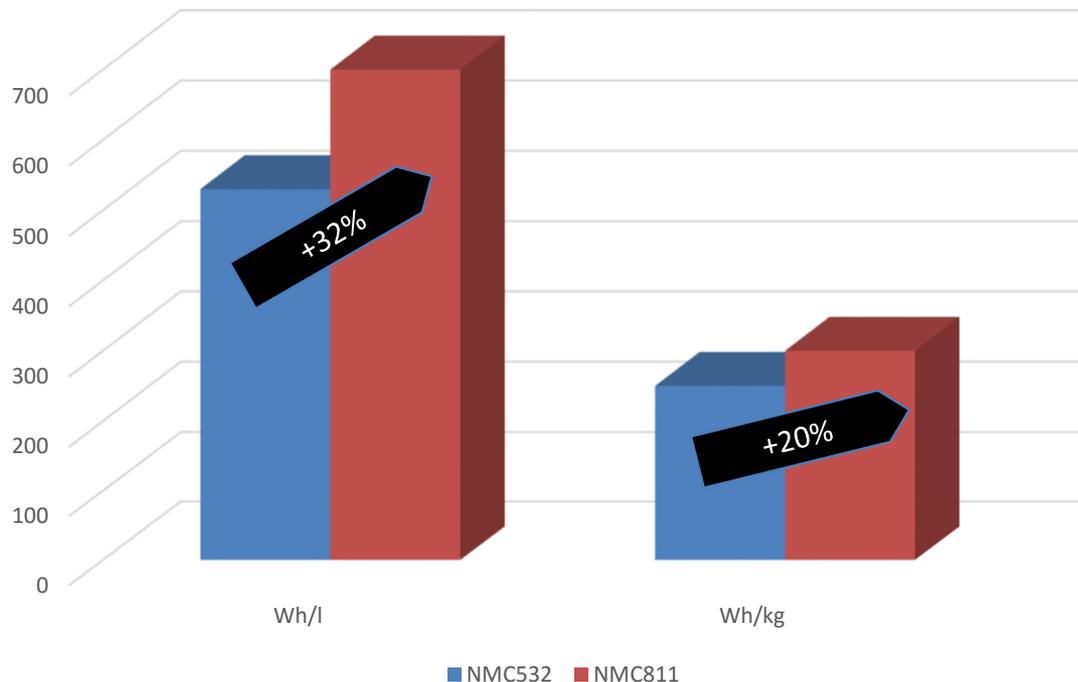
18650 Cell Capacity (mAh)



- ▶ Volumetric energy density is increasing due to better materials and cell structure
- ▶ Doubled in 15 years
- ▶ Requires continued innovation to continue

NMC 811 reduces cobalt content and increases energy density

Energy Density of Pouch Cells



BUT:

- ▶ Material difficult to handle during manufacture (extremely hygroscopic)
- ▶ Gassing observed at high cell voltages

Faraday Challenge



Faraday Challenge
£246M, first 4 years (of 10)

Faraday Institution
£78M, TRL1-3
Academic Research

Innovate UK
£88M, TRL3-6
Proof of Concept

APC
£80M TRL6-8
Industrialisation

Phase 1, 2017/18

Phase 2, 2018/19

Phase 1 2017

Phase 2 Jan 2018

Phase 3 Dec 2018

UKBIC
(+£28M 2019)

- Degradation
- Multi-scale modelling
- Solid state cells
- Recycling

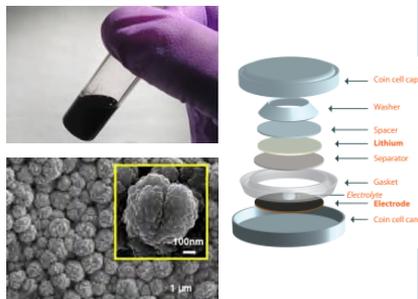
- Next Gen Li-Ion
- Electrode Manufacturing
- Sodium Ion
- Beyond Li-Ion

- Feasibility Studies
- CR&D
- Existing IDP and IUK calls

Existing APCX calls

UKBIC – Manufacturing research and prototype facility

Gramme Scale



Typically university scale research using small quantities of hand-made materials

Used for fundamental materials research and initial half-cell experiments at coin cell scale

Funders typically EPSRC, Faraday Institution

E.g. Oxford, UCL, Imperial, WMG

Kilogramme Scale



Typically corporate R&D lab or University / Catapult centre

Used to demonstrate scalability of materials to full size cell, and to develop electrode mixtures, deposition processes and cell formats.

Funders typically Innovate UK, EPSRC, Faraday Institution

E.g. WMG, QinetiQ

Tonne Scale



Typically full scale manufacturing facilities used at low rate. Expensive, inflexible, and impossible to access except by owner. **UKBIC provides bespoke facility for this purpose.**

Used to develop and prove materials, cell design, manufacturing processes and parameters “at-rate” prior to full plant investment

E.g. No public facility in UK or EU

Kilotonne Scale

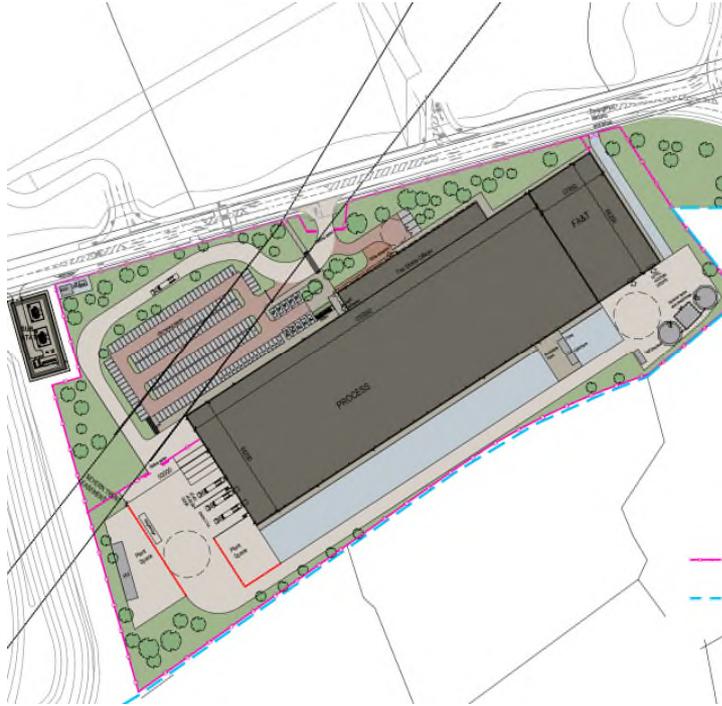


Full scale, high volume manufacturing plant. Typically 6-50GWh/year

Used to deliver very large volumes of cells with no variation or flexibility to chemistry, format or quality. Cost/kWh and process consistency are critical

E.g. Tesla Gigafactory, LG Cheongju, Panasonic Osaka, Samsung Ulsan

UK Battery Industrialisation Centre – UKBIC – opens 2020



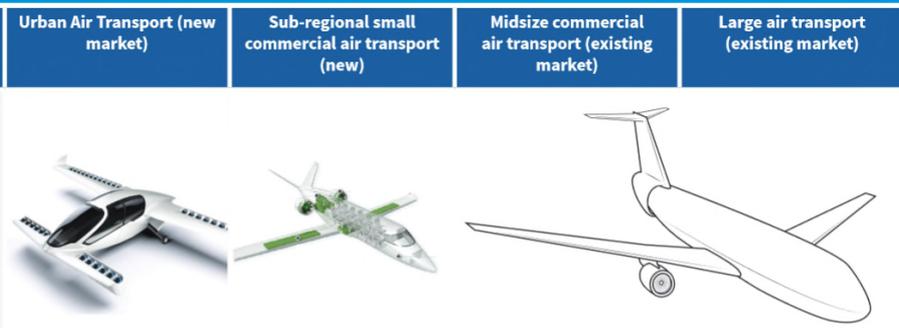
UKBIC on track for 2020 opening



Electrification is no longer just an automotive phenomenon



Aero industry now taking electrification very seriously



Source: ATI Insight_07 – Electrical Power Systems

Category	Urban Air Transport (new market)	Sub-regional small commercial air transport (new)	Midsize commercial air transport (existing market)	Large air transport (existing market)
Power requirement	150-200kW	2MW propulsive	22MW propulsive	60MW propulsive
Energy requirement	100-200 kWh*	12 MWh	55 MWh	390 MWh
Non-propulsive energy requirement	5-10 kWh	0.1-0.3 MWh	1-6 MWh	8-30 MWh
Number of passengers	1-5	9-20	120-200	240-500
Range	30 miles + limited divert	300 miles + divert	800 miles + divert	3000 miles + divert
All-up weight	1t	2-10t	~100t	~250t
Recharge/refuel time	2-10 mins	15-30 mins	20-60 mins	< 2 hours
More electric architecture	-	-	Evolved	Evolved
Hybrid	EV	PHEV		MHEV
Advanced hybrid or electric				
Operating altitude	Tens of metres	Low commercial	Commercial	Commercial
Operating speed (max)	<150mph	300-400mph	600mph	600mph

UK Chemical industry engaging in battery supply chain

AUTOMOTIVE BATTERIES

A major supply chain opportunity for UK chemical and material companies

Innovate UK



Automotive batteries: A major supply chain opportunity for UK chemical and material companies

Summary

Prepared for the UK Advanced Propulsion Centre and Innovate UK

April 2019

E4tech Strategy | Energy | Sustainability

REPORT SUMMARY: APRIL 2019

Produced by the Advanced Propulsion Centre UK and Innovate UK. Supported by KTH & WMG University of Warwick. Authored by E4tech



Chemistry Council logo: A circular logo with colorful dots representing atoms.

SUSTAINABLE INNOVATION FOR A BETTER WORLD

Images on the cover: A transparent car chassis showing internal components, a row of wind turbines against a sunset, a group of four diverse children's faces, and a stylized human head profile composed of a grid of blue dots.

Our Strategy for delivering chemistry-fuelled growth of the UK economy

What's critical for the next 12 months ?

- Faraday Challenge – funding for years 5-10 (post march 2021)
- Launch DER – and maximise synergies with Faraday
- Secure a Gigawatt hour per year scale electrode and cell production facility in the UK
 - Support UK Chemistry industry to meet its demands
- GROW UK SKILLS BASE IN BATTERIES AND ELECTRIC VEHICLES
 - Don't hope you can recruit – start TRAINING now !

Thank you



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