CANNOCK CHASE U3A SCIENCE & TECHNOLOGY GROUP

HOP ON - ALL ELECTRIC CARS BY ~~2040~~? 2030?

Tory Government announcement July 2017, phasing out petrol & diesel cars

Can it really happen?

U3A
THE UNIVERSITY OF THE THIRD AGE

The Target

- No more solely petrol or diesel cars sold after 2030.
- All petrol & diesel cars and vans to be “electric” by 2040
  - To improve air quality, particularly in cities and on main roads from petrol & diesel emissions and CO2.
  - 40,000 deaths attributed to nitrogen oxides in the UK/ann

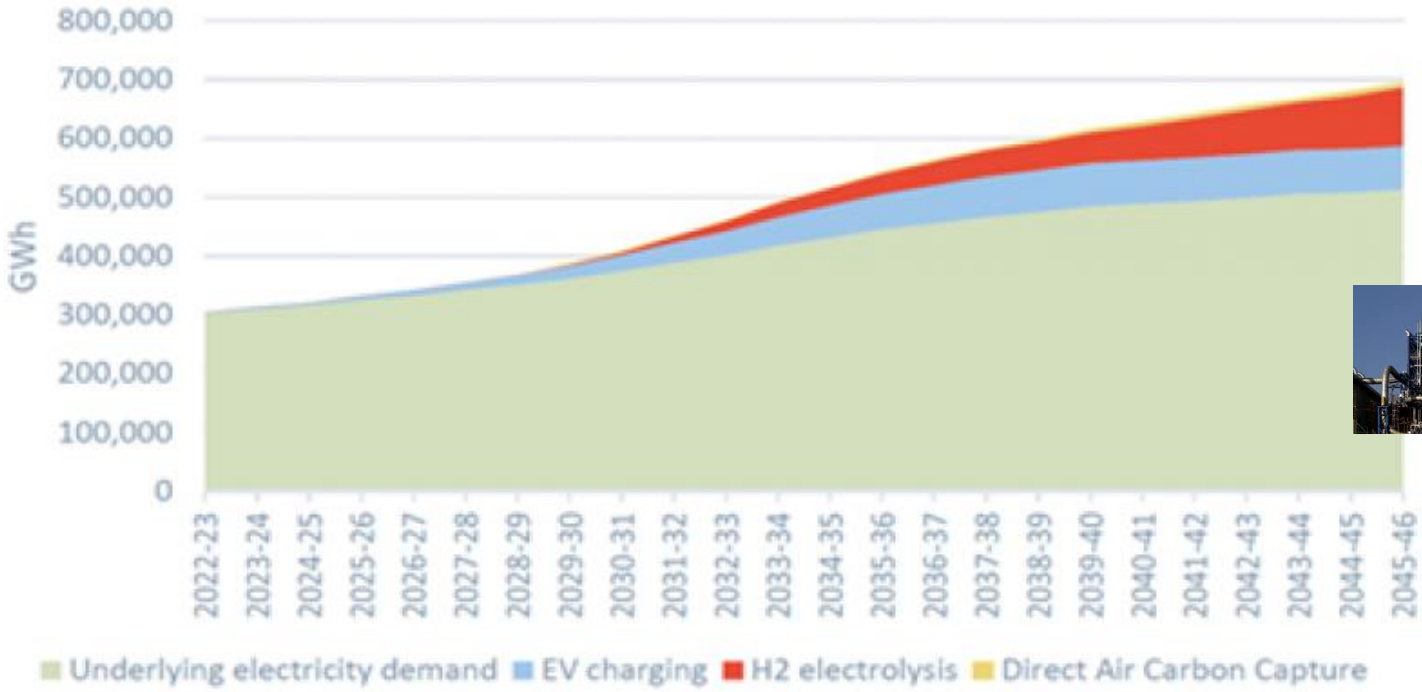
However…

- No target on trucks in City Centres
- No target on Buses & Coaches in City centres
- No target on Diesel trains stopping at City Centres
  - Many electification programs have been cancelled (2017)
- No target on trucks delivering across the channel
- No target on introducing alternative fuels?

The Implications

1 GW = 1 billion or 10^9 W

Figure 1: Electricity demand forecast – Central Scenario



Source Cornwall Insight

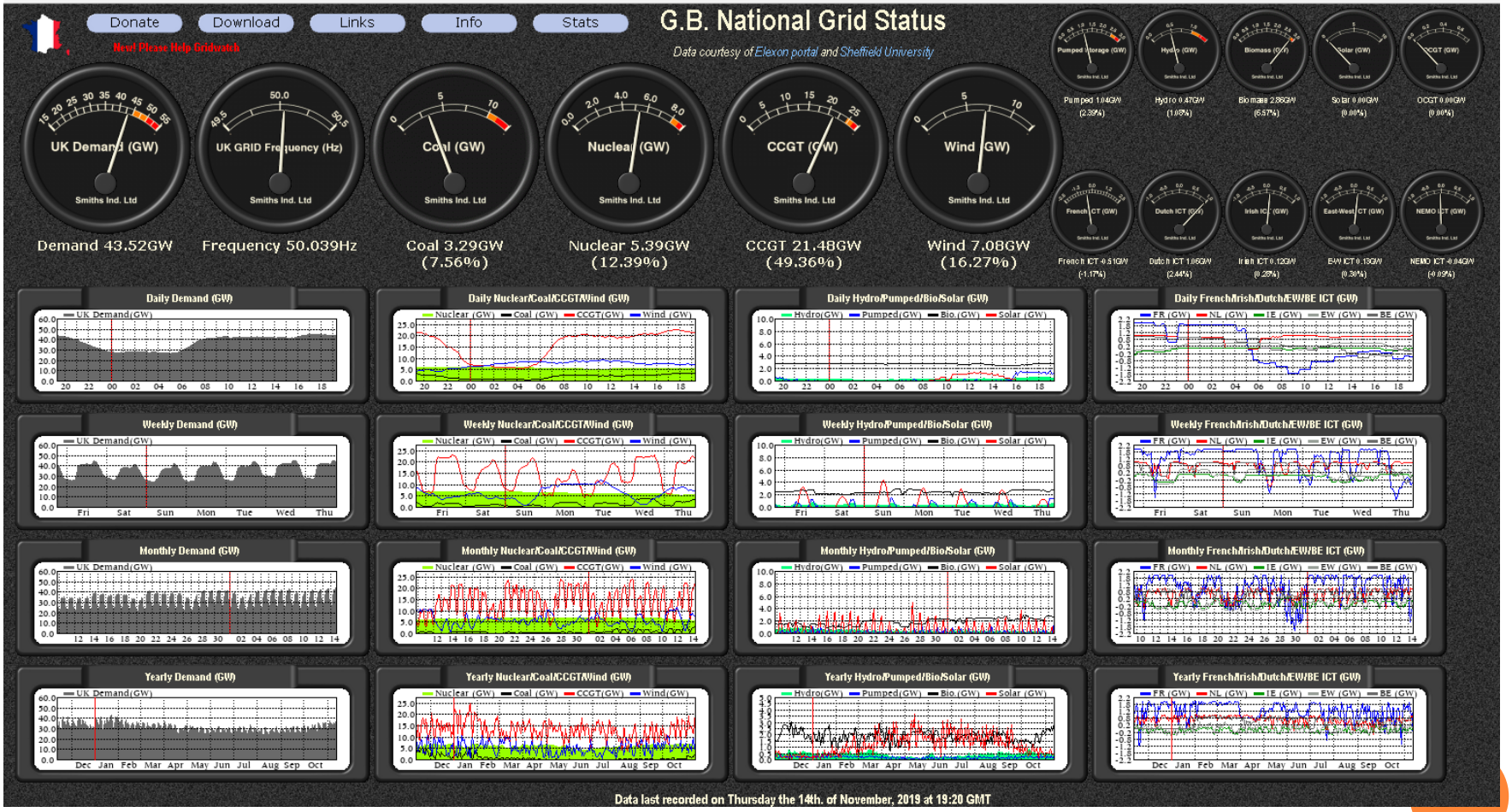
Note: These volumes do not include load to meet exports to interconnected markets, load to service pumped storage hydro or batteries

- By 2050 with all electric, extra demand could be +18GW
- (Current grid peak capacity is 55-60GW) - needs +32%
- How will this power be generated, with zero emission?

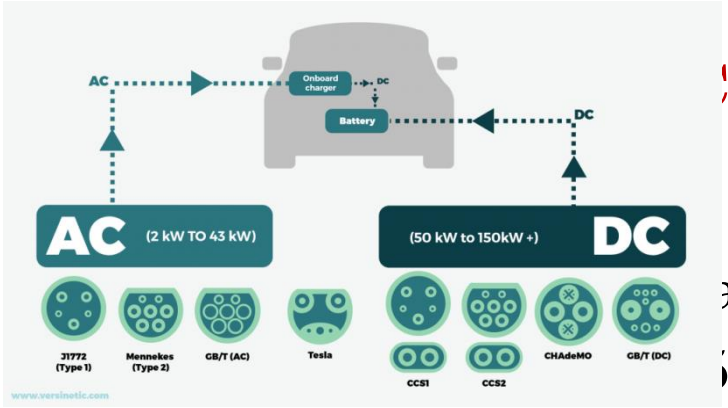
Take a Look at Gridwatch

Most sources are fossil fuels still.
How is additional 8-18GW demand going to work?

Includes:
Biomass, Solar & Hydro.
French link, Dutch link,
Irish link, Wales/Ire link,
Belgian link.



https://www.gridwatch.templar.co.uk/ Nov14th 2019)



...TURE – CHARGING EV

...How?

...at 3, 7, 22kW.

AC charge depends on rating of car on-board charger

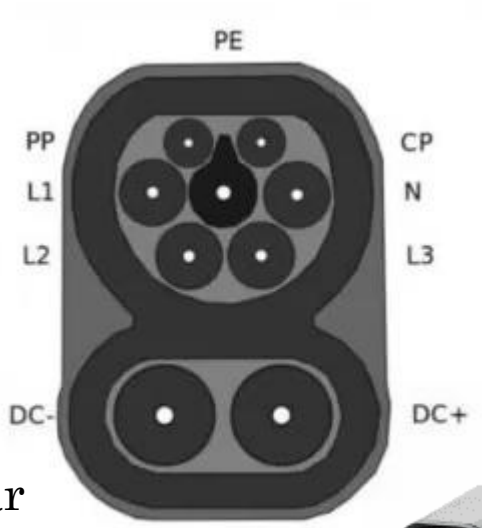
...50kW to 150kW+.

- **Home Charging (3kW or 7kW AC)**
  - Slower charge, several hours currently (up to 20).
  - What if you live in a terraced house or high rise block?

- **Public charging points**
  - 60+ different providers of charge points
  - 60+ different accounts, apps, RFID card, or subscriptions needed to operate them, some use contactless cards.
  - Tesla have their own system, no-one else can use.
  - Currently around 42,000 in the UK, mixture of types.
  - 400,000 charge points would cost **£30bn by 2035** (for 1 in 3 cars being electric) + the electricity demand! [lamposts?]
  - Public rapid points can be expensive electricity, at 40p/kwh.

2. The Infrastructure And the EV charge connector line up…

	N. America	Japan	EU *and the rest of markets*	China	All Markets *except EU*
AC 3-7-22kW			Mennekes (Type 2)	GB/T	
DC >50kW RAPID			CCS2	GB/T	Tesla

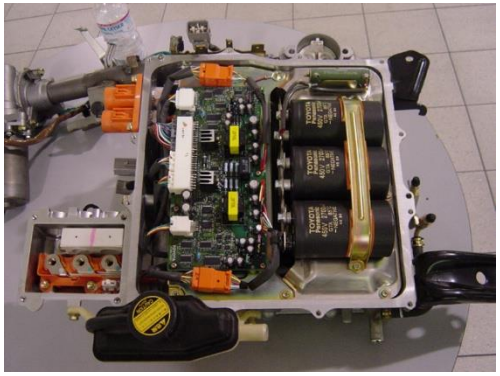


Car connector

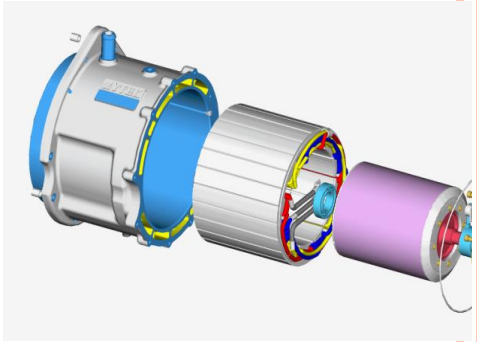
UK EVs & plug-in hybrids

Providers….

3. The Infrastructure - Disposal



- **Disposal & Recycling**
  - 1 million cars scrapped each year in UK.
  - Batteries (toxic chemicals in Li-ion)
  - Cobalt and lithium could be recovered.
  - Power inverter electronics
  - Motors (rare earth magnets - Neodymium)
  - Existing petrol & diesel cars disposal by 2030 (Tens of millions)



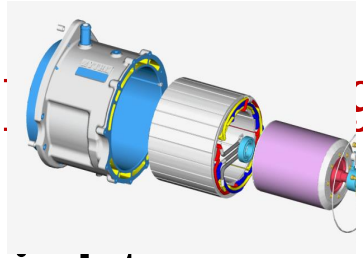
4. Taxation & Subsidies

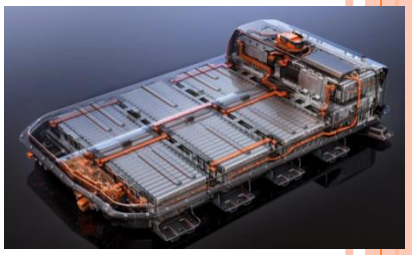
- Currently, approx 80% tax on petrol & diesel
  - Current fuel duties amount to £28bn/annum
  - What will the Chancellor do?
  - Where will it then come from? Tax on electricity?

- Road Tax currently free for EVs.
  - What's your future prediction?

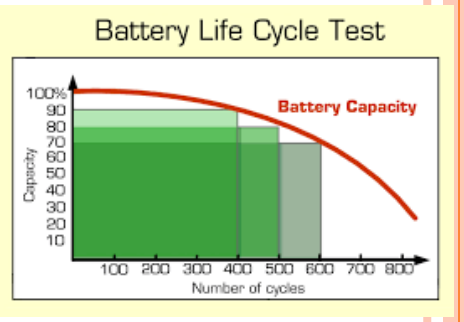
- Subsidy for Electric Vehicle Purchase (£5000 in 2011)
  - Guess what will happen to that?
  - Well, it already has. (PHEV now £0, EV now ~~£2500~~)
  - Whereas, Germany is increasing subsidies.

5. Current Limitations of [illegible]9)





- **Security of Supply, Cost & Weight**
  - Battery Lithium & Cobalt (controlled from Chin
    Australia, Argentina, Congo) maybe even Cornw
  - Costly & heavy battery (can easily weigh half a
  - Rare motor magnets Neodymium (Brazil, China
    Lanka and Australia).
  - Once again, we are causing mining misery and plundering rare earth resources.

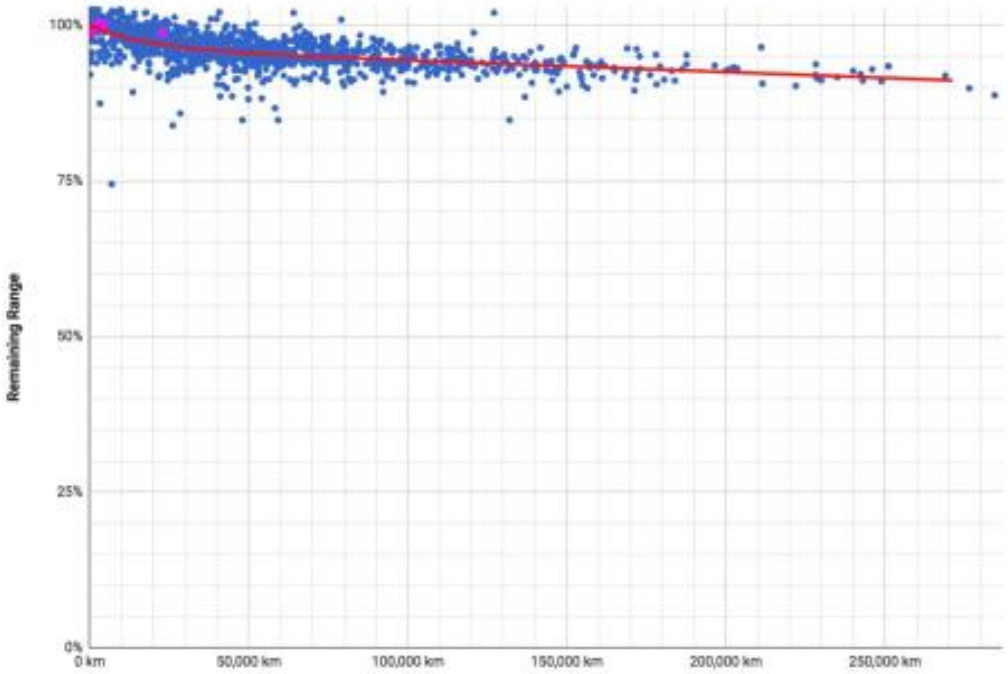


- **Battery Life-time cost may be very high**
  - Discharges and charges deteriorate capacity kwh, (or range).
  - Current petrol cars expected to last 10 years, more for diesel.
  - Most EV batteries now warranted for 5-7 years, last 10-20yrs.
  - Cost of disposal or recycling of millions of batteries.
- **Charge time and availability of chargers**
  - Multiple types of public charger, often out of service.
  - All but DC rapid chargers will take 8-20 hours (if car is capable).

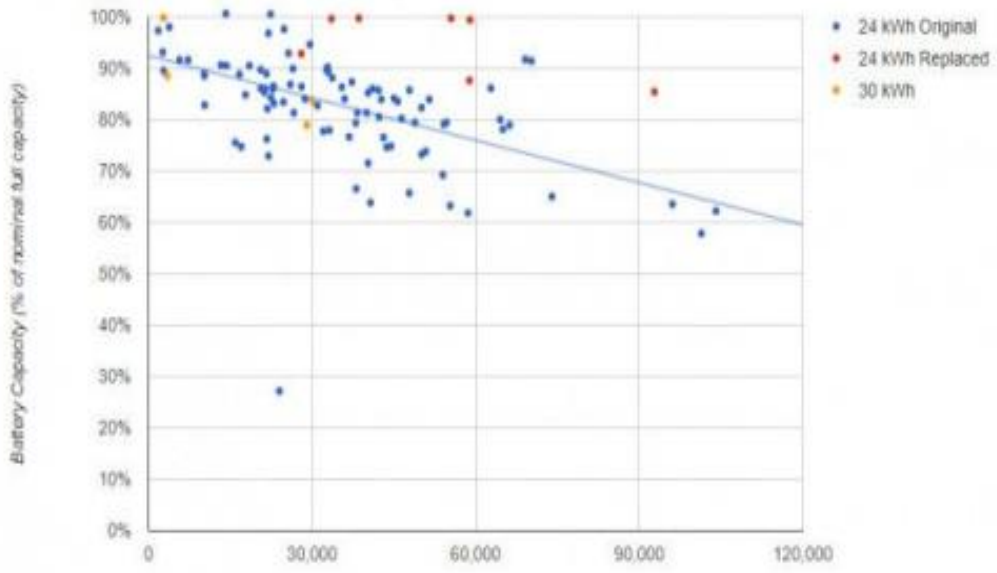
6. Performance Limitations

- **Range**
  - Range poor on some small models (as low as 70-100 miles), majority up to 150-250 miles. 2021 has seen 300 miles+.
  - Higher range usually means larger / heavier battery.
  - Wet or cold, using electrical heater, lights or A/C reduces range.
  - Range display has units of miles/kwh. 50kwh at 4m/kwh=200m
  - Capacity (range) will decrease with each (fast) charge cycle (Tesla is pretty good), but others can be poorer. Loses 20-30+%.
  - A 200 mile range in the Summer, can reduce to 150 in Winter.
- **Speed, Acceleration**
  - High speed or high acceleration will kill range, because of wind resistance, even 70mph.
- **Towing caravans or trailers**
  - Electric motors have superior starting torque at zero speed.
  - But not for long! Any additional tow weight will severely reduce the range, so many cars unsuitable.

Tesla Model S/X Mileage vs Remaining Battery Capacity (Same chart as above but at full scale for better perspective)



LEAF Reported Battery Capacity vs Miles Driven



However, there are performance pros for EVs…

- **Instant full torque from rest.**
- (Petrol Ford Focus = 170Nm, MG5EV = 260Nm, Tesla = 441Nm)
- MG5 acceleration in boy racer mode, 7.5 secs to 60.
- Teslas can get to 60mph in 4 secs (dual motor)
- **Plenty of engine power.**

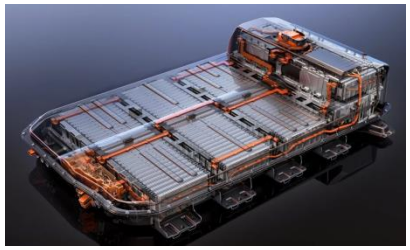
- MG5 Capable of over 115mph, Tesla 162mph
- Petrol Ford Focus = 125hp. MG5 = 156hp. Tesla = 449hp
- **Regenerative braking** recovers some energy back into the battery. Less use of brake pads.
- But only if you brake! Unlikely on a motorway.
- **Nice and quiet**

7. Manufacturers & Suppliers

- **Skill & Technology change.**
  - New high voltage inverters, 3ph motors, DC-DC, and power distribution design, HV heater, A/C, brake vacuum, AC charger, HV battery & charge control, regen braking, safe S/W.
  - Extra safety risks building and using HV batteries.

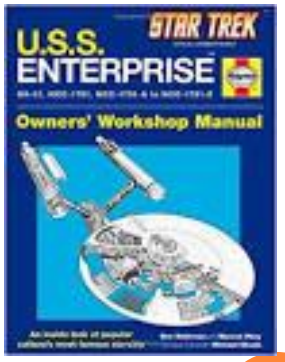
- **Development costs and time for better cell chemistries.**
  - Current batteries have taken over 100 years, and still lacking.
  - Fire risks for lithium (new chemistries needed – LiFePo4).
  - Rapid charging deterioration and charge capacity loss.
- **Investments for production plant and designs.**
  - Battery plants? (BMW Hams Hall, JLR at i54, Coventry)
- **Affordability (£5k-£40k+ premium now).**
- **Security of rare material supply, Li, Co, Nd etc.**
- **Vans, Trucks and buses possible?** (all long distance)

8. Dealers & Repairers



- Handling high voltage batteries training.
- Fire risks when handling, shipping or disposing.
- Handling high current electronics, motors and power connections.

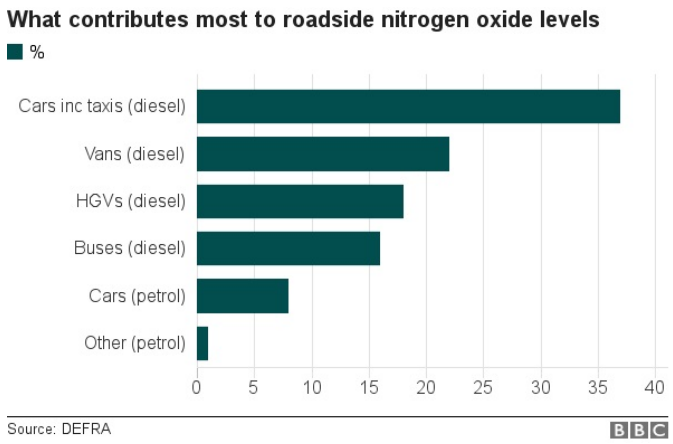
- Existing small garages, can they cope?
  - Training / New Equipment on EVs.
  - Testing facility costs
  - Insulation tape - nope?
  - Crash repairs
  - Charging facilities
  - Suggest a lot will be out of business in 10 years.



- Home Repairs?
  - Haynes manuals?

9. Existing ICE car & van owners

- **Incentives to change**
  - Subsidy has been reduced from £5000 to £1,500 for pure EV.
  - Scrappage scheme? Not yet.
- **Alternatives to battery electric?**
  - Will there be any by 2030?
  - Alternative fuels, hydrogen engines
  - Hydrogen fuel cell cars seem completely ignored by Gov't.
- **Most polluting vehicles**
  - If you felt guilty, diesel
  - is bad for NOx.
  - Hybrids can be worse than diesel
  - for CO2 emission in general.



What needs to be done to make it happen? A few thoughts…

- **Battery Technology improvement**
  - Range improvement, new chemistries, **more miles per kwh (currently 2 to 4 on 50-70kwh).**
  - Need for overcoming disparity between petrol and lithium energy by weight.
  - Investment to develop, assuming there are new chemistries, or super capacitors.
  - Charge time improvement, less capacity degradation, equivalent to petrol fillup.
  - Less weight, Less volume, less complexity,
- **Public Charging Points improvement**
  - Fast & slow charge points massive increase, to allow long trips, and improved reliability.
  - National political drive to give a single account method and simple access.
  - Introduce cohesion and fines on charging point suppliers. (£620m allocated, but little evidence)
- **Incentives**
  - Increase grant incentives
  - Scrappage scheme
  - Reasonable taxation
- **UN's Intergovernmental Panel**
  - Recommends switch to electric cars to reduce carbon emissions
  - How is this possible if power stations use fossil fuels?
- **National Grid reinforcement**
  - Meet demand increase for charging (and home heating using heat pumps).
  - More renewable resources, **tidal**, geothermal, and wind power (but solar a dead duck now).
- **HAS THE GOVERNMENT THOUGHT THIS THROUGH, I wonder?**

What the Government is allowing or NOT doing...

The 10 point plan (Nov 2020)

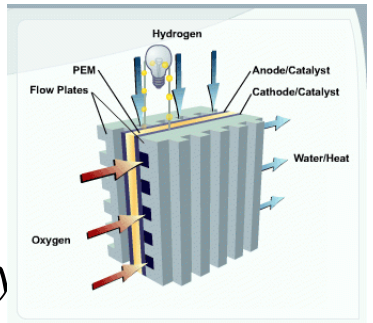
- **Allows Biomass burning - (e.g.DRAX)**
  - Trees being lopped, pellitised and imported – not sustainable.
  - Huge CO2 emission at Drax (but not counted in UK emissions!).

- **No mention of TIDAL power**
  - No investment or promotion forthcoming.
  - Yet, tidal guarantees 24 hour generation.

- **No mention of GEOTHERMAL energy**
  - Plenty of free heat, but no investment.
- **No mention of "green" hydrogen.**
  - Precious little infrastructure currently, or investment.
  - "Blue" hydrogen only mentioned, still causes emissions from hydrocarbons.

- **Govt still issuing licences** for oil & gas exploration.
  - But still no really suitable house heating alternative.

My Personal View…

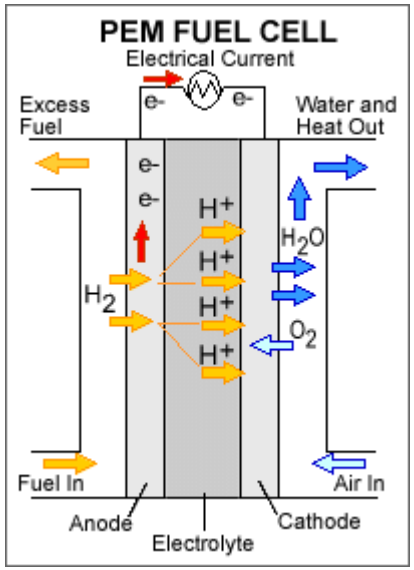


- ***Electric cars are amazing, but…***
  - *Batteries still don't meet a diesel range, except by getting larger, and the recharge time is long vs fossil fuel.*
  - *OK for 90% of journeys….Unless it is …*
- Combined EV and a **Zero Emission** range extender.
- **Enter the Hydrogen Fuel Cell (PEM).**
  - The energy in 1 kg of hydrogen gas is almost 3 times 1kg of petrol (H2 = 33kwh/kg, Petrol = 12kwh/kg)

- **Hydrogen Infrastructure**
  - California is leading the funding and building of hydrogen fuelling stations for FCEVs. Over 40 in CA.
  - As of 2021, UK hydrogen stations total 11.
  - Average of 5 minutes to fill a vehicle with hydrogen.
  - 1kg of hydrogen currently costs about £10.
  - Toyota Mirai can achieve 400+ miles on a tank of H2 (5.5kg).

Fuel Cells - The Down Side

Proton Exchange Membrane (PEM)



Electrolyte is a copolymer of poly(tetrafluoroethyl ene) and polysulfonyl fluoride vinyl ether

- Of course there are some problems…
  - PEMs use a **platinum** catalyst anode.
- PEM cars are a little expensive currently.
  - £65,000 for a Toyota Mirai.
  - Durability may still be an issue for transport.
  - Better and cheaper materials are needed.
  - Each cell gives around 1 volt, so many cells needed.
- PEMs really need pure hydrogen, but also need a lot of controlling with plumbing, and take a while to start up. Still need a battery for acceleration.
- Hydrogen dispensing almost non-existent
  - London, Swindon, Abergavenny, Sheffield
  - Current fuel refiners will have to change to H2.
  - Needs an emission free way to produce the H2.

So, Are There Any H_2 Cars (in 2022)?

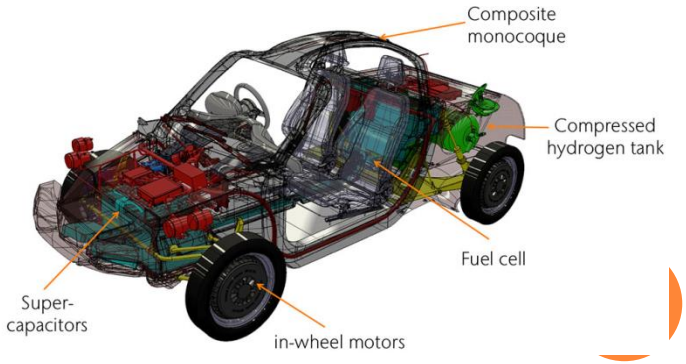
- The Toyota Mirai

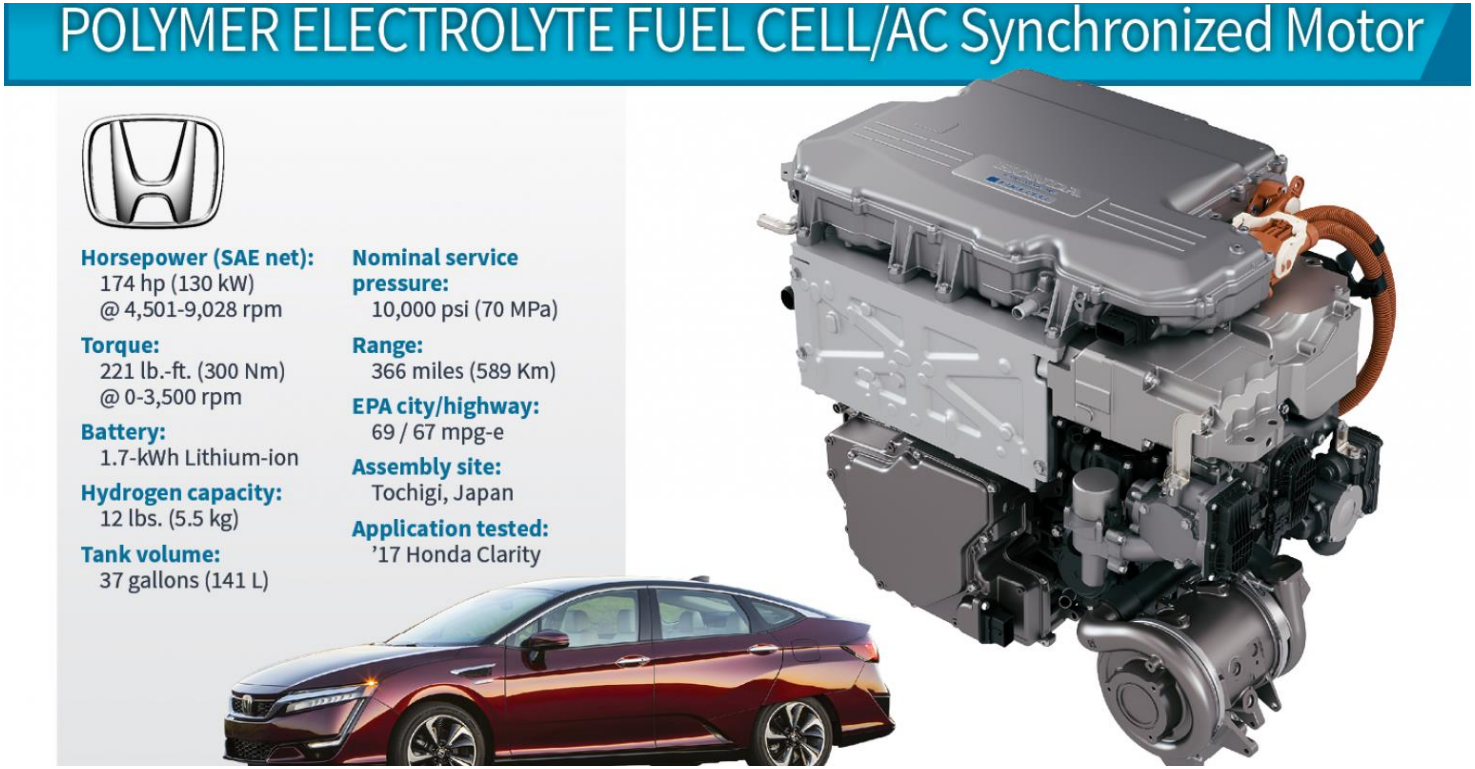
Can cost up to £55 to refill for 400 miles

- The Honda Clarity FCV

- Hyundai
  - NEXO

- A little company in Wales (Powys) makes the Rasa (Riversimple)
- 250mpg equiv





- Tempted? Pure EV or FCEV

- Will EVs or FCEVs help with reducing CO2 and climate change? Not entirely, no. Brake dust better, but…
- EVs Particle matter from tyres and shifted CO2.

A Few Battery Evs in UK













- That's it folks

- https://www.gridwatch.templar.co.uk/

LFP batteries

Triphylite
$LiFePO_4$