RCEA
(SUSSEX)

An Association for Retired Professional Engineers

NEWSLETTER April 2022

President's message

Hello everyone, and a warm welcome to the April Newsletter.

After many months of lockdown and uncertainty, I am pleased to say that our programme of talks since September have been well attended and have proved very successful.

Despite calls at the AGM last September for new blood to join the committee, unfortunately no one came forward, so we are where we are, with committee members holding more than one job at the same time. Please, if you feel you want to get involved, talk to me, or any committee member.

Having said that, the entire committee have worked extremely hard to ensure that we have a full programme of talks lined up for the 2022 / 2023 season, starting in September and at least 3 visits planned during the summer months. Details of all events can be found on the website.

In December last year, 31 members and guests attended the annual Christmas Lunch at the Windsor Hotel in Worthing, which, as in every year, proved very successful.

Regarding Field Place, having changed the venue for our talks to the Pavilion, this has proved a good move, giving us better sound quality and a more spacious setting, an essential thing with Covid still being around.

Along with the talks and visits, the coffee mornings are still proving popular, but there is always room for additional folk to attend.

Further on in this newsletter, you will find a synopsis of the recent talks and details, together with the reply slips for the visits planned during May, June and July.

Keep an eye on your emails as our Membership Officer, Mike, will be sending out details of thing you need to know as they crop up.

May I take this opportunity to wish you and your nearest a very pleasant summer, and look forward to catching up again in September.

George Woollard

President
April 2022

PROGRAMME OF EVENTS May 2022 – September 2022

12th May	**Thursday**	**Visit – Submarine Museum, Gosport**
19th May	**Thursday**	**Coffee – at Spotted Cow, Angmering**
26th May	**Thursday**	**Coffee – with Partners at Swallow's Return**
6th June	**Monday**	**Visit – Planetarium, Chichester**
16th June	**Thursday**	**Coffee – at Spotted Cow, Angmering**
30th June	**Thursday**	**Coffee – with Partners at Swallow's Return**
12th July	**Tuesday**	**Outing – Water Lilly festival, Sheffield Park**
21st July	**Thursday**	**Coffee – at Spotted Cow, Angmering**
28th July	**Thursday**	**Coffee – with Partners at Swallow's Return**
18th Aug	**Thursday**	**Coffee – at Spotted Cow, Angmering**
25th Aug	**Thursday**	**Coffee – with Partners at Swallow's Return**
15th Sep	**Thursday**	**Coffee – at Spotted Cow, Angmering**
20th Sep	**Tuesday**	**AGM and Talk – Eastleigh locomotive works**
29th Sep	**Thursday**	**Coffee – with Partners at Swallow's Return**

All talks and meetings will commence at 2.30 pm and be held in the **Pavilion** (now our normal venue), Field Place, Worthing, BN13 1NP unless another venue or time is indicated. Timings for visits and outings will be as printed in the detailed description of the activity.

Coffee mornings commence at 10.30 am.

We will always inform our members of any late changes to our programme by email, but suggest that members should increasingly rely upon our website for up-to-date details of events.

Website of the RCEA

Our website, **www.rceasussex.org.uk** carries the very latest information on all of our events.

New Members and Speakers for Talks

The RCEA needs new members and speakers to ensure that we can continue as a thriving organisation. Please think of appropriate people you know and encourage them to come along to our talks and hopefully join the RCEA.
We also need more speakers to give talks to us on Tuesday afternoons from September to March. We are aware that many members have the knowledge from their working careers to provide interesting talks. If you are willing to give a talk, please let us know. Speakers from outside organisations are increasingly hard to find and often seek payment for their services.

New Members

E. A. Bridges, BSc.	Angmering, West Sussex
D. Farrer-Brown, BA, MB, ChB, MRCP (UK), DPD	Littlehampton, West Sussex
R.S. Fowler, CEng, MiGasE	Burgess Hill, West Sussex
J. Hopkins	Worthing, West Sussex
C.J. Rickard	Worthing, West Sussex

RCEA Insurance

Members need to be aware that the insurance policy that the Association holds is solely for the protection for the assets and liabilities for the Association as an entity. The policy does not provide cover for personal injury or loss to individual members. Members attend the Association's events at their own risk; although under some circumstances there may be some cover from the insurance arrangements of the venue owner.

Newsletter Entries

If you would like to provide an article for inclusion in a future newsletter it would be very welcome as we are always looking for new material in addition to reports on previous talks and visits/outings. From feedback from our members, we know that the newsletter is particularly appreciated by those who are no longer able to get to our meetings and visits, so if you are able to contribute in this way it would be much appreciated. Articles should preferably be Microsoft Word documents, although we can usually convert both text and pictures (even photographs) into a suitable format. Accompanying pictures are best supplied as separate files which will be embedded within the text during editing.

Brief Detail – Visits, Talks and Outing May 2022 – September 2022

Visit
Thursday, 12th May 2022 – Submarine Museum, Gosport

Following the talk on Submarines given on 8/3/2022, we have arranged a visit to the Submarine Museum commencing at 11:00am. The museum is situated at Haslar Jetty Road, Gosport, Hampshire, PO12 2AS.

There are only 20 places available. Applications by Saturday 7/5/2022 please, using reply slip at end of newsletter.

Outing
Monday, 6th June 2022 – South Downs Planetarium

We have arranged an outing to the planetarium, commencing at 10:30am. The planetarium is situated at Kingsham Road, Chichester, West Sussex, PO19 8AE.

Applications by Monday 30/5/2022 please, using reply slip at the end of newsletter.

Outing
Tuesday, 12th July 2022 – Sheffield Park Water Lilly festival

Members will recall that we attempted to arrange this visit two years ago but had to cancel due to the onset of Covid restrictions, which effectively closed down many of the National Trust's activities.

Sheffield Park is a large area of Capability Brown-landscaped grounds with lakes in East Sussex. The nearby house is privately owned and not open to the public.
For several years now Sheffield Park has held a festival between June and July when the water lilies are in bloom. The natural lilies are supplemented by large artificial ones and a floating pontoon allowing visitors to 'walk' out onto the lake. This year there will also be an attendant art exhibition.
The event attracts large numbers of visitors, and we have been fortunate to secure a **guided tour** of the park and lakes. The visit starts at 10:00am with a guided tour of approximately 1 - 1.5 hours.
Following the tour, members are free to further explore the grounds and/or to seek food and drink in the tea rooms which are located just outside the main entrance. Visitors can re-enter the gardens after visiting the tea rooms without additional charge.

Members can view further information on the festival using the QR link opposite which will take them to the National Trust's website.

Applications by Wednesday 6/7/2022 please, using reply slip at the end of this newsletter.

Talk
Tuesday 20th September – AGM and Talk – Eastleigh locomotive works

Members may recall that our speaker, Colin Boocock, gave us an entertaining talk in March 2018 of his experiences of travelling across India by train.
This time he will cover the full 100+ years history of Eastleigh Locomotive Works in Hampshire, including Colin's own experience there in1950s and 1960s, and brings the story up-to-date with the closure of the works in 2006 and its resurgence since then.

Reports

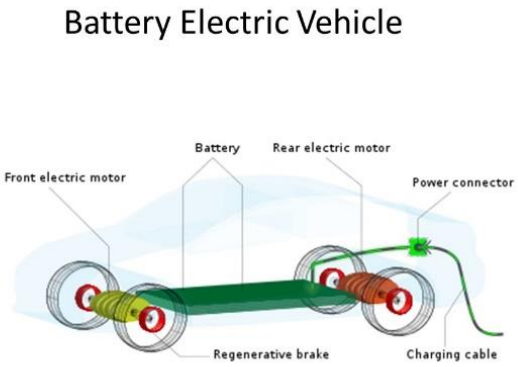
Talk
Tuesday 14th December 2021 – All Your EV questions answered
Gerard Sauer

Our speaker, Gerard Sauer, started his talk by explaining that he had studied automotive engineering in Holland and Germany, starting his subsequent career in engine development in motor racing, before moving on to the development of electric vehicles.

The first electric vehicle that he had been involved with was a converted London taxi cab powered by a hydrogen fuel cell (below left), but at this time (the mid-90s) the technology was very immature and costs were prohibitive so the project was rapidly brought to a halt. Gerard then got involved in the development of a commercial electric vehicle (below right) which was again powered by a hydrogen fuel cell.

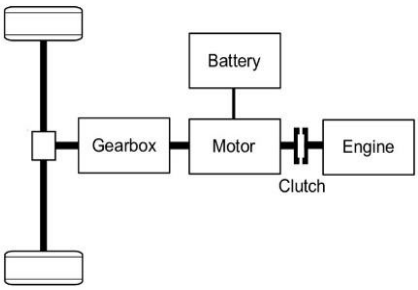
It soon became apparent to him that hydrogen, and in particular hydrogen fuel cells, had a long way to go before they would become economically viable, so he began to get involved in battery-propelled vehicles, and to date has himself owned three Tesla cars.

Gerard contrasted the relative simplicity of the design of a battery electric vehicle (opposite) with the added complexity of a hybrid (overpage left) and a fuel cell vehicle (overpage right), concluding that neither could match the advantages of the 'straight' battery electric vehicle in terms of reduced component count, drive train efficiency and above all manufacturing cost.

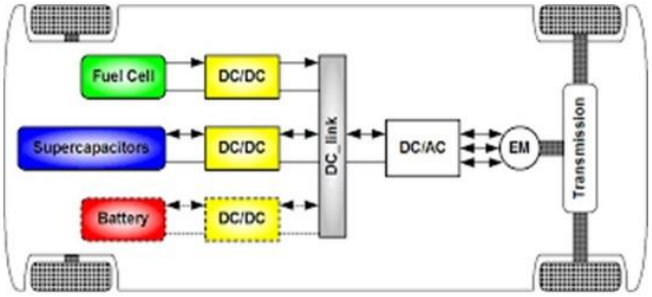


Tesla in particular have been remarkably successful in reducing component count with their GIGA castings which replace large numbers of welded fabrications and pressings used by traditional, or legacy vehicle manufacturers, who are yet to move away from these costly vehicle design techniques.

Parallel Hybrid



Fuel Cell Vehicles



Today we have an increasing choice of electric vehicles available on the market (see below), ranging from relatively expensive premium brands down to more modest offerings, still capable of providing over 170 miles in range, which Gerard felt was capable of fulfilling the needs of the majority of private car users.

Gerard tabled the list of today's offerings:

Tesla Model S	Volkswagen ID 3	Mercedes EQC
Tesla Model 3	Vauxhall Mokka E	Skoda Enyaq
Tesla Model Y	Volkswagen e-Golf	Volkswagen ID 4
Tesla Model X	Audi E-Tron Quattro	Fiat 500 E
Renault Zoe	Nissan Leaf	Audi Q4 e-tron
Hyundai Ionic	Porsche Taycan	Peugeot e-2008
Honda e	Vauxhall Corsa-e	Polestar 2
Peugeot e-208	Jaguar I-Pace E400	Peugeot e-208
Hyundai Kona Electric	Kia e-Niro	Hyundai Ioniq 5
BMW i3	MINI Electric	Vauxhall Corsa -e
BMW iX 3/4 series	Ford Mustang	MG Z-e

All these cars have more than 170 Mile range. Approximately 85% of people only travel 35Miles/Day. The average annual mileage today is 8,500miles/pa The total number of public EV charge points in the UK is 38,500 and rising. The number of petrol stations was 26,700 in May 2020.

Although 'Range Anxiety' is still an issue for many prospective buyers, Gerard referred to the increasing number of public EV charge points now available in the UK, which is gradually overcoming this problem. Many of these public charge points are capable of fully recharging a battery in under 45 minutes, and Gerard suggested that anyone considering a new EV should ensure that it is capable of rapid charging.

Gerard instanced 4 'mass market' EVs now available in the UK capable of 200-mile range (overpage left) and singled out the Hyundai Kona (overpage right) which he had driven and found very capable. There are now over 387,000 electric vehicles in the UK. Public charging points now available are rated at 7Kw, 22Kw, 50Kw, 120Kw and 350Kw. If you are unfortunate enough to run out of battery charge whilst driving, whereas previously you had to wait for recovery to a public charge point, some of the rescue services are now equipped with on-board chargers that will provide a limited recharge to enable you to get to a public charge point.

Although all the early progress in EV development was made by relative new comers like Tesla, the traditional automotive manufacturers have now had to accept that the future will be electric. Renault have publicly stated that from 2023 all their passenger vehicles will be electric only, and even Ford have recently introduced a very attractive electric alternative, the Mustang (below left) as have Jaguar, the I-Pace (below right) in the luxury sector.

Tesla are still the market leaders with their latest Model 3 (below).

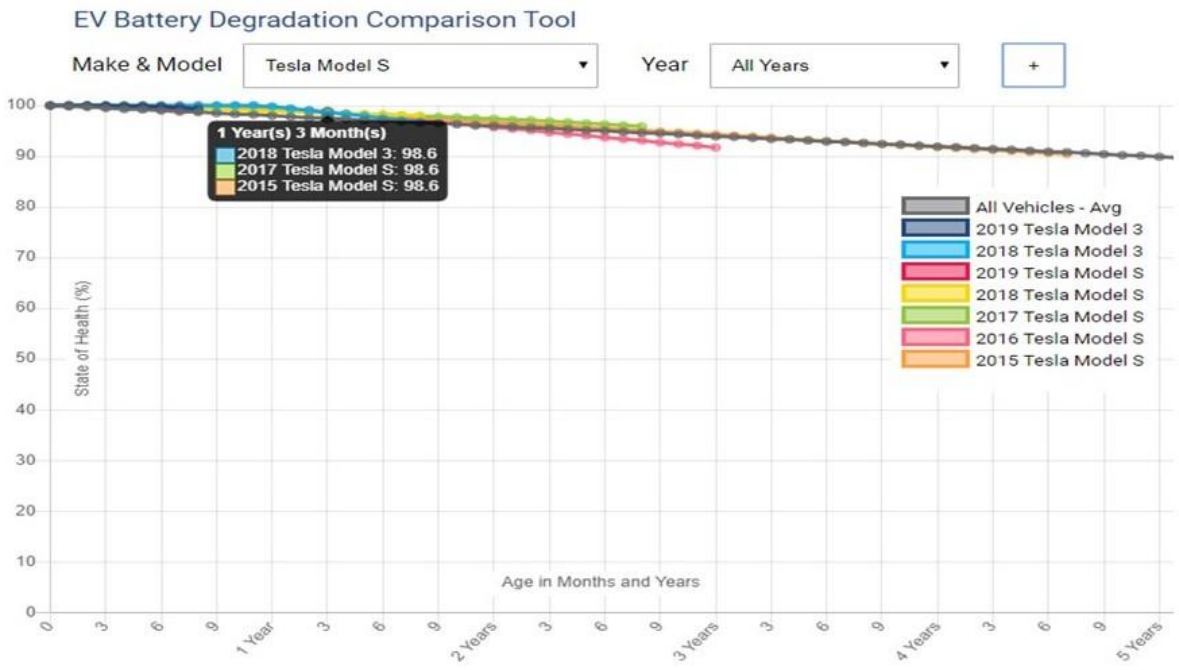
In the near future we can expect to see further choice in EVs, including the BMW IX3, the Tesla Cybertruck, Polestar 2 (Volvo) and the Tesla Model Y, an SUV. There will be developments in faster charging, more public charge points (vital for people without their own charging facilities), a larger green energy grid, wider operating temperatures and longer range up to 500 miles.

Gerard gave the following tips for those considering getting an EV.

- Get a wall charger compatible with your car
- Apply for the home charger Grant (£500.-)
- Apply for the EV Grant when buying the car. (dealer will do the application work)
- Load up the ZapMap app on your phone.
- If possible, no less than 7 kW, but preferably 22kW (Three phase)
- Make sure your car can fast charge, (Min 50kW)
- Always run between 20-80%
- For long trips charge to the max, but use straight away
- Pre-heat that car on the charger.

Gerard explained that the ZapMap is an application that you can download on to your mobile phone that shows not only the location of public charge points, but is also regularly updated to show if they are operational. A 7Kw charger can on average provide about 21 miles of charge per hour. Charging today's batteries to beyond 80% capacity can cause problems with the growth of dendrites within the battery cells, which can cause failure if left in this condition for any appreciable time, but charging to 100% capacity is acceptable if the EV is used straight away such as on a long trip.

Having discussed the merits and operational requirements of EVs, Gerard had previously told us that there were some downsides. Currently available batteries do degrade with time as illustrated in the following slide.



There are also a number of other issues that prospective EV users need to be aware of shown in the slide below.

1) Your insurance might be a bit more (10-12%)
2) You will spend a bit more time along the way.
3) If the car breaks down, not everyone can fix it.
4) If you run out of charge, it will take longer to get you going again.
5) In the winter you have less range and slower charging
6) Residual values for early cars may not be as good as ICE cars, but later cars 2014/15 onwards do keep very good residual value.
7) If you live in a block of flats, its supercharging for you!
8) There will be some early system frustrations.

A further potential problem with the introduction of large numbers of EVs is the capacity of the electricity grid to charge them. Gerard proposed a number of potential solutions (right) and explained that with recent improvements in inverter technology, it will be possible to use the surplus electrical energy stored in the car's battery to supplement the grid at times of high demand in the home with minimal losses. Turning to Renewable Energy (RE), the latest developments in wind turbines suggest that it will be possible to generate 22MW from a single turbine (when the wind is blowing). Fortunately, in the UK there is usually wind in some locations, even on a 'windless' day, such that with sufficient overcapacity in wind turbines, sufficient generating capacity can be ensured. FF stands for Fossil Fuels in the slide opposite.

What about the grid capacity?

- We are at the bottom of the ladder!
- Car-Grid-Car-Home is already being tested successfully.
- Silica-Carbide two way inverters/chargers are here.
- It is estimated that by 2045 there will be 42-45 tW of capacity sitting in batteries in the UK(85% of the time the car is not moving) current base load demand is 12 tW
- Localised grid management will become the norm everywhere
- RE capacity is growing exponentially (22MW wind generators)
- Battery capacity is growing to 400-500 W/hr/Kg halving weight handicap, and par with, or below, IC drive-train weight.
- New calculations are showing that just 30% RE overcapacity will provide enough grid capacity to avoid interruptions.
- The reduction in FF demand will free up huge quantities of energy.
- 40% of users will be able to charge overnight
- 28% of users will be able to charge at work.

On the subject of EV taxation, clearly as more EVs come onto the UK roads, implying fewer IC-engine vehicles, the government will be forced to start to tax EVs and it is estimated that once the EV market share reaches 27% (currently 8%) EVs will be taxed on mileage or Kwhrs consumed. It is also expected that as vehicle manufacturing costs reduce with EVs, further additional levies will be needed to maintain the tax take for the government.

Gerard was hoping to conclude his talk by showing an animated video from the web, but this did not prove possible, so interested readers are referred to the link https://www.youtube.com/watch?v=mk-LnUYEXuM&t=103s to view.

Our thanks to Gerard for an interesting and thought-provoking talk on a very topical subject which attracted a good turnout on a somewhat cold day in December.

Talk
Tuesday 11th January 2022 – The history of weather forecasting
Ian Currie BA, FR Met S, Cert.Ed

Our speaker, Ian Currie (see right), has always been fascinated by the ever-changing moods and patterns of our skies and is now a full-time weatherman, broadcaster, author, columnist, speaker and editor of Weather eye magazine that he established. He has contributed to and appeared on many TV and radio programmes and has written or co-written a number of county weather books illustrating outstanding events from counties such as Dorset, Suffolk, Hampshire, Berkshire, Surrey, Sussex, Kent and Essex and has chronicled in his Book 'Frosts, Freezes and Fairs' the great freezes on the Thames and other UK rivers. This latter was featured on BBC Radio 4. He brought along many of his publications for members to peruse.
As weather plays such an important role in all human activity, attempts have been to forecast it for millennia. As long ago as 650 BC, the Babylonians tried to predict short-term weather changes based on the appearance of clouds and optical phenomena such as haloes.

Hippocrates recognized the connection between the weather and general well-being in humans around 400 BC and always considered the effects of weather before advising on health matters.

All of the early attempts to forecast the weather were based upon observations of the sky, often combined with following popular folklore sayings such as 'Red sky at night, Shepherds delight' (see left).

Such forecasts sometimes came true, but it was soon recognised that if more accurate and longer-range forecasts were required, much more information would be needed.

As early as 300BC, Philo of Byzantium (below left) was experimenting with a thermoscope, an early thermometer, as was Hero (below right) in 150 BC.

Crown Copyright, Science Museum, London.
An impression by A. R. Thomson, R.A.,
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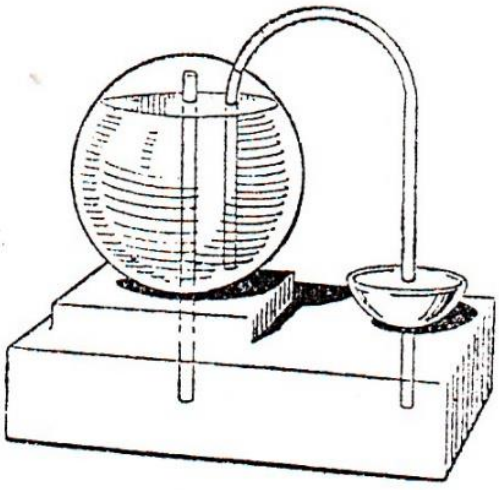
Philo of Byzantium investigates the properties of air. A primitive thermoscope can be seen amongst his instruments.

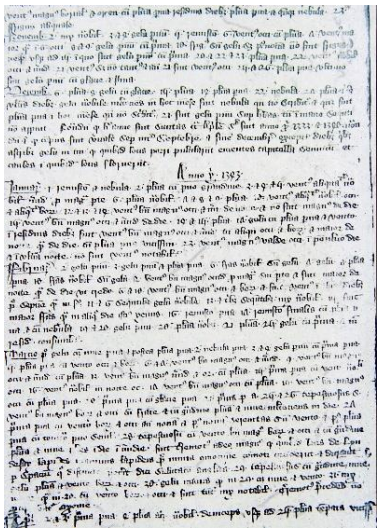


HERO'S THERMOSCOPE, 150 B.C.

Another important development in measurement techniques came in 1643 with the invention of the barometer (left) by Evangillista Torrecelli,

Since the majority of people worked outside on the land at this time, often involved with fishing or farming, it became common place to keep records of weather patterns in order to better manage planting and harvesting times.

In fact, as far back as the fourteenth century, Merle had compiled weather diaries (below).



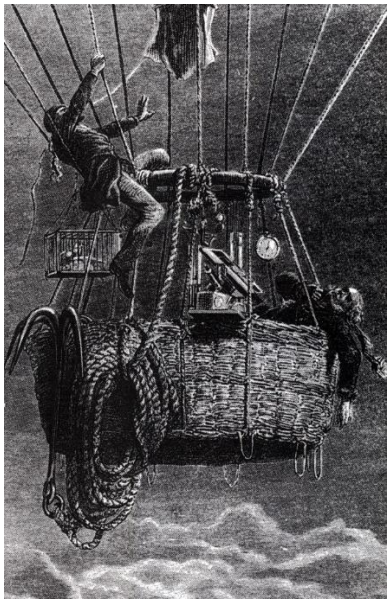
As men travelled further and further around the globe, the need for accurate weather forecasts grew, particularly for ocean travellers, but we had to wait until 1854 for the beginnings of what we now know as the Met Office to start under the direction of Robert Fitzroy. Fitzroy had had a very illustrious career as the captain of HMS Beagle which carried Charles Darwin on his voyages of discovery, and had also been Governor of New Zealand before his Met office career.

Weather Cocks (right) became commonplace in Europe in the ninth century, but other than showing the direction of the wind, they were largely ornamental rather than functional.

We had to wait until 1862 for major advances in meteorology to take place, when James Glaisher (overpage left) and his co-pilot Henry Coxwell began a series of hot air balloon ascents to measure temperature, barometric pressure and humidity at altitude.

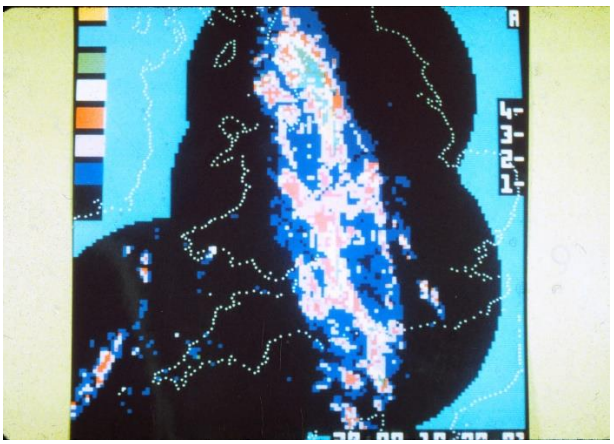
Ascending to about 30,000 feet was a hazardous activity and proved almost fatal on one occasion when lines became entangled (overpage right).

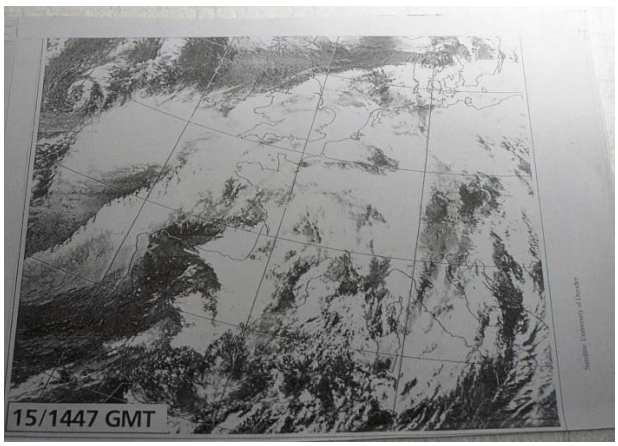
Glaisher was the Superintendent of the Department of Meteorology and Magnetism at Greenwich for 34 years, a Fellow of the Royal Society and a founding member of the Meteorological Society and the Aeronautical Society of Great Britain.



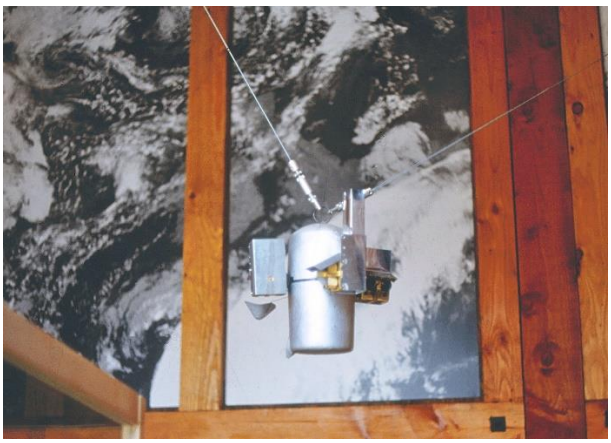
Our dependency upon accurate weather forecasts was never more starkly demonstrated than during the second world war. Readers of our article on Operation Overlord (D Day) in our March 2020 newsletter will recall that the planned invasion of Europe, originally planned for 5th June 1944 had to be delayed until 6th June due to an unfavourable weather forecast.

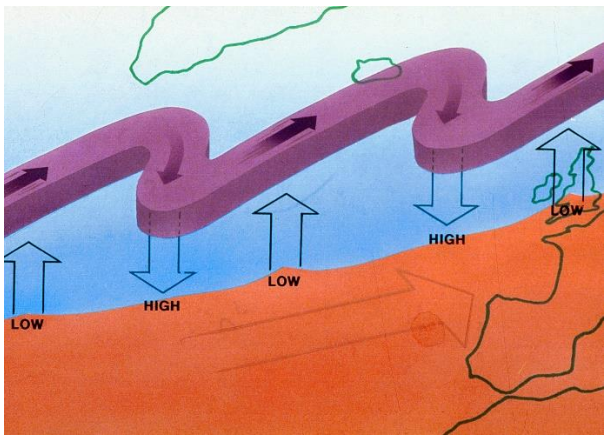
By this time the Met Office had the additional benefit of radar weather maps (typical one shown below), but even with this degree of sophistication, they do not always get the forecast right as evidenced by the October storm in 1987 (below right) which caused so much damage in the south of England.





Our ability to accurately forecast the weather today has improved markedly with the use of radio sondes (below left), giving us information about the strength and direction of the jet stream (below right)





Today we have a proliferation of automatic weather stations (below left) and of course the use of powerful computers (below right).

Our thanks to Ian for a fascinating and entertaining insight into the history of weather forecasting.

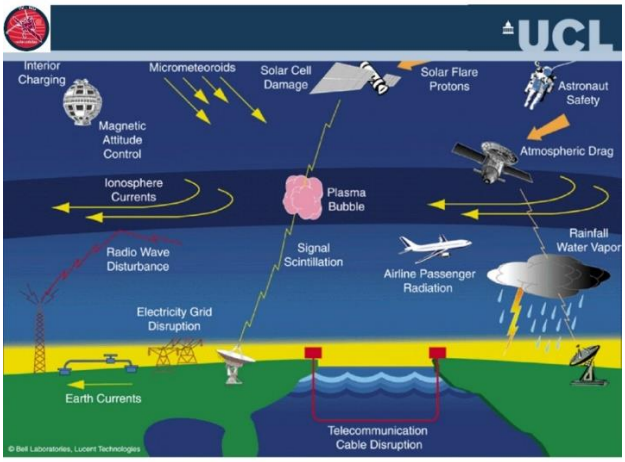
Tuesday 8th February 2022 – The Solar Orbiter

Chris Brockley-Blatt, University College London

Our speaker, Chris, is a chartered mechanical engineer currently working as Project Manager responsible for one of the six remote sensing instruments aboard the Solar Orbiter. She works at the Mullard Space Science Laboratory (MSSL) based near Dorking in Surrey. MSSL is the Department of Space and Climate Physics at UCL, having opened in 1967 and has collaborated with all of the major space agencies including ESA, NASA and Russia.

She explained that her talk would cover observation of the sun from space rather than from the ground, where solar observation is always limited by prevailing climatic conditions.

The Solar Orbiter is a spacecraft intended to address big questions in Solar System science to help us understand how our star creates and controls the giant bubble of plasma that surrounds the whole Solar System and influences the planets within it. She showed us a quite remarkable picture of the sun with our earth shown to scale in the background.



The sun influences much of our daily activities as Chris illustrated in the picture opposite.

Mankind has always had a fascination with the sun, even before the days of Galileo and the use of telescopes in studying the sun.

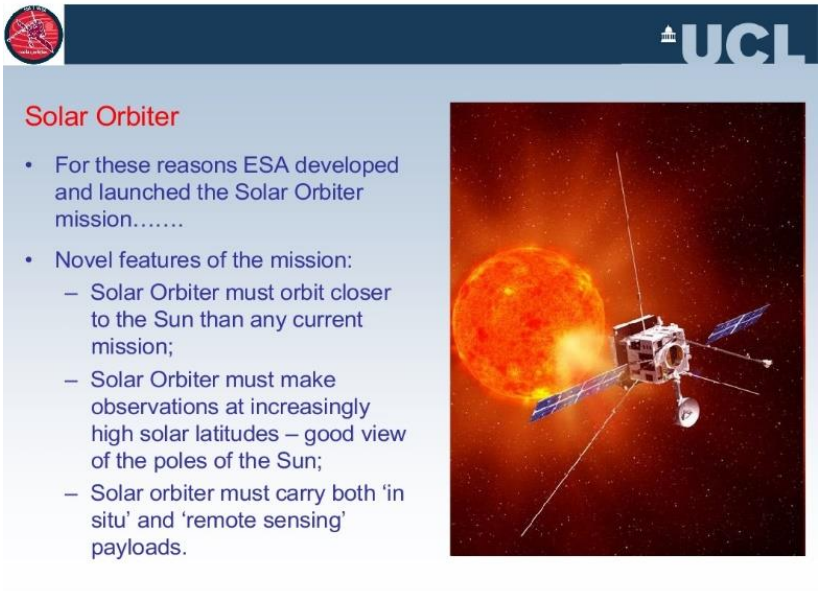
Even today one must never attempt to look directly at the sun with the naked eye.

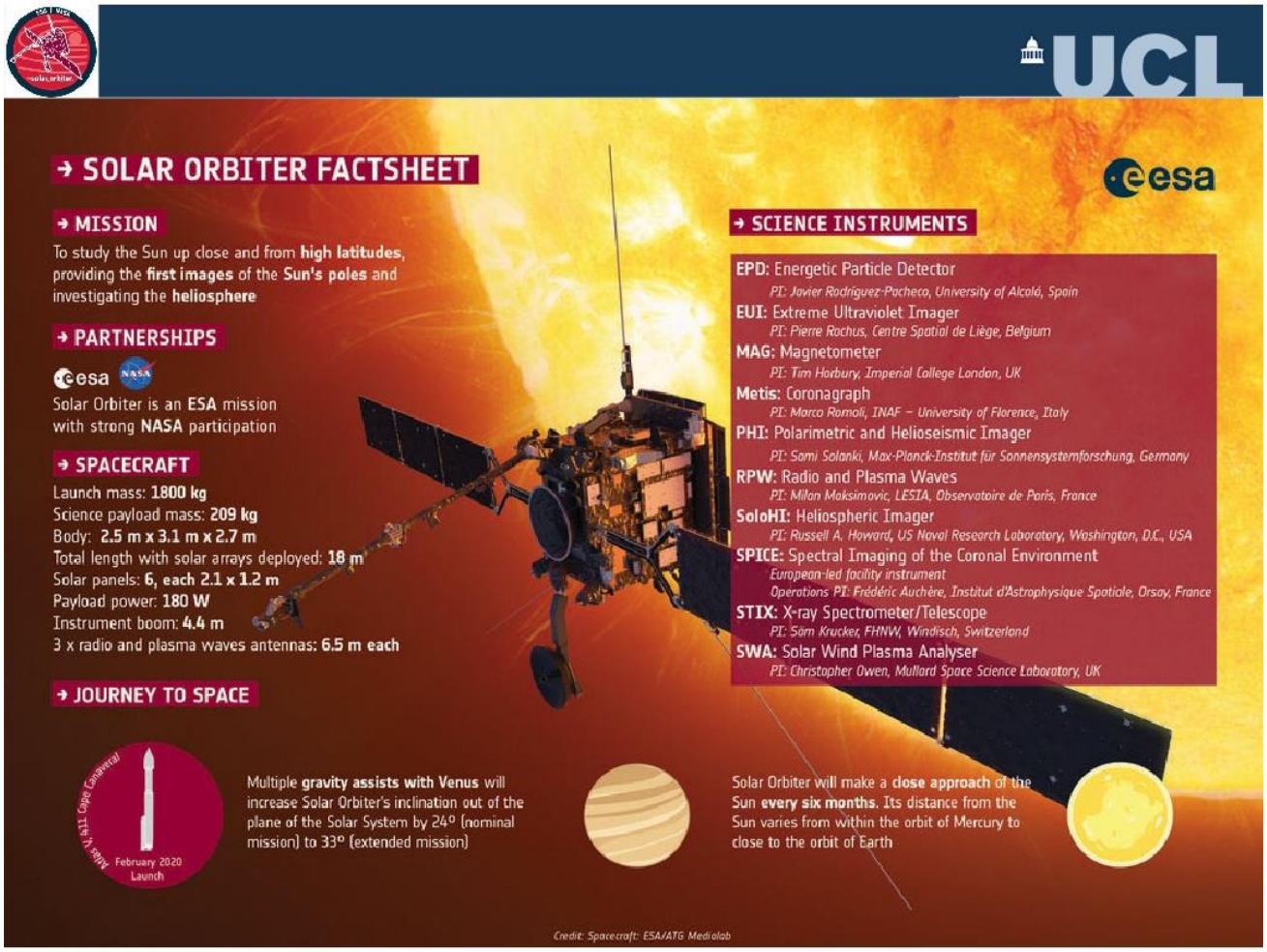
The Solar Orbiter project began in 2007 with an Announcement of Opportunity to all interested parties to join the project.

Airbus became the prime contractor in 2010 and the main features of the mission (opposite) were agreed.

The factsheet for the Orbiter is shown below.

The spacecraft was successfully launched in February 2020 by NASA at Cape Canaveral, and is manoeuvred whilst in space using hydrazine thrusters.





Chris explained that she had responsibility for the Solar Wind Analyser which is situated towards the back of the spacecraft so operates in a very cold environment, needing to be enveloped in a thermal blanket.

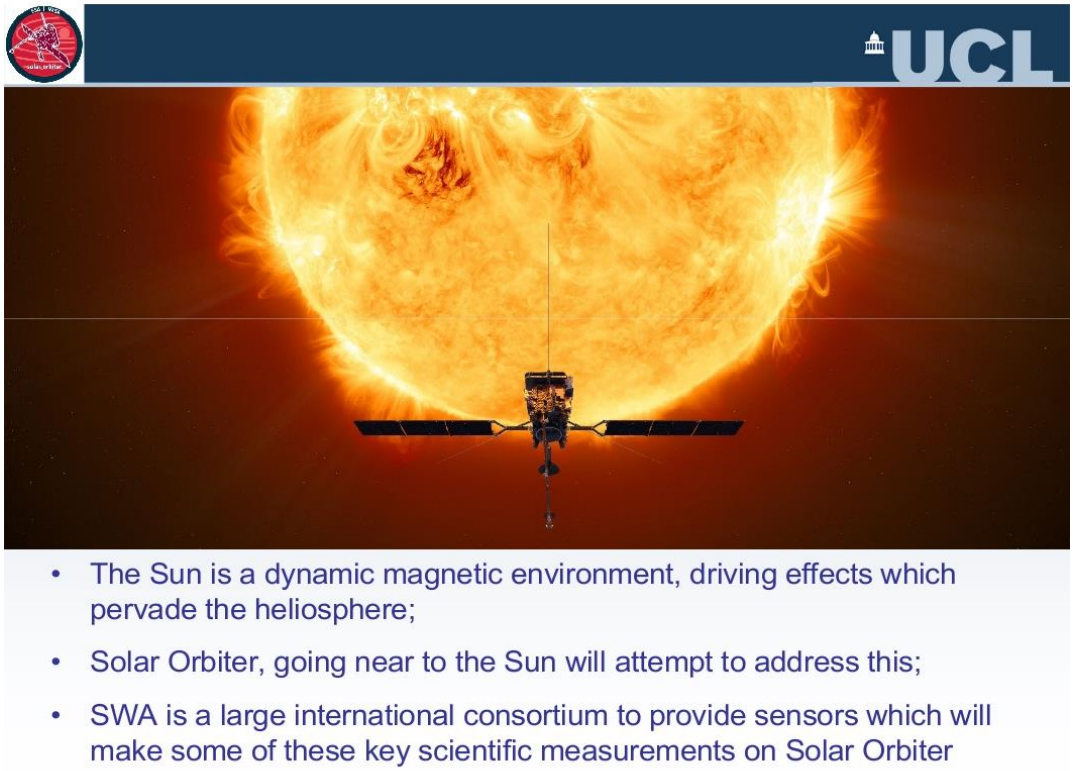
She had very kindly brought one in for us to see (left)

Its design has to enable it to function reliably with minimal electrical power requirements at 28v as all power has to be provided from the solar cells for the entire spacecraft. Additionally, it has to undergo severe vibration testing to ensure that it can survive launch in the nose cone of the rocket.

The solar wind is a stream of charged particles released from the upper atmosphere of the Sun, called the corona. This plasma mostly consists of electrons, protons and alpha particles with kinetic energy between 0.5 and 10 keV. The composition of the solar wind plasma also includes a mixture of materials found in the solar plasma: trace amounts of heavy ions and atomic nuclei such as C, N, O, Ne, Mg, Si, S, and Fe. There are also rarer traces of some other nuclei and isotopes such as P, Ti, Cr, Fe and ^{6}Fe, and ^{58}Ni, Ni, and ^{62}Ni. Superposed with the solar-wind plasma is the interplanetary magnetic field. The solar wind varies in density, temperature and speed over time and over solar latitude and longitude. Its particles can escape the Sun's gravity because of their high energy resulting from the high temperature of the corona, which in turn is a result of the coronal magnetic field.

Finally, Chris showed a picture of the Orbiter against the background of the sun – looking a little 'fragile' when approaching such a harsh and unforgiving object as the sun.

Our thanks to Chris for an interesting and entertaining talk on this fascinating topic.



Talk
Tuesday 8th March 2022 – Submarines through the Ages
Nigel Manger

Our speaker, Nigel, now retired from the navy, was a mechanical engineer serving on a number of submarines during his career.

He began by explaining that the majority of early submarines were powered by internal combustion engines, initially petrol and then diesel, until nuclear propulsion became the preferred method of propulsion, permitting very much longer immersion times before needing to surface. All submarines carried batteries which enabled limited, near silent, travel below the waves. The batteries were also needed for engine starting.

The picture on the right shows Holland 1, the first submarine to be commissioned by the Royal Navy in 1902, which unfortunately sank whilst under tow in 1913on the way to the scrapyard.

It was raised in 1982 and is now on exhibition at the Royal Navy Submarine Museum in Gosport to which we have arranged a visit this year.

Read further for details of how you can join us on this visit.

The navy became more and more interested in the capability of submarines following Holland 1, and began to name their subsequent submarines using ascending letters of the alphabet.

C1, shown below, was the first of the C class submarines with a length of 142 feet 3 inches (43.4 m) overall, a beam of 13 feet 7 inches (4.1 m) and a mean draft of 11 feet 6 inches (3.5 m). They displaced 287 long tons (292 t) on the surface and 316 long tons (321 t) submerged. They had a crew of two officers and fourteen ratings.

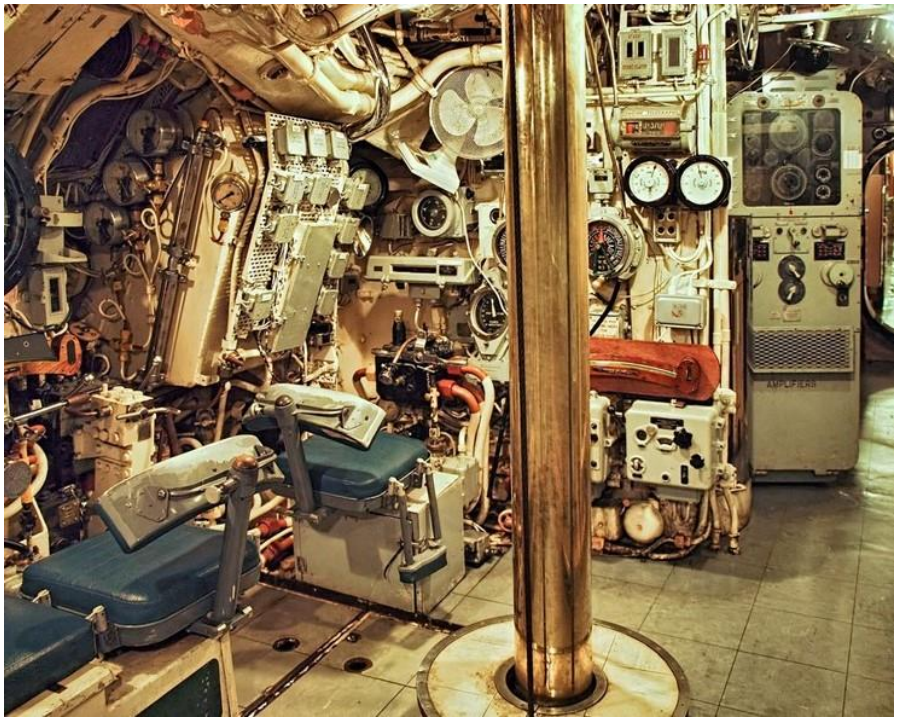
For surface running, the C class boats were powered by a 6-cylinder 600 hp (447 kW) Vickers petrol engine driving a single propeller shaft. When submerged the propeller was driven by a 300-horsepower (224 kW) electric motor. The submarine could reach 12 knots (22 km/h; 14 mph) on the surface and 7 knots (13 km/h; 8.1 mph) underwater.

The boats were armed with two 18-inch (45 cm) torpedo tubes in the bow. C1 was built by Vickers at their Barrow-in-Furness shipyard, laid down on 13 November 1905, launched 10 July 1906 and was commissioned on 30 October 1906. The boat was equipped with wireless telegraphy and saw action during WW1.

The quality of the air in submarines was a major problem in the early days, and submarines often carried live mice which performed a similar role to the canaries used in mines to give an early indication of the build-up of toxic gases.

Hot bunkering was common due to the very restrictive space available for the crew, and submariners tended to be largely unshaven and casually dressed as a result.

Even in modern submarines, space is always at a premium as can be seen in the picture to the left.

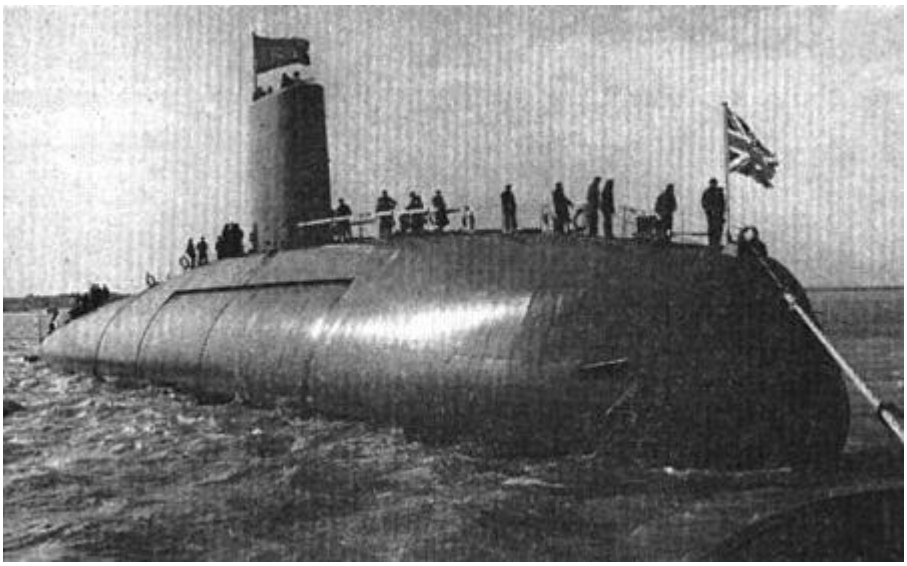


By the outbreak of WW2 in 1939, the UK had a total of 67 submarines, largely left over from WW1. Germany had 65 U boats in 1939, with some 1250 in total being commissioned over the WW2 period. Although the U Boats, armed with torpedoes, were a deadly threat to surface shipping, they had a distinct disadvantage in that they had to mainly run on the surface in order to recharge their batteries and were thus susceptible to attack from surface vessels and to aircraft.

However, the allies could not provide air cover in the 300-mile wide so-called 'Atlantic Gap', and Germany used this advantage very successfully by organising their U Boats into 'Wolf Packs'.

The U Boat threat was eventually largely overcome through use of the convoy system, radar (for when the U Boats were on the surface) and ULTRA, which was developed at Bletchley Park, enabling the UK to listen in to U Boat transmissions.

Better ASDIC also played a major part in defeating the U Boat threat, but ASDIC is 'blinded' once depth charges are used by the surface ships, often resulting in many submarines being able to escape detection.



The importance of submarines became even more apparent during the 'Cold War' era and the UK launched its first nuclear-powered submarine, HMS Dreadnought, on Trafalgar Day in 1960, commissioned into the Royal Navy in 1963. Dreadnought had a displacement of 3,500 tons on the surface, was 81m long, a beam of 9.5m and a draught of 7.9m. She was powered by a Westinghouse S5W reactor feeding two geared steam turbines developing some 15,000 hp (11,000kw).

Today the UK operates the Trident nuclear deterrent, seen right, replacing the previous Polaris system.

Trident comprises 4 Vanguard class submarines each carrying 135 men in relative comfort compared to the early days of submarines.

Trident carries 8 nuclear missiles with 40 warheads making it a powerful deterrent against nuclear attack to the UK

One submarine is always on sea patrol at any one time, with the other 3 based in the Clyde being refitted or preparing for deployment.

Several other countries operate similar nuclear deterrents, principally USA and Russia.

The Russian navy operate Oscar1 and Oscar2 submarines, shown left, which carry cruise missiles.

Oscar2 submarines are 155m long with a displacement of 24,000 tons and carry 107 crew.

Our thanks to Nigel for an interesting talk on this subject.

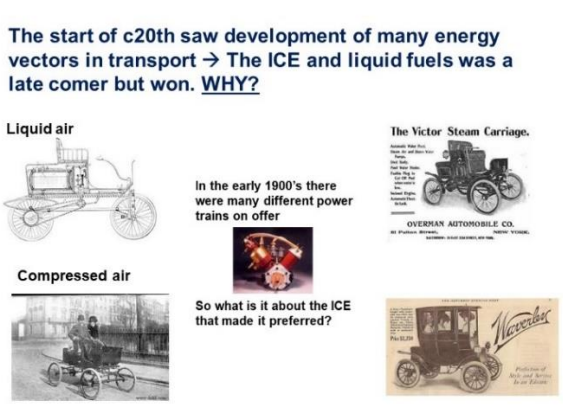
Talk

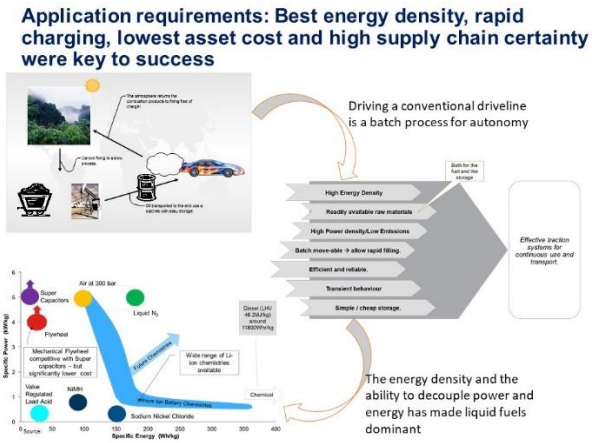
Tuesday 12th April 2022 – Hydrogen – can it decarbonise our lives?

Dr Penny Atkins and Professor Andrew Atkins.

Penny is Deputy Director of the Advanced Engineering Centre at the University of Brighton, and Andrew a visiting professor at Loughborough, Brighton and Portsmouth Universities. Both have extensive expertise in the energy sector and particular interest in the future use of hydrogen.

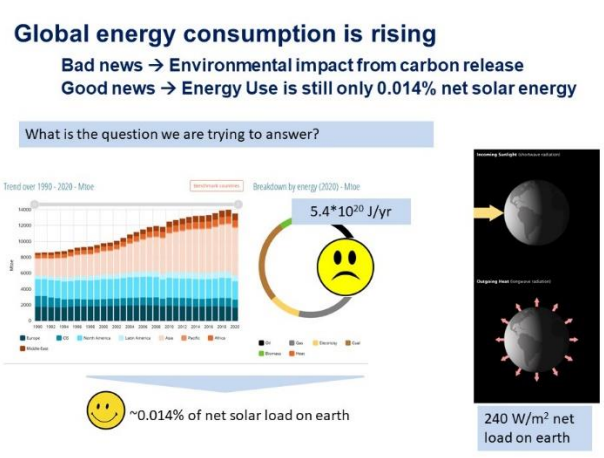
They began by taking us back to the origins of motorised transport, focussing on the internal combustion engine (ICE) which currently dominates the transport sector.

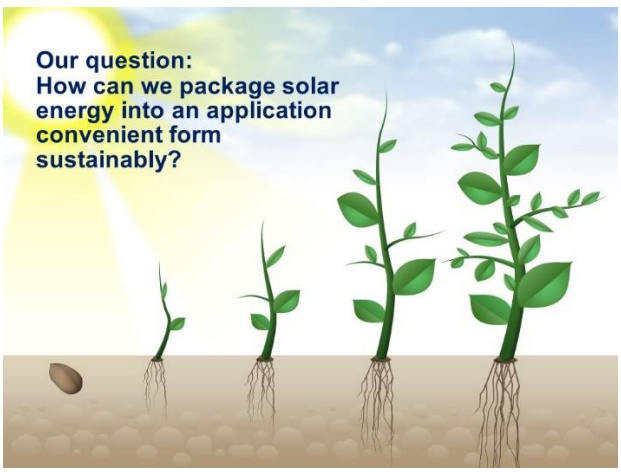


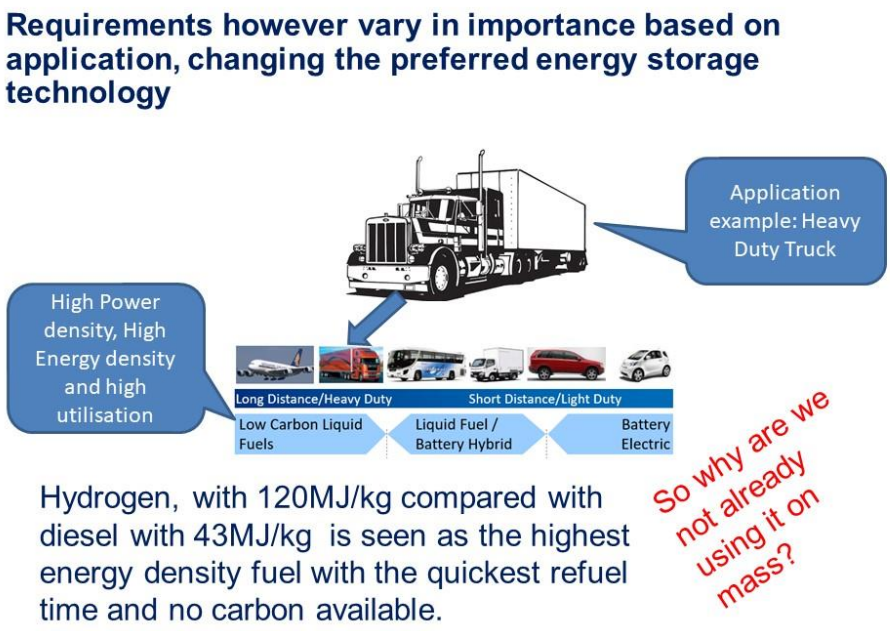


As we all know, the current favourite to replace the ICE are vehicles powered from batteries, which in some ways represents a return to the very early days of motorised transport when some of the first cars on the road were battery powered.

Our speakers then set the scene (see below) against which all 'new' energy alternatives need to be judged, emphasising the dual requirements of sustainability and low (preferably zero) environmental impact.







Hydrogen has been identified as having a key role in our journey to net zero carbon by 2050. The UK Hydrogen Strategy identifies it as a replacement for the hydrocarbon fuels we rely on that is both clean at point of use and low carbon. The Strategy sets out an ambition for a thriving hydrogen economy by 2030 producing 5GW of the gas. But how will we make, store, distribute and use this energy vector? There are a range of technological options with widely varying commercial and environmental impacts.

On the plus side, hydrogen is the most abundant element, has the smallest molecules, is the lightest gas and has a very high calorific value by weight. Hydrogen burning gas boilers are not a problem and incur very little extra cost. A trial in the north used natural gas mixed with 20% hydrogen which proved to be a success in terms of practicality and safety.

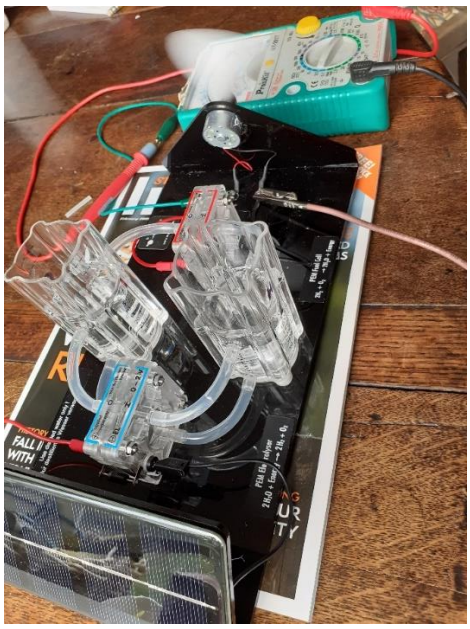
Balanced against these positives are a significant number of problems yet to be solved. Hydrogen is very corrosive, (prolonged contact with stainless steel will cause it to become brittle), has only one third of the calorific value of natural gas by volume, is currently not easy to make in quantity without creating a significant amount of carbon dioxide and is difficult to distribute for use in domestic heating as all joints in the network need to be more gas tight due to hydrogen molecules being extremely small.

Hydrogen Production

Looking firstly at the production of hydrogen, electrolysis would seem to be the current front runner, and our membership secretary, Mike Wooldridge, brought with him a model electrolyser for members to see (right).

In the model electrical power is generated by the photo voltaic cell in the foreground, producing both hydrogen and oxygen in the tall vessels. This is ultimately combined again in the fuel cell to generate electricity to power the fan at the top of the picture.

The two slides overpage show the current thinking with regard to hydrogen production.



Production - There are many ways of producing hydrogen, only a few are low carbon

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Colour	Technology	Materials	Energy	CO_2
Yellow	Electrolysis	Water	Grid mix	High
Green			Renewable electricity	Low
Pink			Nuclear	
Turquoise	Pyrolysis	Methane	Grid mix	Very low net
Black	Gasification	Coal and water	Fossil fuel	Very high
Brown		Brown coal and water		
Grey	Reforming	Coal and methane and water		
Blue	Reforming/ CO_2 capture			High/medium

Low carbon, green hydrogen, can be made from water using electrolysis

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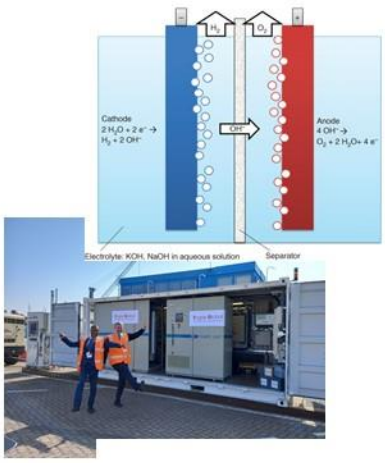
Three main electrolyser types:

- **Alkaline Electrolysers (KOH or NaOH)**

  The water has hydrogen removed at the cathode creating OH which is transported across the fine separator to the Anode where oxygen is removed.

  The alkaline fluid remains and more water is added to maintain concentration

  This technology is well established. Installed at Portsmouth Port 1 month ago.

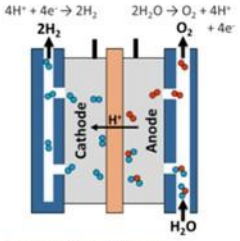


- **Polymer Electrolyte Membrane (PEM)**

  Water reacts at the anode losing an electron to the external circuit to create OH- and H+, the H+ is drawn through a selective membrane and the OH- reacts to form O2 and H2O. At the cathode the H+ receives electrons to form H2.

- **Solid Oxide**

  Similar to PEM but use a ceramic and water enters as steam.



Source: US Dep of Energy

Hydrogen use for road transport

For transportation, two possibilities exist: fuel cells creating electrical power, and burning the hydrogen in an internal combustion engine.

Vehicles utilising fuel cell technology have been prototyped over many years, all eventually failing to reach production. Shown below are some more recent attempts.

Use - PEM fuel cells are on the road in a range of vehicles from passenger cars to buses and trucks

- PEM fuel cell demonstrators are on the road in a range of applications, for example:
  - Bus demonstrators on the road in Aberdeen, Birmingham and London, co-funded by the Fuel Cells and Hydrogen Joint Venture (FCH JU) under the Horizon 2020 programme through the JIVE project.
  - Refuse trucks in Eindhoven as part of the Life 'N Grab Hy! Project
  - H2Haul will trial 16 H2FC trucks in Belgium, France, Germany, and Switzerland
- Brighton and Hove buses plan to introduce 20 H2FC buses into commercial operation
  - Part funded by European Commission (£2.9M) and UK low emission bus scheme (£4.3M)

Source: On board with hydrogen at Brighton and Hove - routeone (route-one.net).

There are a range of issues that are limiting uptake of PEM fuel cells in transport – cost and durability are key

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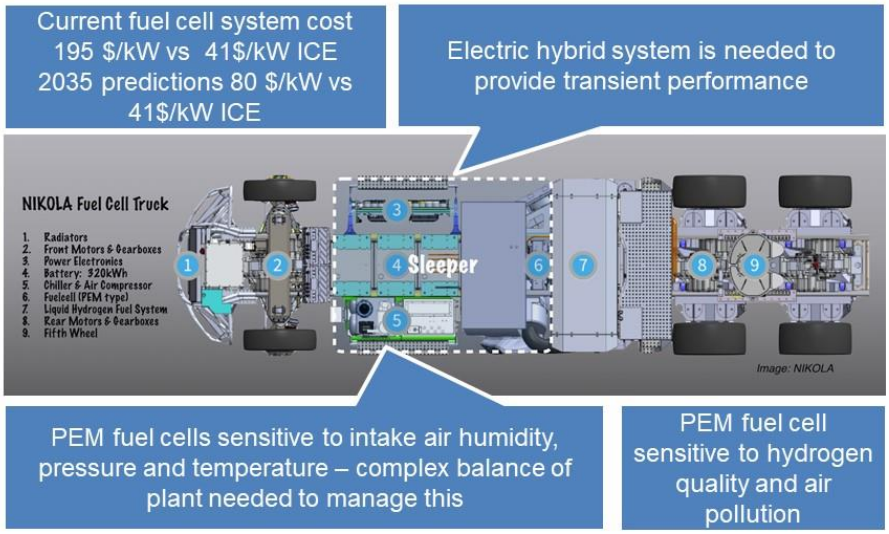

The alternative to a fuel cell is to use the hydrogen to directly fuel an ICE, and there is currently renewed interest in this method as shown in the following slides.

Hydrogen is seen as an enabler for decarbonisation in transport where electrification may not be suitable due to higher energy density fast refuelling and potential for zero tailpipe emissions

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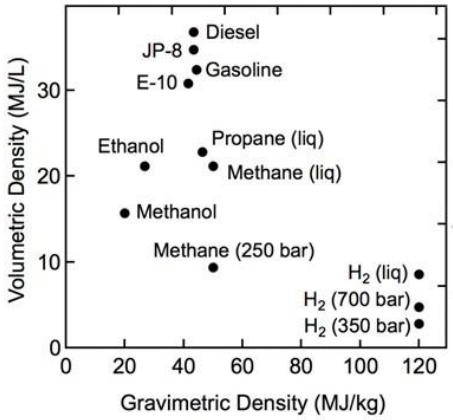
Hydrogen properties influence technology for its storage and use

Property	Gasoline	Hydrogen
Flame speed (m/s)	0.58	3.51
Minimum ignition energy (MJ)	0.14	0.018
Flammability limits (gas vol %)	1.4-7.6	4-75
Joule-Thompson coefficient K/MPa (1bar, 300k)	N/A	-0.5



- Putting it in an engine is not straight forwards
- Storing it is a pain

Hydrogen engines are being investigated by many major players for truck, off highway and motorsport applications

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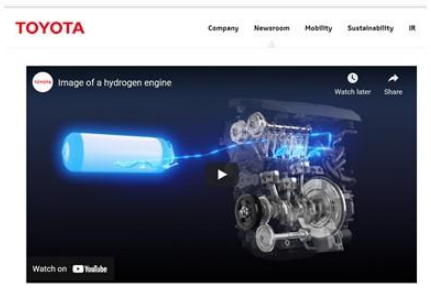

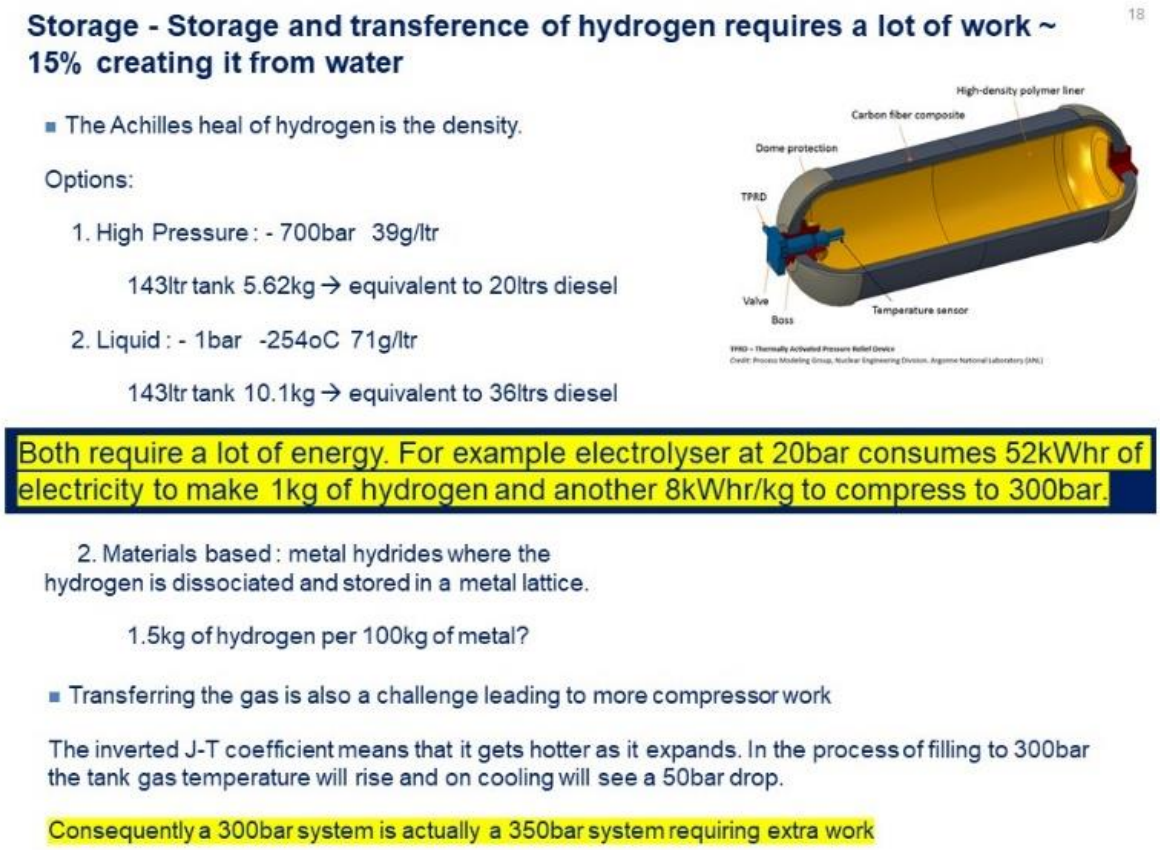

The storage of hydrogen still remains one of the major problems limiting its more widespread use for road transport, as shown above.

In this talk, which generated a host of questions after the tea break, our very knowledgeable speakers have succeeded in setting the possible future role of hydrogen into context.

Our thanks both to Penny and Andrew for an excellent presentation, to David Thomas for taking the notes, and to Mike Wooldridge for the extensive list of questions and answers which appear below.

Questions and Answers following the talk.

Q1 Highview Ltd?
A. This is a British company that has a number of patents covering the exploitation of electrical power (presumably ideally 'surplus' renewable) to cryogenically compress and store air (-196 C, 1/700 volume). Then boil the air off when needed to power an engine working on said compressed air. Initially sales were 'zero' for 11 years, but in the last 18 months they have totalled £450m.

Q2 Put H2 into the UK gas grid?
A. This has been, and is being, tried. But the Hydrogen tends to escape – especially from older pipework. It may be more efficient to first convert the H2 to Methane, which can be contained more easily {after all, methane is used already). However, there are successful experiments using wholly(?) H2 in locally bounded systems – eg Keele University campus, and, according to an audience member, 2 villages in Spadeadam, Scotland. It was also noted that one of the foils shows about 30% of green hydrogen production being fed into 'the grid' by 2030, so presumably UK Gas Transmission is fairly confident about increased use of H2 – but it's not clear in what form or what percentage. The speakers mentioned the potential danger of pockets of H2 in the grid that may not have mixed properly. These could cause intense local heating (melting?) of nozzles on domestic appliances.

Q3 Use of H2 for domestic purposes?
A. Yes. Pure H2 could work well in boilers and cookers, using catalytic conversion which produces heat at 820 C.

Q4 What about the water quality and volumes needed for electrolysis? The future.
A. It needs to be very pure. Andrew runs a company that produces electrolysers (30kW?), and prefers to start with rainwater rather than tap water when it comes to preparing the required water. Volumes of water are generally not a problem, but they can be in dry areas
The discussion digressed into world water use in future. We all know that this is going to be a problem for some countries, but maybe some of us hadn't realised, that Saudi Arabia for example, currently returns so much brine to the Red Sea after desalination (Google tells us that Ras Al-Khair Power and Desalination Plant produces 1,036,000 cubic meters of fresh water per day) that there is a serious possibility that salinity will rise to such a level that it will choke off certain natural sea life in 5 years' time.

Q5 Safety of Hydrogen?
A. Hydrogen is very ignitable, even at low concentrations (4%) in the atmosphere. The flame also spreads very quickly - much faster than for methane etc. However, because of it's lower volumetric fuel density, the flame is not so injurious to people as might be expected, since "it flashes past very quickly, and may only singe your beard" – but don't try it at home. Good ventilation is important. An 'inverted roof' is a good idea, so that any escaped hydrogen does not collect in the normal internal 'Vee', but rather, escapes up the slope either side. Interestingly, we were told that one can throw a lighted match into a container of liquid hydrogen, with no attendant combustion – because there is no oxygen present.

Q6 Hydrogen for use in gas turbines?
A. Yes, this is being worked on – for example Rolls Royce have a project underway.

Q7 Hydrogen surface tension?
A. It seems odd for a gas, but hydrogen tends to stick to the walls of the container. The external pressure may have to be deliberately dropped in order to suck the last bit out.

Q8 What about using hydrogen to make hydrocarbon liquid fuel?
A. Yes, this is possible, but expensive. But it could well be the zero-carbon path adopted by large long haul jet aircraft in future.

Q9 Life expectancy and maintenance of electrolysers?
A. As regards the 30kW ones that Andrew's company makes, the full life expectancy is not yet known. But the Potassium Hydroxide needs changing every 6 months. Also, the membranes (made from a polymer mesh) are somewhat delicate and must be carefully handled.

Q10 Comparison with nuclear power?
A. One has to remember that nuclear power stations were originally the 'by-product' of producing fissile weapons grade material – hence were not necessarily built to be economically justified. It takes a long time (>10 years) to plan, build and commission a nuclear (ie fission at present) nuclear power station, and we have the waste problem. It seems that there was a window of opportunity to build Thorium fuelled power stations - with virtually no reactive waste – but that was 15 years ago, and we've missed the opportunity now, if we want to meet our zero carbon targets.
Interestingly the name 'nuclear' can also be a PR barrier. Andrew remembers working on what are now called (medical) MRI scanners, but started life being called Nuclear Magnetic Resonance scanners. But people tended not buy them whilst the devices were tainted with the name 'Nuclear', so this adjective was dropped.

Some further comments by MCW
For non-petrol heads, looking at Hydrogen fuelled Internal Combustion Engines (ICEs) it is impressive to see the amount of design effort that is given in order to keep Nitrous Oxide emissions low. We were told about lean mixes, re-use of exhaust gas, and use of Argon. We were also referred to the original Ricardo Dolphin engine, which is a 2 stroke engine, having a separate piston doing the mixture compression, and passing this to the power cylinder via a heat exchanger which takes up heat from the exhaust.
We were also shown pictures of the newly installed (1 month old), low-cost electrolyser at Portsmouth harbour made by Andrew's firm (EN-Gas, Horsham). Google tells us that this supplies Hydrogen as fuel to power a boat (driven by an outboard).

REPLY SLIP VISIT TO SUBMARINE MUSEUM, GOSPORT

To:George Woollard 18 St Lawrence Ave, Worthing West Sussex BN14 7JF (01903 523640)

E Mail : Georgewoollard1@hotmail.co.uk

Can you please reserve me …….. places for the outing to The Submarine Museum, Gosport on **Thursday 12th May 2022 at 11.00am**

Full name:……(Block capitals)

Address………

……

……

Telephone Number…….Name of guest/s …….

E mail address……

I enclose a cheque made payable to RCEA for **£……**

(£17.00 per person)

Applications by Saturday 7th May 2022
Only 20 places available, so first come, first served.
Email bookings and payment on the day acceptable

Submarine Museum address:
Haslar Jetty Road
Gosport
Hampshire
PO12 2AS

REPLY SLIP VISIT TO SOUTH DOWNS PLANETARIUM

To:George Woollard 18 St Lawrence Ave, Worthing West Sussex BN14 7JF (01903 523640)

E Mail : Georgewoollard1@hotmail.co.uk

Can you please reserve me …….. places for the outing to South Downs planetarium in Chichester on **Monday 6th June 2022 at 10.30am**

Full name:……(Block capitals)

Address………

……

……

Telephone Number…….Name of guest/s …….

E mail address……

I enclose a cheque made payable to RCEA for **£…….(£8.00) per person**

Applications by Monday 30th May 2022
Email bookings and payment on the day acceptable

South Downs Planetarium address:
Kingsham Road
Chichester
West Sussex
PO19 8AE

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REPLY SLIP – Water Lilly Festival, Sheffield Park at 10:00am on 12/7/2022

To: Malcolm Hind, 7, The Castle, Horsham, RH12 5PX or email malcolmhind@msn.com with full details as below.

The visit starts at 10:00am with a guided tour of between 1 and 1.5 hours which involves some walking, largely on footpaths. A small number of self-drive mobility scooters are available to hire but must be pre-booked by callingVisitor Reception on 01825790231 Option 4. These mobility scooters are very popular, so early booking is advisable.

Costs for this outing are:
National Trust or RHS members - £3.00 (for the guide).
Non - members (adults) - £16.30, Non - members (children aged 5-18 years old) - £9.65. Both costs include the charge for the guide.
Car parking is free. Visitors opting to arrive/depart using the nearby Bluebell Railway should be aware that the walk to/from Sheffield Park will take approximately 25 minutes from the Bluebell Railway station.

I would like to attend the **outing to the Water Lilly festival at Sheffield Park and Garden, East Sussex, TH22 3QX on Tuesday, 12th July 2022 commencing at 10:00am.**

Full Name…… Mobile telephone……
Address……..……..……
……..……
……..…...
Email address……..……..
Number of National Trust/RHS members……Number of Non-National Trust/RHS adults…….
Number of Non-National Trust/RHS children (ages 5-18)……

Please include payment as a cheque payable to RCEA for the above.

Applications by 6 July 2022 please.

End of Newsletter

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