



Minutes

Name of Meeting		Environment and Sustainability Forum
Date and Time		31 st August 2021, 17:00-18:40
Venue		Microsoft Teams
Attendees	Name	Role/Organisation
	Natasha Dix	IWC Strategic Manager Contracts Waste Env
	Colin Rowland	IWC Director of Neighbourhoods
	Richard Grogan	IWC AONB Lead Officer
	James Brewer	IWC Planning Team Leader
	David Newton	IWC Strategic Manager Transport and Regen
	Holly Jones	IWC Climate Change Project Officer
	Jonathan Bacon	IWC Cabinet Member - Environment
	David Adams	
	Alex Lawson	
	Ali Day Logan	
	Brian Taylor	AgeUK (IW) Older Person Steering Group (OPSG) / Whippingham Parish Council
	Nora Clinton	
	Colin Palmer	
	Daisy Brasington	
	David Barry	
	David George	
	Dina Jung	
	Fred Woodworth	
	Jennine Gardiner	IWC Rights Of Way Assistant
	Tony Gillingham	IWC Tree Officer
	Steve Hastings	IWC Corporate Scrutiny Chair
	Ian Boyd	
	John Medland	
	Julie Jones-Evans	IWC Cabinet Member
	Marianne Sullivan	
	MND Stuart	
	Sarah Talbot	
	Robert Sauven	
	Stuart George	
Venetia Verey		
Dave Wallis	Island Roads	
Ian Ward	IWC Councillor	
17:00	ND	<p>Welcome</p> <p>Apologies</p> <ul style="list-style-type: none"> • Chris Ashman • Andrew Garratt • Geoff Brodie • Karen Lucioni • Emily Tapsfield

		MS Teams and housekeeping <ul style="list-style-type: none"> No amendments to last month's minutes
17:05	RG	Introduction to the Biosphere designation <ul style="list-style-type: none"> Biosphere designation is a world initiative run by UNESCO IWAONB is invited to a UK "Man & Biosphere Committee" meeting re. UK biospheres—there are several around the country and Ireland--and asked if IOW could gain biosphere status There were concerns around post-Brexit environmental designations and we wanted to raise IOW profile both in UK and globally There was a 2-year consultation and bid writing process, which led to over 150 pages of application including various maps and why the UN should award the Island a designation The Island is a very high in biodiversity area – New Forest and Thames Basin are the only other areas in the south with greater levels of biodiversity Isle of Wight is also the only place in Britain for several species e.g. wood calamint and reddish buff moth. It also has important populations of rare wildlife like red squirrels The application was considered for 6-9 months and awarded in Paris 2019 The designation is considered a medal for what our parents and grandparents had achieved to that date in terms of how they allowed nature to work with development and human interaction The designation is about celebrating nature plus human interaction with nature, also how we as a community celebrate our culture and work with the environment to keep it The island has been buffered by the Solent from a lot of negative impacts on the mainland, so nature here has continued to thrive in spite of 20th/21st century development on the mainland 3 plans brought together will take Biosphere forward: <ul style="list-style-type: none"> AONB management plan IOW planning document – now in draft Marine plan for the seas around IOW These 3 plans also formed submission to the UN for status Deep peat bed, extensive seagrass beds, unique grasslands on and around the Island provide living spaces for animals and plants but also provide ecosystem services for humans, e.g. clean air, carbon sequestration We want to protect these aspects of countryside and promote their conservation 75% of the Island is under some sort of designation and we will have to continue to do what we've done but also create policy that protects and enhances landscapes and species. This must be done in partnership with people AONB team is keen to be a part of this in partnership with other organisations
17:10		Q&A
	MS	Enforcement is an issue on the Island and the council doesn't seem to be able to do much. Will we have proper enforcement shortly?
	RG	The Biosphere designation doesn't add anything new that isn't already under UK law for protections. Development and other activity has to be judged as legal or not – there provisions in law and policy to protect these things
	ADL	75% of the Island is under designations, however, traditional farming uses various chemicals (e.g. fertiliser). Use of chemicals is in contradiction to these designations as they can cause environmental damage. Shouldn't we work with farmers to look at organic/regenerative agriculture?

	RG	I have been advising farming since 1998 and we are getting there in small steps. There is a huge stumbling block around tradition and education– chemical companies were very good at selling to farmers. This is slowly disappearing; however, the drip feed effect needs to be considered. Can't vouch for every farmer but the general feeling is that chemicals are expensive and should be used sparingly. Ecosystem services e.g. carbon sequestration should be considered as strongly as 'normal' aspects such as growing food.
	ADL	We are working with the council – can we push forward and show farmers how regenerative agriculture works?
	RG	IWAONB are working with farmers on these topics but need to balance with economics. We need to convince people they don't always need chemicals - almost need to wean farmers off them
	DB	What is the council (as opposed to you Richard) doing to support farmers developing Farmer Facilitation Clusters? They are wonderful for bringing farmers together - great examples in Cumbria and Yorkshire
	RG	IWAONB are working with groups in Eastern Yar/South Wight/ New Town catchment but these must be farmer-led – the council can't enforce them Council to confirm what they are doing separately from IWAONB
	ND	How can anyone get more involved in these groups?
	RG	Groups are farmer-led so tend to be groups of farmers wanting to work together. The council needs to work more on communicating about these so people know what farmers are achieving
17:20	HJ	Climate strategy and interaction with other plans
		<ul style="list-style-type: none"> • Slides attached separately
17:35	ADL	What does net zero look like? Net zero is impossible
	HJ	There is a difference between net zero and true zero <ul style="list-style-type: none"> • True zero means eliminating all emissions from every source. This may be possible in the future in many sectors, but is not realistic at this time • Net zero means reducing emissions as far as possible, then offsetting the remaining emissions through carbon removal methods (e.g. planting schemes, carbon removal technology) • The council is taking a net zero approach as there are several sectors where meeting net zero is simply not possible yet
	ND	We have focused much of the strategy on the emissions reduction pathway provided by Regen. There are several challenges locally, e.g. infrastructure for greater electrical capacity to allow us to reduce use of fossil fuels in energy and transport, which is why we are aiming for net zero with a maximum of 15% offset
	IB	What is the role of the Island as recipient of carbon credits from elsewhere?
	JB	There is a nitrate scheme that is well-known and allows the island's land to be used for offsetting nitrates for mainland development. In terms of having other offset schemes based here it may help for nature recovery, which is another angle of the Environment Bill in local nature recovery strategy. Certainly considering this but it is TBC at a later date
	MND Stuart	Can the Council look to exceed planned standards on new housing as for resource use and energy efficiency should be a baseline if the Island is to seriously manage towards net zero, reduce resource use and improve biodiversity.
	JB	On council's the own estate/land and how it uses that but also other development: building regulations are changing in April 2022 and the Future Homes Standard will be introduced in 2025. This is definitely something that could be looked at and responded to in the Planning Strategy consultation

	ADL	Where do we offset to, on a contained planet? The maths doesn't add up
	HJ	<p>Agree that 15% offset is an ambitious target and we do still need to work towards finding land. We are currently working through council-owned land to see which areas can be used in what ways. Much of the Island offsetting target is likely to depend on private landowners and we need to engage with them to get started on larger scale planting schemes.</p> <p>Offsetting will not rely solely on trees, however that is what a lot of the focus is on right now as that is where the majority of funding is aimed. There will be other planting schemes taking place e.g. hedgerows, wildflowers, rewilding, as well as marine schemes such as seagrass, sea kelp etc.</p> <p>Carbon credit purchases have been proposed as an option, but this will be solely as a last resort if we are unable to find space for offsetting locally. There are many complexities around carbon credit schemes so if we were eventually to take this option, we would need to very carefully assess available options.</p>
	NC	Who crunched the numbers on this strategy?
	ND	These came from the Regen study and are largely based on national figures from BEIS
	CP	You mentioned the lack of local skills amongst local contractors. Are there plans to support upskilling?
	ND	Economic Development are already looking into this, and funding has been received under the Green Homes Grant. Future Isle of Wight are also supporting parts of this scheme.
	CP	I queried the Regen figures about the ferry footprint. What was the result please?
	ND	We have used per ferry figures, not per passenger
	HJ	We have included the new figure in the final draft of the Climate Strategy so you'll see the Island carbon footprint has increased since the previous draft
17:45	JB	Draft Island Planning Strategy <ul style="list-style-type: none"> Slides attached separately
17:55		Q&A
	DB	Why hasn't the previous Island plan been finished?
	JB	The current Draft IPS is the next stage in the process – the previous version was based on government housing targets, this version is not after the comments received last time. The Council has had to build evidence to support this position and is now progressing forwards with an aim to have the plan finished and adopted in 2023.
	MND Stuart	Grateful for the substantial effort on this new plan. The plan should provide an absolute local link allocation priority for housing and as mentioned previously focus on better development standards. Retro fitting should also be a key part of any extension or changed applications.
	JB	<p>We've already touched on affordable housing crisis. One thing we've tried to do is introduce housing mixes to ensure we are meeting needs for areas with most shortages, e.g. there is a serious need for 1-2 bed homes on the Island.</p> <p>Development standards are a challenge of different things at different times e.g. the Future Homes Standard – what if something else comes in before that's rolled out in 2025? Comments are welcome in the Planning Strategy consultation</p>
	NC	Does the planning department concern itself mainly with housing? Or does it also consider need for forestry, rewilding, land for renewables etc to meet net zero?

	JB	Housing does get the most focus but is not the only topic. Various other strategies being developed by the council will inform the plan, e.g. tree planting strategy. Should we be allocating large areas for rewilding/offsetting? It would be good to hear thoughts in the consultation. This is not something that has happened previously but could be considered now.
	CP	Do you have any plans to exceed the 10% renewables target for new homes?
	JB	This is a minimum right now – the challenge here is viability. If we increase something, something else may need to decrease in turn to accommodate. The concern here is affordable housing. Everything in the plan has been examined for viability. There is a whole package of things to consider, and we can't just focus on one thing. We have to be very cautious about what and how we adjust to avoid impacting any groups unfairly.
	CP	8 miles of new cycle track appears to be unambitious. Why is the length set so low?
	JB	It can be difficult to join stuff up. There is a good cycle network locally, we could do more but has to be paid for. Viability comes in again – we need to find balance. 8 miles seems unambitious but realistically is likely to be positive. It's a question of what will people accept in terms of funding needed?
	PF	Thanks for presentation – I would like to urge people to respond on things they do like as well as what they don't like to avoid skewed views being presented to developers/planners.
	VV	It was said earlier there is no AONB enforcement, who will be renewing the data sets for habitat protection? SINC data and BAP possibly last updated in 2000 and 2005
	RG	Isle of Wight BAP was reviewed and revised in 2020. AONB lead this with partners on the Isle of Wight Biodiversity Partnership. AONB will be publishing their own AONB Nature Recovery Plan shortly. SINCS were reviewed in 2019.
18:00	DN	Transport plans
		<p>The new Local Transport Plan (LTP4) is at an earlier stage than many other plans discussed tonight. We're currently in the stage of reviewing the previous version of the transport plan alongside an updated evidence base of current issues and policies, so it's a really good chance to align carefully with other plans. Some of the aspirations that have been discussed tonight, e.g. locations of cycle lanes will be critical but can be really challenging as we either need to find land or battle other priorities. The next LTP needs to consider priorities closely. Principles will be outlined in the first draft of the plan – a 'people first' approach to town centres as an example to reflect the contents of the climate strategy. This is been pursued with some success in Newport for the high street to encourage less traffic, less congestion, and more room for people. But nervous about losing parking spaces which leads to challenges. This illustrates the kinds of conversations that will be required to help develop the new plan.</p> <p>LTP 4 will cover 2023-2038 – as such it is updating the time period of the existing plan (which also runs to 2038) due to changes in the environment, society and transport policies. This period ties in nicely with climate strategy dates and targets to ask 'if we want a sustainable transport network what do we need to do?'. There is a huge amount of work ahead.</p> <p>Principles and issues are to be established as a 'first wave' series of test and adjust cycle events due to take place shortly. Following this we need to talk to all stakeholders re. delivery of the LTP – what are the key issues from their perspectives? This will be over the next few months or so. A draft strategy is expected to be delivered in spring 2022. From then there will be further formal</p>

		<p>engagement and consultation in early summer 2022. We will receive feedback, review content, and redraft the plan. Autumn 2022 sign off is the current target with a 2023 start date for the new plan.</p> <p>Once the LTP is signed off the next level needs to be considered: detailed transport infrastructure. Further spatial allocations for new initiatives identified will need to be decided in this phase while making reference to the development of the Island Planning Strategy. This will highlight the need for sustainable communities that can sustain local shops/services to reduce short trips taken by car, so cycling becomes more viable for everyday life. Big stretches of new paths, while important, may not be the key answer – instead smaller local links within towns/removing obstacles to frequent cycling and walking may be more important.</p> <p>It will be key to make public transport as well as active transport more viable for residents e.g. improving the bus service. National bus strategy ‘Bus Back Better’ was published in March 2021. It encourages modal shift to reduce emissions. Local Authorities have been more engaged during Covid and the government wants to capture momentum to help bus services recover. This will be a launchpad for improving sustainable transport. Enhanced partnerships will be required under Bus Back Better: these are agreements between councils and bus service providers to develop the local bus services to improve affordability, connectivity, and frequency of transport. The council will work with bus providers to develop new arrangements. The first Bus Service Improvement Plan (BSIP) is due March 2022 – this will form a legal framework with partners which will be revisited on an annual basis.</p> <p>The LTP and BSIP will closely link to planning/climate strategy develop to keep weaving conversations and plans together and build detail.</p>
18:05		Q&A
	JJE	Shaping Newport is doing our first international Car Free Day on 22nd September.
	JJE	To manage expectations around car free day: have been a lot of changes since the first one, normally we would have areas of town set up as ‘reclaim the streets’. Going to be based in St Thomas square with messaging, Cycle Wight etc. next year will be more like a standard day with road closures etc.
	CP	What assumptions are you making about the uptake of EVs?
	DN	Figures come from the climate strategy – various other plans/strategies are also being pulled in
	IB	Will the new LTP be able to adjust the PFI programme where required to deliver positive change?
	DN	It is contractually binding. There is more flexibility than often thought but will be binding, so performance measures will be needed.
	DB	[Are there plans for] cheap buses?
	DN	The priority is to get pricing right. Conversations are yet to happen.
	CP	One of the disincentives for cycling outside towns and villages is mixing bikes and vehicles on narrow rural roads. Are there any plans for lower speed limits? The Island of Jersey has 40mph everywhere for example.
	DN	TBC – a speed review overall will be taking place this year. We will look at this as a whole. It is mentioned in the climate strategy around town centres. We need to build culture of driving slower to allow for pedestrians/cycling etc.

	DA	With EVs people only see no exhaust pipe, they still have to be built and the destruction caused by the lithium mining is catastrophic.
	HJ	There is a lot of emphasis on and research surrounding EV batteries and recyclability at the minute. We can expect to see a lot of progress over the next few years, especially as EV uptake increases rapidly.
	FW	Does the council footprint capture all contractors?
	HJ	Not yet as there is some complexity around this, but we are discussing ways to do this to ensure we are capturing everything in future footprints.
	ND	Certain items are not captured by procurement, mostly smaller purchases/contracts, so we need to work out a way to ensure we are covering all of these.
	FW	Electric buses – does the enhanced partnership mean we can encourage EV buses?
	DN	Yes – we can influence, but this is not directly in control, plus we are challenged by various aspects (e.g. steep areas may not work for EV buses), so we are looking at other options as well as EV buses.
	NC	When enacting the climate strategy, will we be avoiding separate or “siloed” working? Will we be tackling this cross-functionally?
	ND	Yes – the mission zero climate hub will be one of first external actions and internally L&D/ decision making processes will change. We need a holistic overview while encouraging people to take specific actions that can make an immediate difference.
		Colin Palmer has kindly provided some extra information to answer additional questions that were posted in the chat function during the Q&A. These can be viewed in the Appendix at the end of the minutes.
18:25		Pre-submitted questions
		My question, the climate crisis is from all the latest information getting much worse much more quickly than we were previously led to believe, so are there any plans to:
		1. seriously stop the use of dirty fossil fuels
		<ul style="list-style-type: none"> • We need to get the strategy adopted before we can take next steps • Renewable generation is largely outside the council’s control as most new installation will rely on developers although we will engage as and when we can, as demonstrated with the PTEC project. • The council continues to engage with SSEN and SGN about possible solutions for the island, particularly with regards to the capacity issues but also around future gas to hydrogen systems • The council is working to identify council-owned land that could potentially be used towards different aspects of the climate strategy, e.g. renewable energy generation, or planting/rewilding • The National Grid continues to decarbonise at pace and estimates show that electricity across the UK could be net zero as soon as 2033.
		2. green up our transport system i.e. electric buses charging points for EVs
		<ul style="list-style-type: none"> • Decisions around electric buses largely belong to bus companies – the council cannot enforce purchase of these but there is scope in bus improvement plans to influence. The current target date for phase out of heavy ICE vehicles is expected to be 2040. • Some funding has already been awarded to the council for 10 new EV charge points under the on-street residential charging scheme and the council will be applying for more funding for further chargepoints • If you are interested in an EV charging point near your home you can submit a request: Energy Initiatives - Service Details (iow.gov.uk)

	<p>3. insulate homes via grants</p> <ul style="list-style-type: none"> • Funding has been awarded to the council under the Green Homes Grant and the Economic Development Team are working on rolling this out • The Warm Up Wight scheme is also available for free insulation to homes that meet certain income and energy performance eligibility criteria.
	<p>4. stop UKOG from helping make things worse</p> <ul style="list-style-type: none"> • The council has committed to continuing to hear any applications for oil/mineral exploration or extraction on the island. This is to ensure that residents and local stakeholders continue to be involved in decision making processes instead of them being heard elsewhere and bypassing the island entirely when the decision is made • An application being made does not automatically mean it will be granted.
	<p>5. maybe battery storage at scale so the cross-Solent cable cannot be used as an excuse for blocking increasing solar and wind capacity on the Island</p> <ul style="list-style-type: none"> • This has been discussed in the past and was deemed too expensive; however, battery technology is evolving rapidly so this may be an option in the future although there are still some capacity issues that may apply to battery storage • During our last meeting, Future Isle of Wight had also mentioned the possibility of using, for example, EVs as a form of mobile battery storage that could support the island's capacity • Flexible connections are also being explored as a possible solution and a way of avoiding the need for another interconnector.
	<p>6. the IPCC report as we and most scientists know is on the conservative side of the facts so maybe it is also time to think about that local food security question that I posed a long while ago.</p> <ul style="list-style-type: none"> • The resilience section of the climate strategy has been redrafted in line with the UK climate impacts report published by the CCC in June • Sustainable agriculture has been considered in the resilience section but there is definitely scope to work further on 'eat local' and other food security plans.
	<p>7. Above all I think it is time to start telling the public the truth about the climate emergency.</p> <ul style="list-style-type: none"> • The climate strategy has been drafted in line with the most recent research from the IPCC. The section outlining the latest findings was updated a few days before going to CMT with the new IPCC report published in July • The way the IPCC works is that they assess all relevant research that has taken place around the world and publish overall findings accordingly • I agree the IPCC has been conservative in statements in the past but judging from the most recent document published in July, plus another that was leaked shortly after, there is much less room for conservative statements. • IPCC scientists leaked the second document to avoid governments having the ability to reword summaries to seem more positive prior to publication (Greenhouse gas emissions must peak within 4 years, says leaked UN report Climate change The Guardian).
	<p>Are you following a model when drawing up the climate strategy e.g. the sustainable development goals, Doughnut economics etc?</p>
	<ul style="list-style-type: none"> • The climate strategy has been informed by a variety of research, including the IPCC and CCC reports, the SDGs, BEIS statistics, and national and global policy including the Climate Change Act, the Paris Agreement, the Environment Bill, etc (full details are referenced throughout strategy). • The council has largely based the action plan on the research conducted by Regen on behalf of the council, which examined how different sectors are

		<p>contributing to climate change across the Isle of Wight – this is also in line with BEIS statistics. It's somewhat a sectoral approach (e.g. transport, energy, housing) which broadly matches how carbon footprints are often split, although some actions and outputs haven't necessarily matched those sectors or have grouped better under other headings which is why we've included actions under 'enabling' and 'resilience' as well.</p> <ul style="list-style-type: none"> • In terms of next steps, we recognise that the strategy and action plan is fairly heavy reading and it is not particularly easy to filter through and find the information that is relevant to you or your organisation's activities and interests. We are currently looking at ways to better break up and filter the information as part of our engagement strategy, and may end up using an approach similar to One Planet to make the information easier to filter through • We can't confirm exactly how we will do this as we're not at that stage yet, but we will provide this information as soon as we have further detail available.
		There are over four million poor-quality homes in England, over half of which are lived in by older people, how will the IWC help older Island residents who make a significant proportion of our population, make the changes necessary to their homes and life styles in the light of a rapidly changing climate?
		<ul style="list-style-type: none"> • The Warm Up Wight and Green Homes Grant are available to anyone who meets certain eligibility criteria. These are largely based around income and energy performance of existing homes • The council is working on the best way to better promote these schemes to residents who maybe wouldn't access them via the internet • We are also monitoring the funding situation closely and will begin to work on any new schemes related to housing as they become available.
		When does the IWC intend to develop active, working relationships with Parish Councils and relevant third sector organisations to help build public engagement around climate change issues and which organisations might be included?
		<ul style="list-style-type: none"> • ASAP. We have plans to set up a group specifically for T&P councils based around coordinating climate action and finding projects that we can combine efforts on. We will be launching this during Q4 • We are also working on an engagement strategy that will allow the council to better work with third parties on the climate strategy. Again, we are still working out the details of this so I can't confirm exactly how this will look at this stage but we will be seeking to develop partnerships to allow partners to be much more involved or possibly take ownership of parts of the island action plan where possible, as we recognise that there are some areas in which non-council organisations will be able to have much more of an impact.
18:35		AOB
	ST	Noise from Wightlink – cars coming off/going on are causing a loud banging noise day and night. There is a huge number of vehicles.
	CR	We will take this away and look into it. We will aim to respond before the next forum.
Date of next Environment & Sustainability Forum: 30th September 2021, 17:00-18:30		
Topic: planting and restoration		

Appendix

Hydrogen catamarans

Hydrogen powered catamarans were indeed trialled by Cheetamarine on the Island. It was a technical success, but widespread adoption of the technology will not happen until the cost of hydrogen and of fuel cells comes down. There is a great deal of research going into the use of hydrogen for heavy vehicles and shipping. For ships it looks more likely that the hydrogen will be converted to ammonia, which can then be used in existing engines as well as in fuel cells.

It is not fanciful to expect that regions such as the Gulf states will start to install vast solar arrays to produce hydrogen/ammonia for bunkering ships. The cost of electricity from solar PV in such locations is now the lowest cost electricity ever, anywhere. (<https://www.carbonbrief.org/solar-is-now-cheapest-electricity-in-history-confirms-iea>)

- <http://www.cheetahmarine.co.uk/en/deliveries/worlds-first-hydrogen-powered-boat-smashes-targets>
- <https://marine-offshore.bureauveritas.com/magazine/shipping-industry-ready-ammonia>
- <https://spectrum.ieee.org/why-the-shipping-industry-is-betting-big-on-ammonia>
- <https://www.lr.org/en/insights/articles/decarbonising-shipping-ammonia/>

EV battery recycling

The recycling of EV batteries is in its infancy, but that does not mean it will not happen. At present, most EV batteries are redeployed for stationary uses once they reach the end of their useful life in a vehicle (having lost maybe 20% of their capacity). There is a large and growing demand for storage on electricity networks across the globe, at present far outstripping the availability of ex-EV batteries. Also for domestic batteries - see the Powervault link.

Reuse links

- <https://www.powervault.co.uk/>
- <https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/second-life-ev-batteries-the-newest-value-pool-in-energy-storage>
- <https://blog.ucsusa.org/hanjiro-ambrose/the-second-life-of-used-ev-batteries/>
- <https://cleantechnica.com/2016/11/24/recycling-ev-batteries-makes-sense-using-home-energy-storage-lux-research-echoes-tesla-cto-jb-straubel/>

Recycling links

- <https://www.ev-battery-recycling.com/index>
- <https://fullycharged.show/blog/why-ev-battery-recycling-is-set-to-take-off/>
- <https://www.apcuk.co.uk/news/roadmaps-explored-understanding-battery-challenges-chemistry-recycling/>

Shift away from lithium

Lithium is only a small fraction of the materials used in Lithium ion batteries (see attached paper from the Union of Concerned Scientists). Nickel and graphics are used in much larger quantities. That said, there is a great deal of research going on into alternative chemistries (see a few selected links below). However, I do agree that the huge investments in gigafactories might have the effect of locking in Lithium ion. History shows us time and again that if a technology gets an initial head start on the alternatives, it can be very difficult to displace. The QWERTY keyboard I am using to write this is a prime example.

- <https://www.imperial.ac.uk/electrochem-sci-eng/research/alternative-battery-chemistries/>
- <https://www.freethink.com/technology/sodium-ion-battery>
- <https://www.faradion.co.uk/>
- <https://graphenemg.com/energy-storage-solutions/aluminum-ion-battery/>

Breaking the laws of thermodynamics - hydrogen net energy loss

The basic laws of thermodynamics apply to all energy conversion systems. So, burning any gas to generate electricity or motive power is up against these limits. Modern gas fired power stations (the most efficient fossil fuelled technology and an extremely mature technology) are around 60% efficient - which is actually more than 80% of the theoretical thermodynamic limit. A fossil fuelled car (another very mature technology) does a lot worse - 20%, maybe 25%, overall efficiency.

In the case of hydrogen, if it is made by electrolysis of water using electricity, the conversion efficiency is around 60%, with potential for improvement. See attached paper (Burton et al.). If that hydrogen is then burnt to create heat, the conversion efficiency will be in excess of 90% in a good boiler. If it is used in a fuel cell to produce motive power or electricity, the conversion efficiency is up to 60%, again with potential for improvement. Thus, the overall efficiency is low - from source (say a solar farm) to wheel in a vehicle it is only 30% to 40% efficient. In comparison, if that electricity were used to charge batteries, the overall efficiency allowing for transmission, battery cycle efficiency and electric motor efficiency is 70% to 90% (see the InsideEVs link).

- https://en.wikipedia.org/wiki/Combined_cycle_power_plant
- <https://www.linkedin.com/pulse/how-calculate-overall-thermal-efficiency-combined-cycle-marcial/>
- <https://insideevs.com/news/406676/battery-electric-hydrogen-fuel-cell-efficiency-comparison/>
- <https://www.sfc.com/en/glossar/fuel-cell-efficiency/>