Betterworld. Solutions

Battery arrays to reduce peak UK electricity demand by 17.5%

UK peak electricity demand can be reduced by 17.5% by investing £21 billion on a 6:1 10GW battery array. It will save 14.6 million tonnes of CO_2 emissions annually.

An £8.4 billion investment in a smaller battery array would reduce peak demand by 7%.

Hinkley C will generate 7% of the UK's electricity at a cost of £26 billion.

UK-wide restrictions on green energy and battery array connections to the grid are bad for the environment.

Contents

Page: Topic

Green backup as well as green energy: the case for battery arrays

As the UK transitions to a green economy, we will need more electricity, and in particular green electricity, as gas and diesel cannot be green. The grid distributes the power that is generated and is operating at close to peak capacity, which means that in many parts of the country green energy connections to the grid are being refused or only sometimes allowed if the green energy provider pays an exorbitant fee to allow the connection of green energy to the grid [1].

There is a difference of around 12-Gigawatts of electrical requirement at any time during a 24-hour period. That very roughly translates into a demand for 40-Gigawatts of electrical power during the day and 28-Gigawatts of electrical power during the night [2]. In line with Government policy, an increasing proportion of UK energy is provided by renewable energy sources.

However, there are periods during the day when electrical demand is much higher than others and this is currently dealt with by various forms of demand management, the majority of which fall back on fossil fuel and other CO2e emitting generating capacity [3]. Only a tiny part is provided by green storage solutions, the most compelling of which are grid level battery arrays. Ideally, these arrays should be working in tandem with non-renewable sources that by their nature have fluctuating output but this is not happening in large parts of the country.

Legislation out on 1st April 2023 might resolve some of the issues as the maximum that an ENA (Energy Networks Association) can charge for connection has been set at £1,720,000 per Megawatt [1]. That is an approximate 17% increase in the price of a 1-Megawatt battery array which costs around £1 million but is a huge improvement on the up to £10 million that has been quoted for some connections to the grid. Evidence that green energy cannot be connected to the grid has been provided by the generators, Octopus Energy [4], battery array providers and is highlighted by reports that hundreds of millions of pounds are being spent to pay wind farm operators to stop providing power to the grid, to prevent the grid from being overloaded [5].

As we move to a green economy we will need more wind, more solar and more electric vehicles with batteries. The only sensible way to charge a lot of electric vehicle batteries at the same time, without bringing the grid down, is to have even bigger batteries storing energy to charge the smaller batteries in electric vehicles. In the long run, massive investment in the grid will be required and generation by gas and possibly even coal and nuclear energy will continue to be part of the mix. Increasing the importance of renewable or green energy sources is only possible if there are adequate storage solutions.

1 – See Appendix 9

2 – See Appendix 12

3 – See Appendix 12

4 – See Appendix 2

5 – See Appendix 5

The country currently has approximately 2.1-Gigawatt[6] of battery arrays, which is a small fraction of what is required. Probably the major reason for such a small amount is the refusal of connection to the grid, to prevent overloading, but battery arrays themselves will not overload the grid as the battery arrays are intelligent and can store the energy to be released at a time when the grid needs it.

A (6:1 10-Megawatt battery array) 10-Gigawatt battery array could provide 60-Gigawatt hours of energy. The batteries could be slowly recharged at night or when daytime demand is low and fast discharged at peak times. We are unlikely to be able to displace all the standby coal and gas generation, but might it be possible to displace 40% with battery arrays capable of storing and delivering 24-Gigawatt hours of energy?

This will not happen without significant investment, including private sector investment. However, currently if you buy power to fill your battery off-peak, you can only sell it for much less at peak time, which looks like a deliberate disincentive for investors. Is it possible that just changing the price mechanism as well as making grid connections a priority would accelerate the use of battery arrays, make the UK a greener economy faster, and help deliver the UK's Net Zero goals more efficiently?

Battery Arrays Summary

1. We cannot have a green economy without electricity. (Appendix 13)
2. Neither hydrogen nor Carbon Capture and Storage are CO2e beneficial now and will never be until we have an excess of green energy. Apart from battery arrays there is no other practical storage option currently available, and it is likely to be true for the next 20 years. (Appendix 14, 5)
3. We cannot make use of all the solar and wind energy generated without battery arrays, and we are currently wasting a significant part of the green energy produced, because the grid cannot take it, at the point it is supplied. (Appendix 5)
4. We cannot charge small car batteries without large battery arrays, or we need to massively increase peak electricity supply and stop peak charging of car batteries, which will not be popular. (Appendix 3)
5. There is a pent-up demand for grid connections of wind and solar, often with battery arrays included. The connections are being refused or delayed for up to a decade and is the number one reason that we have practically no battery storage in the UK. This in turn prevents more solar and wind energy from being generated to replace gas and oil generated power. (Appendix 1, 2, 9, 10, 17)
6. Battery arrays would accelerate the shut-down of the worst "dirty power" generation more quickly. (Appendix 1)
7. The technical challenges to replace dirty energy with green and potentially have too much power for the grid to manage at peak, are really a management issue and battery arrays would make it easier to manage the transition without over-loading the grid. (Appendix 3, 6, 7)
8. Battery Arrays would not require massive investment in the grid, but that investment will be required in any case if we want a green economy. (Appendix 3)

6 – See Appendix 11

Restriction on Green Energy Connection to the Grid

I want to be clear that my engagement is entirely public service. Neither I nor my business have any commercial interest in generating electricity, the Network or battery arrays. Dr. Alex is one of the leaders in the field, but I am the one driving this, fundamentally for my grandchildren.

The purpose is to inform, and the ask is to present information to the right people so that the UK gets the green energy that it is the policy of the Government to deliver.

Ofgem have put in writing that battery arrays are generation, but yet they have also asked DNOs to provide battery arrays[7].

Completely contrary to Government policy there are restrictions, UK-wide, on the distribution of green energy. This is not about whose fault anything is, but an understanding of the facts.

Fact: The DNO in Derby will not allow our business in Derby to connect solar energy to the grid.

Dr. Alex has advised me that in large parts of the UK there is a restriction on connecting green energy to the grid, in many cases the restrictions apply until 2030.

Dr. Alex provided me with proof in confidence about 2 separate denials to connect from the "National Grid" and which he may or may not wish to share. One from Coventry denied connection until 31st October 2028. Another from Northern Powergrid denied connection above 1MW until 2031.

Greg Jackson the CEO of Octopus has been recorded to claim that a wind farm can be built in a year but can take 6 to 7 years to connect to the grid[8].

It is only important if it is both true and contrary to Government policy and if it is diminishing the ability to lessen the worst impacts of climate change.

7 – See Appendix 3

8 – See Appendix 2

Why Battery Arrays Matter

UK peak energy demand is approximately 40GW during the day and 28GW at night. A 6:1 10GW battery array would provide 60GWh and change daytime peak consumption to 30GW and increase night-time peak consumption to 33GW. The battery array would be quick release at peak demand during the day and slow re charge at other times.

The peak would then be 33GW and not 40GW, which is a reduction of 17.5% (100% less 33/40) and in theory would not require any increased investment in the grid, if in fact we had a national grid. The cost of the battery array would be circa £21 billion, against the projected £26 billion cost of Hinkley C to generate 7% of the total electricity demand for the UK.

Electricity cannot be stored in any other way apart from battery arrays. Less peak demand means less generation capacity or more likely the same generation capacity to deliver more electricity as we move from fossil fuels to green electricity.

Wind and solar are unpredictable generation and charging electric vehicles cannot come directly from the grid at peak demand times, so battery arrays are essential for a green electricity future. Even if only 40% of the peak demand could be stored and used to provide the same 7% as Hinkley C, the cost would be £8.4 billion for a smaller battery array instead of £26 billion for Hinkley C.

The point is that batteries are currently an essential part of delivering more green electricity, but not anywhere nearly as useful if they cannot be connected to the grid to manage peak demand. A failure to allow connection of battery arrays is both wasteful and leads to the unnecessary generation of more electricity to meet peak demand.

Why is refusal to connect to the grid important?

The Government has no money and according to one leading venture capitalist.

“We share your belief that dealing with the peaks is key. Indeed, the investment (and climate) opportunity from dealing with the peaks in power supply has been a core strand of our Infrastructure strategy for several years. We are not alone, and there appears to be plenty of capital to support that thesis. I would also expect to see more operating companies follow AES’s lead by investing in their own battery capacity. Better to do this than wait for Governments to work out what is necessary.”

If true there is plenty of capital available, but it has not been deployed if the peak demand to lowest demand gap for electricity has not changed in the last decade.

Small businesses can and would deploy their capital more readily if they could connect a battery array to the grid and benefit financially from the ability to buy and store energy at a sufficiently less cost than the price it could be sold for at peak times.

The Government cannot afford the capital outlay for the minimum 7% reduction in peak demand or increase of the 7% peak supply that a circa £8.4 billion battery array would provide. Venture Capital could provide the capital but have not invested, private businesses (wind and solar) or households would probably invest more in solar energy if they could have small battery arrays that they could connect to the grid.

Improving the business case for battery arrays requires connection to the grid and a fairer price for energy supplied.

The author does not know how generators and distribution networks are remunerated and that is the key to ensuring that energy storage becomes a significant part of the provision of more green energy.

P28 Compliance — Planning Limits for Voltage Fluctuations

The principle of taking energy when it is cheaper or when you need it and selling it when it is more expensive or when you have excess is a mechanism to increase generation/reduce demand or reduce generation/increase demand on the electricity grid and that can have consequences for the grid management and cause problems with grid voltage fluctuations.

The issue is that of the rapid change in voltage caused by the simultaneous swing of multiple BESS systems on a related part of the network. **To be clear this only applies to batteries that import and/or export power to the grid.**

A P28 study is carried out to determine whether or not a power system and any related equipment meets DNO requirements for voltage fluctuations.

The study must determine the maximum and minimum voltages that can be tolerated by electrical equipment without adversely affecting its performance.

According to the P28 Standard, the maximum permissible voltage dip is 3% for less than 10 minutes of energisation, and 1% for regular energisation.

Simply a BESS may impact on other connected users.

Many current GSP groups are closed to battery technology due to P28 compliance.

To fix the issue requires building more GSP groups and reconfiguring the network to bring the impedance down (expensive) or upgrading existing connections onto a higher voltage (very expensive).

This is a management issue that requires fixing through investment and the application of technology.

Are Batteries CO2e Beneficial

It may or may not be true that there is widespread scepticism at “Westminster” that battery arrays are CO2e beneficial after considering the CO2e cost of production, use and disposal.

Under separate cover, [9] I have provided the evidence that the 1.25MW battery array that AESSEAL® installed recently is good for the planet. The CO2e cost, including disposal over the 15-year life cycle, is circa 112 tonnes and a CO2e net benefit of 2415 tonnes over the same 15-year period.

On a macro level for £26 billion Hinkley C is reported to save 9 million tonnes of CO2e annually and an £8.4 billion investment in a battery array to reduce peak demand by 7% would save approximately 5.84 million tonnes of CO2e.

9 – See Appendix 4

Battery Recycling

The environmental challenges of recycling batteries at end of life are being addressed. An example is Technology Minerals [10] and its battery recycling business, Recyclus, who have just received Environment Agency (EA) approval to open the UK's first industrial scale lithium-ion battery recycling plant in Wolverhampton moving the UK nearer to a circular battery economy.

Once the commissioning phase is complete, Recyclus will be able to process up to 22,000 tonnes per year of lithium-ion batteries. Recyclus will receive revenues from the collection of lithium-ion batteries, and via the direct sales of material recovered from the batteries. This material, called 'black mass' contains large quantities of lithium, nickel, cobalt, and manganese which can then be extracted and re-used in new battery production.

This offers an environmentally friendly solution for end of life batteries and further addresses concerns which may be raised about the disposal of batteries. It also reduces the impact on the environment of the effects from mining.

The Problem with Hydrogen

Hydrogen is the lightest and most abundant element in the universe.

When hydrogen is combusted with oxygen it forms water. It may be possible therefore to use hydrogen as a low-carbon fuel source. Hydrogen can be combusted directly, or it can be used in a fuel cell to produce electricity.

H2+O2⇨H2O or more accurately 2H2+O2⇨2H2O

Hydrogen Production

Over 95% of the world's hydrogen is produced using the "Steam Methane Reforming" process (SMR). In this reaction, natural gas is reacted with steam at an elevated temperature to produce carbon monoxide and hydrogen. A subsequent reaction — the "Water Gas Shift" reaction (WGS) then reacts additional steam with the carbon monoxide to produce additional hydrogen and carbon dioxide.

The Steam Methane Reforming reaction is:

$$CH_4 + H_2O \Leftrightarrow CO + 3\,H_2$$

The Water Gas Shift (WGS) reaction is:

$$CO + H_2O \Leftrightarrow CO_2 + H_2$$

It seems clear that the secret of producing hydrogen is that it is produced primarily from fossil fuels.

Hydrogen can also be produced by the electrolysis of water, but this is a more costly approach than the SMR route.

10 – See Appendix 8

The Carbon Footprint of Steam Methane Reforming

The carbon footprint of hydrogen production via SMR can be broken down into two parts.

1. Firstly, as indicated by the SMR and WGS reactions, 100% of the carbon in the incoming methane is ultimately converted to CO_2. In the process of producing one molecule of CO_2, four molecules of hydrogen (H_2) are produced with the steam contributing the additional hydrogen. Thus, per 4 units of hydrogen produced from methane, 1 unit of CO_2 will be produced.
2. The second part is the carbon footprint associated with the individual process units [11].

Linde, one of the world's largest producers of hydrogen, has broken down the carbon footprint associated with the individual process steps and have concluded that this converts to 9.3 kilograms (kg) of CO_2 produced per kg of hydrogen production [12]. One kilogram of hydrogen is the energy equivalent of one gallon of gasoline which produces 9.1 kg of CO_2 when combusted. This is the equivalent to 0.28 kg of carbon dioxide emissions associated with one kilowatt-hour of hydrogen production.

Of course, that is just the carbon footprint of hydrogen production. To use the hydrogen for power, it still must be compressed, transported, and either combusted or converted to electricity in a fuel cell. The fuel cells themselves must also be built, and there are carbon emissions associated with those construction processes.

For perspective the Energy Information Administration lists [13] the carbon footprint of electricity production from coal and natural gas as 1.0 kg/kWh and 0.42 kg/kWh respectively, but that is for the actual conversion into power and not just the energy content of the fuel.

It is likely that the conversion of hydrogen into power will have a carbon footprint greater than that of natural gas-fired power, but less than that of coal-fired power.

CCS

However, it is possible in theory to capture the carbon emissions generated in the SMR process and that is where the carbon capture and storage technology is being toted and the Government is putting its Net Zero aspirations in this basket. To power CCS a great deal of Net Zero power is required and that brings us back to the beginning.

For CCS to reduce emissions we need low carbon power and we do not have it.

11 – See Appendix 14

12 – See Appendix 15

13 – See Appendix 16

Conclusion

Our electricity supply chain is not actually broken but battery arrays would make it greener, provide more green electricity capacity and connection to the grid is an essential component to accelerate the supply of battery arrays. Battery arrays will be essential to store unpredictable solar and wind power and to re charge E.V.s. It is also a fact that £8.4 billion spent on battery arrays will not scratch the surface of the longer-term requirement to generate, store and distribute more green electricity.

Yours sincerely,

Chris Rea, CBE, DL, BSc, CEng, HonFIMechE

On behalf of Betterworld.Solutions

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Contributors, who actually provided almost all of the detail: -

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APPENDIX 1

Connections delays reported as construction starts on major UK solar plant

Construction of “Project Fortress”, the UK’s largest solar and battery storage plant is under way in Kent as reported by the Financial Times on 24 April, 2023. This project is forecast to generate enough renewable power each year to meet the needs of about 100,000 UK homes.

However, in the FT article the trade body, Solar Energy UK, echoes the Betterworld Solutions report conclusion that the lack of grid-level battery storage is a major obstacle to progress on renewables.

They say that many projects have been told that they have a 10 to 15 year wait to get a connection, with one given a 2037 deadline. “Securing investment in reinforcing the UK’s electricity networks is priority number one for the solar industry.

“Many larger projects, whether solar farms or mounted on warehouse rooftops, are unable to connect to the grid and waiting times for upgrades can stretch long into the 2030s,” (Solar Energy UK, reported by the FT).

(read full article here)

APPENDIX 2

Octopus CEO says grid is “not fit for purpose”.

Octopus CEO says grid is “not fit for purpose”: At the Times Earth Business Summit CEO of Octopus, Greg Jackson, made comments on how building wind farms may only take 1-year worth of engineering but could lead to 6-7 years to get authorisation to connect to the grid.

In a quote, a National Grid representative said: “National Grid is one of the largest green investors in the FTSE & is investing £15 billion over the next 5 years to deliver the energy transition, which is the surest long-term route to energy affordability, resilience & independence.

“National Grid has to operate within a planning & regulatory framework which prevents investment in anticipation of generators requesting a connection to the grid. This needs urgent reform to allow faster connections to the grid.

“We’re working with the Government & regulator to push this forward at pace.”

Octopus CEO says grid is “not fit for purpose”.

(read full article here)

APPENDIX 3

Ofgem confirms approach to boosting green and smart investment in local grids

Ofgem has confirmed that its proposed 2023 price control for electricity distribution networks will:

- Require DNOs to grow their capacity using 'flexible' solutions where they can, such as battery storage or smoothing peaks in demand, before building expensive new network capacity.

(read full article here)

Ofgem launches review into local energy system operation

Ofgem has launched a review into how the energy system is planned and operated locally to ensure Great Britain is ready for a huge increase in green, more affordable home grown power.

This could result in the creation of new independent bodies separate from network companies to oversee local energy systems across the country.

(read full article here)

APPENDIX 4

Report from Environmental Research Institute

The Swedish IVL (Environmental Research Institute) released a report stating that CO_2 emissions from battery manufacture have been halved in recent years and range from 59 to 119 kg CO_2 per kWh of battery capacity. The higher value is where batteries are manufactured solely with the use of fossil fuels and is a worst-case scenario. Many organisations consider the mean of 89 kg CO_2 per kWh as a realistic value for calculating the CO_2 emissions.

Considering 1.25MWh (1,250 kWh) of battery multiplied by 89 = 111,250 kg CO2 or 112 tonnes.

The annual savings are calculated from a combination of a reduction in grid usage and the mix between day and night-time generation and are typical as the usage and generation may vary with weather conditions.

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	TOTAL
CO2e Footprint (tonnes)	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	112
CO2e Savings (tonnes)	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168	2527
																2415

APPENDIX 5

Update 02.03.2023 – Further evidence

Brits paying hundreds of millions to turn off wind farms as network 'can't cope' with the power

(read full article here)

APPENDIX 6

Update 21.03.2023 – University of Sheffield

Battery energy management strategies for UK firm frequency response services and energy arbitrage

(read full article here)

APPENDIX 7

Update 21.03.2023 - Dynamic Containment

National Grid ESO launches new frequency control service. "… but battery storage is expected to make up the bulk of provision in the early stages".

(read full article here)

APPENDIX 8

EA Approval for Lithium-ion Battery Recycling Plant

Robin Brundle, Chairman of Technology Minerals, says: "Given the global shift towards electrification and the growing demand for Li-ion batteries, we believe we have a compelling first mover advantage in this burgeoning market. Our aim is to establish enduring partnerships with businesses and organisations, both in the UK and internationally, offering them an environmentally friendly solution for their end-of-life batteries.

(read full article here)

APPENDIX 9

From: Solon Mardapittas

Sent: Monday, March 20, 2023 8:09 PM

To: Chris Rea

Subject: [EXT] Our Discussion

Dear Chris,

Good to speak to you, as promised please see a bit more detail on the topics we were discussing. Forgive me, I'm a technical person and I hope that I've managed to explain the 2 big questions raised by you in the call without too much Jargon/going too in depth. Happy to continue dialogue if anything is unclear.

1 – Failure to connect to the grid

ENAs and grid restrictions - We submit over 200 applications for battery schemes behind the meter, for I&C customers a year. In the last 6 months, over 60% of our applications have been returned with either complete rejections or prohibitive costs to connect relatively small assets (500kW to 2MW) – with some costs being seen beyond £10m/MW and/or with timescales for connection between 2028 to 2037. Some recent positive news has now capped this at maximum of £1,720 / KW (or £1,720,000 per MW see: https://www.premierenergy.co.uk/blog/electricity-connection-charges-good-news-from-april-2023/, however, this has not resolved (and may even increase) timescales observed above.

The major restrictions observed are caused by upstream substations not being able to deal with either additional generation, potential fault contribution from Inverter based systems (PV, BESS etc.) and network voltage rises/flickers. On the fault issues, the key here to note is that both PV and batteries use very similar technology to convert DC to AC, and although a batteries output is completely controllable, being able to limit based on setpoint and control export/import, the potential for the system to create a fault onto the network is treated identical as a PV system. In some areas in the country there are embargoes connecting any form of generation and unfortunately for the reasons above, this includes batteries.

2 – Price mechanism – DNO's reducing returns

Due to oversubscription of certain flexibility services (e.g., DM/DC/DFFR) by a mix of providers, the flexibility requirement from DNO's in some cases are being met already and in other cases are saturating, reducing the value of these services. As of the end of 2022, there was 2.1GW of installed battery storage – but one of the key new schemes named Dynamic Containment is approaching saturation as the total required capacity was around 1GW (DC – High and DC – Low together) – meaning one of the key revenues for battery storage has now begun to observe saturation and a fall in value.

Solon Mardapittas

Chief Executive Officer, Powerstar

DC = Dynamic Containment, DFFR is a continuously delivered service used to control the normal second-by-second grid frequency changes. Every storage provider must respond to changes in normal grid frequency by decreasing or increasing their import / export power.

APPENDIX 10

Connected Load (Batteries included) refused in some areas up to 2030.

Case Study 1

Below is the "business case" for a 0.5MW battery array which was installed in 2019.

Cost:	£381,000	
Revenue received:	£22,571	To provide grid services
Avoiding DUOS and BSUOS	£29,692	
Triad Savings from Transmission, i.e., not using energy at peak times.	£17,600	
Total annual revenue received	£69,863	18.33% return

As it is also a UPS this was also a very good financial idea. A UPS alone was quoted at £250K.

DUOS – Distribution Use of System

BSUoS – Balancing Services of system

Case Study 2

The grid could not refuse connection as we had permission but only for connected load which is 30% more than the incoming supply (at any time).

Upgraded battery array to 1.2MW. The payment scheme changed resulting in a price reduction.

Cost:	£1,051,545	
Total declines for next 3 years	£106,000	Return reduces to 10%

2993 Solar Panels energy export **Grid Peak Energy Generating Reduction**	£9,000 £30,000	It is better to store and use than sell to the grid as the payment is pitiful
Total annual revenue received (max)	£136,000	12.93% return

Case Study 3

Second battery to get around the connected load limitation.

Cost:	£702,842

The only benefit is to the planet as we will generate more green energy for our own use. There is no return as we might get between £9,000 and £30,000. The circa £9,000 is the price gained for export to the grid and the circa £30,000 is the avoidance of buying as we have more self-generated capacity that we can store and use at will.

The reason to do this is both the ability to pay without a return, which is quite unusual and the annoyance that we would otherwise have been prevented from generating more green energy.

Summary – the grid refuses connections even of batteries to prevent overload in the grid or it is to prevent them from investing in the grid?

Batteries could give and take energy to reduce peak demand, but the grid is actively seeking to prevent that.

In short, absent Government action, batteries will not become a part of the Climate Change Solution.

There are already peak selling prices for energy. Industrial customers get charged a lot more for peak energy consumption, but none of that principle is applied to peak energy reduction. There is no point in buying energy off-peak for 3 or 4 times more than you can sell it for so there is a missed opportunity to use battery arrays to reduce peak energy demand.

APPENDIX 11

UK Battery Storage Project Database Report - Solar Media

There is “a total pipeline of planned capacity of 57GW” of battery storage.

(read full article here)

APPENDIX 12

https://www.energydashboard.co.uk/live

This is a snapshot of peak energy for a single day and also the Generation Mix.

(read full article here)

APPENDIX 13

March 2023 – 428 pages

HM Government Budget Delivery Plan (for Net Zero) – 192 pages

(read full article here)

Powering up Britain – 30 pages

(read full article here)

Energy Security Plan – 80 pages

(read full article here)

The Net Zero Growth Plan – 126 pages

(read full article here)

The total of 428 pages mentions battery arrays twice.

APPENDIX 14

Estimating The Carbon Footprint Of Hydrogen Production

Forbes.com - Jun 6, 2020,06:00pm EDT

(read full article here)

APPENDIX 15

Hydrogen production

Linde - Making our world more productive

(read full article here)

APPENDIX 16

How much carbon dioxide is produced per kilowatthour of U.S. electricity generation?

EIA - U.S. Energy Information Administration

(read full article here)

APPENDIX 17

Ofgem pledge to tackle "unacceptable delays" in low-carbon connections

The UK energy regulator is promising system reforms to connect more low-carbon projects to the grid, supporting concerns voiced by Betterworld Solutions members and others that renewable energy projects are facing unacceptable delays.

In a speech to the Utility Week Conference in Birmingham the Chief Executive of Ofgem, Jonathan Brearley, told energy bosses that the slow pace of connections to the grid was not compatible with the UK ambitions on cost, security or Net Zero.

"It is the biggest risk to decarbonising the power system by 2035 and it is clear we need to go further and faster to get renewable sources of power onto the grid as quickly as possible" he added.

Among the "unacceptable" consequences of the current system, Jonathan Brearley said that at present some 20% of generation capacity in the transmission queue will have to wait for a further 10 years before they reach their offered connection dates, while 40% of projects have been offered connection dates beyond 2030.

The Ofgem chief executive said that the connection queue was being held up, in some cases, by "zombie projects" that would never get built.

Recently, the trade body Solar Energy UK said that the biggest obstacle facing new solar projects is a lack of capacity in the electricity grid. Many projects have been told that they have a 10 to 15 year wait to get a connection, with one given a 2037 deadline.

This echoes AESSEAL's analysis, published on the Betterworld.Solutions website, based on our own experience, research and interviews with members who have been investing in rooftop solar but are finding that there's a financial disincentive due to lack of grid-level battery storage.

Jonathan Brearley has previously been on record as saying that Ofgem should be "the de facto UK regulator for Net Zero". One of the problems with the UK electricity supply chain is that despite government departments being aligned with the 2008 Climate Change Act, the regulator's remit remains unchanged since its establishment.

This means it does not have an explicit mandate to reduce greenhouse gases, leading it to focus on prices and competition, which has led to short-term considerations getting priority rather than the negative longer-term impacts of climate change.

(read full article here)

APPENDIX 18

How limitless green energy would change the world - BBC Future

Current electricity generation – primarily by fossil fuels – is the single biggest contributor to climate change, responsible for 30% of all greenhouse gas emissions. According to the International Energy Agency (IEA), electricity demand is set to grow by 40-60% in some regions in the next 10 years.

(read full article here)

APPENDIX 19

6 Ways to Remove Carbon Pollution from the Atmosphere - wri.org

CCS cost estimates vary but generally range from around $100 up to more than $600 per metric ton of CO2 removed; voluntary purchases of carbon removal credits from direct air capture range from $225 to more than $1,000 per metric ton of CO2 where data is available.

Direct air capture also requires substantial heat and power inputs: Scrubbing 1 gigaton of carbon dioxide from the air could require nearly 10% of today's total energy consumption. To result in net carbon removal, therefore, direct air capture technology would need to be powered by low or zero-carbon energy sources.

(read full article here)

Is hydrogen really a clean enough fuel to tackle the climate crisis? - The Guardian

Blue hydrogen is what the fossil fuel industry is most invested in, as it still comes from gas but ostensibly the CO2 would be captured and stored underground. The industry claims to have the technology to capture 80-90% of CO2, but in reality, it's closer to 12% when every stage of the energy-intensive process is evaluated, according to a peer-reviewed study by scientists at Cornell University published in 2021. Methane emissions, which warm the planet faster than CO2, would actually be higher than for grey hydrogen because of the additional gas needed to power the carbon capture, and likely upstream leakage. Notably, the term clean hydrogen was coined by the fossil fuel industry a few months after the seminal Cornell study found that blue hydrogen has a substantially larger greenhouse gas footprint than burning gas, coal or diesel oil for heating.

(read full article here)

How green is blue hydrogen? - Wiley Online Library

People want to turn on the lights and keep their refrigerator running whether or not the wind is blowing or the sun is shining. So balancing out the intermittent sources of electricity like wind and solar will be an important piece of building a renewable grid.

Geothermal, hydropower, and nuclear are all weather independent and will likely be part of the solution, but increasingly, it's looking like batteries will be a big piece of accounting for variations in wind and solar. The world will need over forty times more grid storage than what's been installed to date by 2030, according to the IEA.

(read full article here)

APPENDIX 20

How new versions of solar, wind, and batteries could help the grid - MIT Technology Review

The rapid scaling up of energy storage systems will be critical to address the hour-to-hour variability of wind and solar PV electricity generation on the grid, especially as their share of generation increases rapidly in the Net Zero Scenario. Meeting rising flexibility needs while decarbonising electricity generation is a central challenge for the power sector, so all sources of flexibility need to be tapped, including grid reinforcements, demand-side response, grid-scale batteries and pumped-storage hydropower.

(read full article here)

APPENDIX 21

Grid-Scale Storage - IEA

Grid-scale battery storage in particular needs to grow significantly. In the Net Zero Scenario, installed grid-scale battery storage capacity expands 44-fold between 2021 and 2030 to 680GW. Nearly 140GW of capacity is added in 2030 alone, up from 6GW in 2021. To get on track with the Net Zero scenario, annual additions have to pick up significantly, to an average of over 80GW per year over the 2022-2030 period.

(read full article here)

APPENDIX 22

Renewables groups sound alarm over UK grid connection delays - Financial Times

Solar, wind and battery storage developers say 13-year wait threatens investment and Britain's Net Zero goals. Renewable energy and battery storage site developers are warning that a wait of up to 13 years to connect to Britain's energy grid is threatening investment and undermining the shift away from fossil fuels. About 600 projects with combined capacity of 176GW are in the queue in England and Wales, according to National Grid, against 64GW of connected capacity. Some battery, wind and solar projects are being told they have to wait until 2036 for a connection.

(read full article here)

APPENDIX 23

We're close to a new era of renewable power generation - weforum.org

Power generation could soon be approaching "the beginning of the end of the fossil age", according to the fourth annual Global Electricity Review from energy think tank Ember.

(read full article here)

The power of battery storage: Evolution and alternatives - RatedPower

Batteries are already economically viable as replacements for gas or oil-fired peaking plants, which switch on for short periods when demand spikes. The world's largest battery storage installations are reaching 300-400MW capacities — big enough to replace small fossil fuel power plants.

(read full article here)

APPENDIX 24

The batteries that could make fossil fuels obsolete - BBC Future

The advent of "big battery" technology addresses a key challenge for green energy – the intermittency of wind and solar.

(read full article here)

APPENDIX 25

National Grid lays out plans for £54bn upgrade to UK energy network - Financial Times

National Grid has laid out plans for a £54bn upgrade to the UK's electricity network, the biggest investment since the 1960s in real terms, to facilitate a rapid expansion in offshore wind energy. The government wants 50 gigawatts of offshore wind operational by 2030, up from 10GW currently, and the new network would provide capacity for an additional 23GW. At full output this would meet almost two-thirds of current peak electricity demand.

(read full article here)

Chris Rea is the Managing Director of AES Engineering Ltd., a small semi-global business with operations in 40 countries.

Betterworld.Solutions is a philanthropic, best practice sharing organisation that seeks to encourage the Boards of companies worldwide to create an investment policy to prevent global warming. It is based upon the principal that more environmental projects would be funded if the decision makers knew that the opportunity existed.

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